PROCEEDINGS

OF THE

Iowa Academy of Sciences

FOR 1894.

VOLUME II.

PUBLISHED BY THE STATE.

DES MOINES:
F. R. CONAWAY, STATE PRINTER.
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LETTER OF TRANSMITTAL.

Iowa Academy of Sciences,
Des Moines, January 15, 1895.

To His Excellency, Frank D. Jackson, *Governor of the State of Iowa:*

Sir—In accordance with the provisions of chapter 86, Laws the Twenty-fifth General Assembly, I have the honor to transmit to you herewith the proceedings of Iowa Academy of Sciences for 1894, and to remain with great respect,

Your obedient servant,

Herbert Osborn, *Secretary.*

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OFFICERS OF THE ACADEMY.

1894.

President—L. W. Andrews.
First Vice-President—H. W. Norris.
Second Vice-President—Charles R. Keyes.
Secretary-Treasurer—Herbert Osborn.
Librarian—Charles R. Keyes.

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Ex-Officio—L. W. Andrews, H. W. Norris, C. R. Keyes, H. Osborn.
Elective—C. C. Nutting, M. F. Arey, W. S. Hendrixson.

1895.

President—H. W. Norris.
First Vice-President—Charles R. Keyes.
Second Vice-President—T. Proctor Hall.
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WINSLOW, ARTHUR	St. Louis, Missouri

PROCEEDINGS

OF THE

NINTH ANNUAL SESSION

OF THE

IOWA ACADEMY OF SCIENCES.

The ninth annual meeting of the Iowa Academy of Sciences was held in the Y. M. C. A. building at Des Moines, December 27 and 28. The following papers were read in full or by title, and by the action of the Academy were referred to a committee of publication consisting of C. R. Keyes, T. P. Hall and H. F. Bain:

J. E. TODD AND H. FOSTER BAIN—Inter-Lœsial Till near Sioux City.

H. FOSTER BAIN—Preglacial Elevation of Iowa. Mississippian Rocks of Central Iowa.

CHARLES R. KEYES—Secular Decay of Granitic Rocks. Synopsis of American Paleozoic Echinoids. Opinions Concerning the Age of the Sioux Quartzite. Illustrations of Glacial Planing in Iowa.

ARTHUR J. JONES—Record of the Grinnell Deep Boring. Topaz Crystals of Thomas Mountain, Utah.

A. G. LEONARD—Lansing Lead Mines.

F. M. FULTZ—How Old is the Mississippi? Formation of the Flint Beds of the Burlington Limestones. Coincidence of Present and Preglacial Drainage System in Extreme Southeastern Iowa. Extension of the Illinois Lobe of the Great Ice Sheet into Iowa. Glacial Markings in Southeastern Iowa.

S. CALVIN—Maquoketa Shales in Delaware Countv, Iowa.

WILLIAM H. NORTON—Occurrence of *Megalomus Canadensis* (Hall), in the LeClaire Beds at Port Byron, Illinois. Geological Section of Y. M. C. A. Artesian Well at Cedar Rapids, Iowa.

LAUNCELOT W. ANDREWS—President's Address. Recent Advances in the Theory of Solutions.

L. W. ANDREWS AND CARL ENDE—Studies of the Physical Properties of Lithium Chloride in Amyl Alcohol.

C. C. NUTTING—Report of Committee on State Fauna.

W. S. FRANKLIN--New Method of Studying the Magnetic Properties of Iron. Design of Transformers and Alternating Current Motors. Note on a Phenomenon of Diffraction in Sound.

W. S. WINDLE—A Kymograph and Its Use.

A. C. PAGE—Volatility of Mercuric Chloride.

N. E. HANSEN—Notes on Applying Pollen in the Cross-Breeding of Plants.

C. F. CURTISS—Changes that Occur in the Ripening of Indian Corn.

G. E. PATRICK—Methods of Soil Analysis.

D. B. BISBEE—Nitrogen Compounds of the Soil.

W. H. HEILEMAN—Chemical Study of Honey.

A. A. BENNETT—Notes from the Chemical Laboratory, Iowa Agricultural College, 1894.

F. C. STEWART--Effects of Heat on the Germination of Corn and Corn Smut.

C. W. MALLEY—Psyllidæ, found at Ames.

ALICE M. BEACH—Some Bred Parasitic Hymenoptera in the Iowa Agricultural College Collection.

HERBERT OSBORN AND F. ATWOOD SIRRINE—Plant Lice Infesting Grass Roots.

L. H. PAMMEL AND ALICE M. BEACH—Pollination of Cucurbits—by Title.

L. H. PAMMEL—Distribution of Some Weeds in the United States. Diseases of Plants at Ames, 1894—by Title.

EMMA SIRRINE—Structure of the Seed Coats of Polygonaceæ.

BRUCE FINK—Lichens Collected by Dr. C. C. Parry in Wisconsin and Minnesota in 1848.

CASSIE M. BIGELOW—Study of the Glands in Hoptree.

T. PROCTOR HALL—Graphic Representation of the Properties of the Elements.

ARTHUR C. SPENCER—Notes on the Minerals of Webster County.

E. H. LONSDALE—Cement Clays in Iowa. Upper Carboniferous in Southwestern Iowa.

REPORT OF THE SECRETARY-TREASURER.

GENTLEMEN: I am pleased to report excellent progress in the Academy for the year.

An act was passed by the General Assembly providing for independent publication, and in time to secure printing of our last proceedings, thus relieving us of any expense for publication, also providing for necessary illustrations.

Articles of incorporation prepared by the committee were duly filed, and no farther action, I believe, is necessary, though it may be proper to print these articles in the forthcoming volume, with copy of amended constitution.

The membership has increased to 62 fellows, 10 associates, and 18 corresponding members.

I am gratified to report a favorable condition of the treasury, and would suggest that for the coming year authority be given to expend such amounts as may be necessary in binding such sets of proceedings among exchanges in our library as may be incomplete volumes, and in further extension of exchanges and additions to incomplete series.

FINANCIAL STATEMENT.

Receipts	$102.92
Disbursements	39.76
Balance on hand	$ 63.16

Accounts with vouchers and stubs submitted herewith.

Respectfully,

HERBERT OSBORN,
Secretary-Treasurer.

Report received and adopted.

REPORT OF THE LIBRARIAN.

GENTLEMEN; During the past year the library of the Academy of Sciences has been steadily growing. Nearly forty serials of learned societies are now being received regularly. There have been received in addition the current publications of the government bureaus, and several state geological surveys. Forty special reports have been put upon the shelves and over fifty authors' excerpts.

Arrangements have been made whereby the Academy has secured an alcove in the state library for depositing the books belonging to the Academy, so that now a suitable and permanent home is provided for its library.

Respectfully submitted,

CHARLES R. KEYES,
Librarian.

CONSTITUTION OF THE ACADEMY.

SECTION I. This organization shall be known as the Iowa Academy of Sciences.

SECTION II. The object of the Academy shall be the encouragement of scientific work in the state of Iowa.

SECTION III. The membership of the Academy shall consist of (1), Fellows who shall be elected from residents of the state of Iowa actively engaged in scientific work, of (2), Associate members of the state of Iowa interested in the progress of science, but not direct contributors to original research, and (3), Corresponding Fellows to be elected by vote from original workers in science in other states; also, any Fellow removing to another state from this may be classed as a corresponding Fellow. Nomination by the council and assent of three-fourths of the Fellows present at any annual meeting shall be necessary to election.

SECTION IV. An entrance fee of three dollars shall be required of each Fellow, and an annual fee of one dollar, due at each annual meeting after his election. Fellows in arrears for two years, and failing to respond to notification from the secretary-treasurer, shall be dropped from the Academy roll.

SECTION V. (*a*) The officers of the Academy shall be president, two vice-presidents, a secretary-treasurer, to be elected at the annual meeting. Their duties shall be such as ordinarily devolve upon these officers. (*b*) The charter members of the Academy shall constitute the council, together with such other Fellows as may be elected at an annual meeting of the council by it as members thereof, *provided*, that at any such election two or more negative votes shall constitute a rejection of the candidate. (*c*) The council shall have power to nominate Fellows to elect members of the council, fix time and place of meetings, to select papers for publication in the proceedings, and have control of all meetings not provided for in general session. It may, by vote, delegate any or all these powers, except the election of members of the council to an executive committee, consisting of the officers and of three other Fellows, to be elected by the council.

SECTION VI. The Academy shall hold an annual meeting in Des Moines during the week that the State Teachers' Association is in session. Other meetings may be called by the council at times and places deemed advisable.

SECTION VII. All papers presented shall be the result of original investigation, but the council may arrange for public lectures or addresses on scientific subjects.

SECTION VIII. The secretary-treasurer shall each year publish the proceedings of the Academy in pamphlet (octavo) form, giving author's abstract of papers, and, if published elsewhere, a reference to the place and date of publication; also the full text of such papers as may be designated by the council. If published elsewhere the author shall, if practicable, publish in octavo form and deposit separates with the secretary-treasurer, to be permanently preserved for the Academy.

SECTION IX. This constitution may be amended at any annual meeting by assent of a majority of the Fellows voting, and a majority of the council; *provided*, notice of proposed amendment has been sent to all Fellows at least one month previous to the meeting, and provided that absent Fellows may deposit their votes, sealed, with the secretary-treasurer.

The following amendments to the constitution have been proposed:

(1) To make place of meeting same as that of State Teachers' Association.

(2) To make librarian an officer of the Academy.

At a meeting in 1894, the following amendment was proposed, That this Academy shall meet in two sections, viz:

(1) Biological section which shall include such as ethnology, geography, biology, geology.

(2) A physical section, including physics, chemistry, mathematics.

A committee of five, consisting of the president and two members selected by him from each section, to decide upon the publication of papers read before the Academy, which of these shall be published in full in the proceedings, and shall prepare for publication abstracts of the remainder.

To facilitate the work of the committee, each member who contributes a paper shall be required to present with it a tabulated abstract of the same or table of contents.

ARTICLES OF INCORPORATION OF THE IOWA ACADEMY OF SCIENCES.

ARTICLE I.

We the undersigned hereby associate ourselves with the intention to constitute a corporation to be known as the Iowa Academy of Sciences, the purpose of which is to hold periodical meetings for the presentation and discussion of scientific papers, to publish proceedings, to colleet such literature, specimens, records and other property as may serve to advance the interests of the organization, and to transact all such business as may be necessary in the accomplishment of these objects.

ARTICLE II.

The membership of the corporation shall consist of the incorporators, and such other residents of the state of Iowa as may be duly elected Fellows of the Academy.

ARTICLE III.

The duly elected officers of the Academy shall be the officers of the corporation.

ARTICLE IV.

The principal place of business of the Academy shall be the city of Des Moines, in the state of Iowa.

The capital stock of the corporation is none

The par value of its shares is none.

The number of its shares is none.

ARTICLE V.

The Academy shall hold an annual meeting in the last week of December, of each year, or upon call of the executive committee, and such other meetings as may be arranged for.

ARTICLE VI.

This corporation shall have the right to acquire property, real and personal, by purchase, gift, or exchange, and such property shall be held subject to the action of the majority of its Fellows, or the council, the executive committee, or such parties as it may by vote direct to transact such business in accordance with the constitution.

All deeds, leases, contracts, conveyances and agreements, and all releases of mortgages, satisfaction of judgments, and other obligations, shall be signed by the president or vice-president and the secretary, and the signatures of these officers shall be conclusive evidence that the execution of the instrument was by authority of the corporation.

ARTICLE VII.

The private property of the members of this corporation shall not be liable for any of its debts or obligations.

ARTICLE VIII.

By-laws, rules and regulations not inconsistent with these articles, may be enacted by the Academy.

ARTICLE IX.

These articles may be amended at any meeting of the Academy called for the purpose by assenting vote of two-thirds of the members present.

ADDRESS OF THE RETIRING PRESIDENT.

RECENT ADVANCES IN THE THEORY OF SOLUTIONS.

BY LAUNCELOT W. ANDREWS.

Ten years ago nothing was known of the molecular magnitudes of substances which could not be converted into the gaseous condition Concerning the constitution of the much greater number of compounds that exist only as solids or liquids, our ignorance was complete.

Within the period named, a host of investigators, among whom the names of Raoult, Van't Hoff, Nernst, Arrhenius, and Ostwald are the most distinguished, have devoted themselves to studies of the liquid state, and their labors have poured a flood of light into the darkness.

The researches of Raoult may be looked upon as forming the basis of the new movement.

Any study of the liquid state must in the first instance concern itself with the phenomena which limit this state, namely, freezing on the one hand and boiling on the other. It had long been known that, in general, the presence of foreign matter in solution depresses the freezing point of a liquid, and raises its boiling point. Coppet had already paved the way for the quantitative study of the first of these phenomena which Raoult (1886–1888) carried on with great experimental skill and extended to the second.

This investigator, unguided and unbiased by any theory, established the interesting and important fact that the depression of the freezing point of a solvent resulting from the addition of small quantities of a second substance is directly proportional to the number of molecules of the material added, being independent of the kind or weight of these molecules, and that the elevation of boiling point followed the same law. In other words: *first*, the depression of the freezing temperature of a solvent is directly proportional to the amount, and inversely proportional to the molecular weight of the substance dissolved; *second*, the elevation of the boiling point of a solvent is directly proportional to the amount, and inversely proportional to the molecular weight of the substance dissolved. An important apparent exception to these laws which will be considered later, was found in the case of those substances which are good conductors of the electric current, that is, of electrolytes. The laws were further found to be limited in their application to dilute solutions.

Important as this principle was in furnishing a method for the determination of molecular weight of those compounds, such as the sugars, which can not be converted into vapor, its purely empirical character, and the important apparent exception above stated, prevented for a time its receiving the consideration and acknowledgement which were intrinsically due to it.

It could not meet general acceptance, or be received with confidence until deprived of its empirical character by a general theory connecting the phenomena in question with other known facts, and until its seeming exceptions met a satisfactory explanation.

In due time Van't Hoff enunciated the theory and Arrhenius furnished the explanation.

Raoult's first law may be expressed by the equation

$$\underbrace{m = K \mid a}$$

in which m = the molecular weight of the substance dissolved, a = the *specific depression*, that is the lowering of the freezing temperature due to dissolving one gram of substance in one hundred grams of solvent. K = a constant dependent upon the nature of the solvent only.

Raoult's second law may be expressed by the following similar equation :

$$m = k \mid E,$$

in which E is the *specific elevation*, or elevation of boiling temperature due to dissolving one gram of substance in one hundred grams of solvent.

Now, Van't Hoff, by means of an imaginary cycle of operations, conceived in analogy with Carnot's famous cycle to which the science of thermodynamics owes so much, showed that the constant, K; of Raoult's formula must be a function of the temperature and of the heat of fusion of the solvent, of the form

$$K = \frac{2\,T^2}{100\,L}$$

in which T = the absolute temperature, L = the heat of fusion of the solvent.

For Raoult's second law a similar dependence of the constant upon the temperature and the heat of vaporization was established. To Van't Hoff belongs, therefore, the signal service of bringing the empirical laws of Coppet and Raoult into close connection with the general principles of thermodynamics, from which they are derived as necessary consequences.

This important step greatly stimulated research. Many investigators began to till the field upon which the sod had been so successfully turned; new and convenient methods were devised for the accurate determination of melting and boiling points. In fact, a new technique was developed. An incidental result of this activity is that mercurial thermometers capable of reading to $\frac{1}{5000}$ of a degree centigrade have become articles of commerce. The only compounds whose molecular weights can not be determined by the new methods are the very few which resist solution in all solvents.

It is interesting to note that the numerous molecular weight determinations thus made show that the great majority of substances have the same molecular weights in the liquid as in the gaseous form, but few being more complex, and that most substances not capable of vaporization without decomposition possess, in fact, when in solution, the relatively simple constitution which had previously been assigned to them on insufficient chemical grounds alone. Among the many other valuable results attained may be mentioned the conclusion that the permanganates are salts of the simple acid $H\,Mn\,O_4$ and not of the more complex molecule $H_2\,Mn_2\,O_8$ and that chromic acid exists in solution as dichromic acid $H_2\,Cr_2\,O_7$. The further conclusion, that most of the true metallic elements resemble mercury in that they consist of monatomic molecules, and differ in this respect from the non-metallic elements whose molecules are complex, has recently been confirmed, in several cases, by vapor density and other independent determinations. The most important theoretical development due to Van't Hoff is the close analogy shown by him to exist between a gas, on the one hand, and a solution on the other. We may summarize the points of analogy as follows:

a. A gas fills uniformly the space to which it is confined. A dissolved substance fills uniformly the space (that is the solvent) to which it is confined. The main difference is that the distribution takes place much more slowly in the second case than in the first.

b. A gas exerts a uniform pressure upon limiting surfaces. A solution exerts a uniform *osmotic* pressure. In both cases we have, at a constant temperature, an analogous relation; for the gas, pressure x volume = a constant, and for the solution, *osmotic* pressure x volume = a constant.

c. All gases contain the same number of molecules in the same space at the same temperature and pressure (Avogadro's Law). *All solutions of substances in a given solvent contain the same number of molecules of the dissolved substance in the same space at the same temperature and osmotic pressure* (Van't Hoff's Law). Further, to put the analogy in its most general form, the pressure exerted by a given amount of substance in the state of a gas throughout a given volume is identical with the *osmotic* pressure which the same amount of that substance would exert, or the same number of molecules of any other compound, if dissolved in the given volume of any solvent.

It is to be noted that, as the familiar "Laws" of Boyle and Charles are not valid for high states of condensation of the gases, (in full analogy), the corresponding laws for liquids are only valid for relatively dilute solutions.

The analogy referred to between the gaseous and liquid states is, in a word, not merely a superficial one, useful only for purposes of illustration, but is of such a profound and far-reaching character that all known laws affecting the gases may be directly applied, *mutatis mutandis*, to the liquid state.

From this analogy the laws of Raoult may be derived, the reasoning differing only in form from that previously referred to. Aqueous solutions of salts, acids and bases, in general, all electrolytic solutions constitute an apparent exception to these laws, inasmuch as the indicated molecular weight is much less than that calculated from the ordinary chemical formulæ. Therefore we must conclude, either that the laws of Raoult are not universally valid and that the theory of Van't Hoff is incomplete, or else that, in the case of electrolytic solutions, the ordinary chemical molecules are split up into two or more parts. The latter hypothesis is that adopted by Arrhenius and defended and adopted with such fruitful results under the name of the Electrolytic Dissociation Theory by its author, together with Nernst and Ostwald.

The main features of the theory may be stated as follows: It assumes that when a salt, such as sodium chloride, is dissolved in water, a certain number of the salt molecules separate into, primarily, two simple parts or ions, in this case sodium and chlorine, charged respectively with positive and negative electricity. These ions are to be thought of as playing the part of new atoms or radicals for the time being, capable of independent motion throughout the solution. This separation or dissociation of molecules into ions is going on continuously and is accompanied by a continuous re-association of ions into molecules. These opposite actions must, when the conditions are constant, ultimately balance one another, the number of molecules dissociated in the unit of time, becoming exactly equal to the number reproduced in the same period from the ions; as in a region of constant population the number of deaths must equal the number of births.

In the solution, this state of equilibrium is reached very rapidly, in fact, as we measure time, instantaneously.

If, in such a solution we plunge a pair of positive and negative electrodes, the previously existing equilibrium will be disturbed, for the negative ions will be attracted to the positive electrode, while the positive ions travel to the negative electrode. As each ion carries its electric charge and deposits it upon the electrode, we have the phenomenon of an electric current passing through the solution. As the ions are thus removed from the solution their place is supplied by fresh dissociation of molecules. It is important to bear in mind that Arrhenius' Theory affords a simple and rational explanation of the fact that those solutions of compounds, which, by methods based on Raoult's law, give results for the molecular weight of the substance dissolved that are below normal, are all capable of electrolysis.

It may be of interest to follow out some of the consequences of the theory and compare them with observed facts. Since both the conductivity of the solution and its departure from Raoult's law are due to the presence of ions, that is to the dissociation of molecules, we might infer that on comparing two salts, one of which gives an aqueous solution of high conductivity and the other low, the latter would nearly conform to Raoult's law, the former not. This is in fact the case. For example, mercuric chloride gives, in water, a freezing point depression nearly corresponding to its normal molecular weight, and the solution is a very poor conductor, while sodium chloride gives a depression corresponding to nearly half its normal molecular weight, showing a nearly complete dissociation into ions, and the solution is of high electric conductivity.

The conception of an aqueous solution of such a substance as common salt, which presents it to the mind as consisting of separated atoms of sodium and chlorine freely moving about in the water, is so contrary to preconceived notions upon which we were brought up that it is at first difficult to grasp. It must be remembered, however, that the ions, sodium and chlorine, are totally different things from the elements of the same name. The ions are atoms highly charged with electricity, which they lose as soon as they unite, to form molecules or separate in the elemental state.

Moreover the ions, although free, are not independent. It is impossible, for example, to remove, as by diffusion or otherwise, from a solution any number of positive ions without removing a corresponding number of negative ions, because of the attraction due to the powerful opposite charges. The new theory explains clearly many things which were incomprehensible on the old theory of electrolysis. According to the old view, the electric current decomposed the electrolyte. Now, to do this, a certain assignable electro-motive force must be supposed to be necessary. To break any stated bond some definite force must be applied. But, in point of fact, the feeblest electro-motive force will send a current through any electrolyte, and therefore will separate its constituents. There is no critical electro-motive force which must be applied to cause decomposition. The new theory assumes that the electric current does not cause any decomposition at all, but simply moves through space the ions which had already been separated by the act of solution, and to do this the lowest assignable E. M. F. must suffice.

The ratio of the conductivity of a solution to its concentration increases with increasing dilution in such fashion so as to approach a maximum value for infinite dilution. This change in conductivity is a consequence of the fact that the degree of dissociation increases with increasing dilution, so that in the most highly dilute solutions, practically all the molecules of the dissolved substance are in the dissociated condition. The assumption is made that all ordinary chemical reactions occurring with inconceivable rapidity in solutions are in reality reactions between ions and not between molecules, the latter requiring an appreciable time for reaction. Thus, a solution of sodium chloride gives an immediate precipitate of silver chloride when treated with silver nitrate, whereas, under the same conditions, chloroform, in spite of its much larger percentage of chlorine, gives no reaction; the reason being that the sodium chloride is dissociated and contains chlorine ions, while the chloroform is not dissociated, and therefore contains none. We have, therefore, for the first time, an adequate explanation of the familiar fact that the usual reactions of an element are not manifested by *all* the compounds containing that element.

It would be aside from the purpose of the present paper to discuss in detail the electrolytic dissociation theory. My object has been simply to sketch in the briefest way one of the most recent developments of chemical thought and probably the most important, historically, of the last half of the nineteenth century.

Is there any question as to what reception should be accorded to the new view?

To say of any doctrine or theory, old or new, "It is true," is to assume for human intellect a finality of judgment which it can never possess. To ask, "Is it fruitful?" is the only legitimate question, upon the answer to which every scientific hypothesis must stand or fall. A doctrine that makes possible a more comprehensive grasp of phenomena already known, and serves as a trusty guide to the investigator in the discovery of new facts, does all that any theory can do. It becomes the genuinely scientific man, then, to accept the services of the latest theory so long as it *is* serviceable, much as he would accept the aid of a beast of burden to carry him across a ford, not carpingly or with irrelevant questions as to pedigree or absolute truth, nor with a demand for everlasting life, but gratefully, demanding only that it should have strength to reach the other shore.

INTERLOESSIAL TILL NEAR SIOUX CITY, IOWA.

BY J. E. TODD AND H. FOSTER BAIN.

Till and loess are well known deposits and need not be defined. It is a peculiar and anomalous relation between the two which it is proposed to describe in this paper. It is well known that the till almost universally occupies a position below the loess wherever the two are found in the same section. A few cases only have been noted where the reverse is true. Such an instance was described by McGee and Call* in an account of the loess near Des Moines. Similar occurrences have been reported by other observers from central and eastern Iowa. These may all be readily explained by an advance of the ice sheet over the loess already deposited around its margin.

The senior author of this paper has, during several years of observation, noted only three or four instances which could by any use of language be mentioned as illustrations of the subject; of these the one illustrated in the plate 1 is the only clear case.

The first instance of interloessial till noted was in 1889 at Riverside Park, near Sioux City. This may still be seen in a gravel pit facing the Big Sioux river near its mouth. The notes taken at that time are as follows:

4. Loess, thickening back from bluff — to 100 feet or more; above a few fresh water shells, including *Lymnea* and *Cyclas;* below one or two specimens of *Helix hirsuta.*

3. Till, brownish; with northern pebbles; disappearing a few rods farther north; containing fine sand blending with the loess.

2. Compact, whitish, silt-like loess, containing *Succinea* similar to shells still living on the bluff above. The upper portion containing carbonaceous streaks and marks, suggesting marsh grass.

1. Gravel, coarse; obliquely stratified, with occasional northern boulders.

The most probable explanation of this occurrence seemed to be that number 1 marks a stage when the river was larger and

*Am. Jour. Sci., (3), XXIV, 202-223, 1882.

flowed at a level probably twenty feet higher than at present. Number 2 is probably a silt capping which originated in a manner analogous to that of ordinary bottom land. The Succinas were probably introduced accidentally, as similar shells may now be found at the base of the bluffs. Number 3 seems to be a slide or wash of till from a higher original level farther back. The drift clays lie thirty or forty feet higher a few rods away. Number 4 is probably the body of a terrace similar to that found south of Sioux City. It is true its upper surface is more eroded near Riverside, and not clearly distinct from the older loess farther north, but the hill-tops of loess do not rise as high as farther north and east.

Somewhat similar deposits occur at Kansas City. Near the foot of Lydia street, under many feet of loess are irregular sheets and strips of limestone fragments, northern pebbles, granite, red quartzite and other rocks. These have a slight intermixture of clay, interstratified with layers of loess. The top of the exposure of the pebble beds is about sixty feet above the Missouri river near by. It is clearly in the base of a high terrace covered with loess. The explanation suggested for the Riverside section is quite confidently applied here with the modification that the wash is not so clearly till, and the under layers of loess are not so regularly deposited.

The best and clearest example of interloessial till is that discovered and examined by both the authors within the past field season, near Sioux City. North and east of Riverside Park there are a number of openings from which sand and gravel has been taken. These usually expose in regular order, loess, brown clay, a thin gravel bed and sand. In one of them, however, a bed of till was found interstratified with the loess. This exposure is about one mile northeast of the Brugier bridge, over the Big Sioux river, and is about 150 feet above that stream. It is as high as any drift exposure in the vicinity. The till is typical boulder clay, consisting of dark brown clay, through which is disseminated pebbles and boulders of northern rocks, such as are found lying at lower levels in the drift of the vicinity. Among the rocks identified is the Sioux quartzite, which is indicated by a hammer at the left of the plate. The bed of till is of variable thickness, being a little over six feet at the left of the pit and tapering from that toward the right to a feather edge. While the whole width of the bed is not exposed the outline seen seems to indicate a lense-shaped body, quite thin relative to its ærial dimensions. The loess is well exposed, both above and below the till bed, and is in each case of a character indistinguishable from that so frequently seen in the city street cuttings and other excavations. The surface above shows the usual flowing lines which so well characterize the topography of a loess covered land.

The intermixture of till and loess seen at this locality cannot be explained by the theories mentioned in the other cases. The till found here is many feet above any known drift found in the vicinity, and is well up in the loess. The most rational theory seems to be that, while the loess was being deposited, a mass of floating ice laden with debris from the adjacent ice sheet, stranded and gradually unloaded its burden or upset as it was floating and dumped into the water the material carried.

Such an explanation for certain tile deposits has been suggested, but there seems hitherto to have been no such clear case observed.

It remains to consider the bearing of this fact upon some general problems concerning the drift. The relation of these deposits to the outer or Altamont moraine is of interest. This moraine, as it has been traced, presents a gap about nine miles wide, in the northern part of Clay county, S. D., about thirty miles northwest. It is also known that through this gap an ice tongue nearly that breadth (nine miles) extended down the valley occupied by the Vermillion river on the west and Brush creek on the east. This came within, perhaps, twenty miles of the typical exposure just described. The next gap of the moriane north of the one just described, is where the Big Sioux comes through, south of Canton, near Fairview. The drift in western Plymouth county, Iowa, near which the exposure described is situated, is thin and patchy, being usually not over fifteen feet in thickness. That the region has not been covered by the heavy land ice would seem to be indicated, not only by this, but also by the general presence of beds of fine sand and clay under the drift, and showing no signs of disturbance.

The deposition of till in the loess indicates their contemporaneous origin, and therefore throws light upon the age of both. It indicates that some of the till outside the moraine is as late as the loess, and argues strongly in favor of all being not long antecedent and of probable similar origin.

INTERLOESSIAL TILL NEAR SIOUX CITY.

The similarity of the higher exposure and the one near the river indicates the probable common origin of both. If this be so it indicates that the trough of the Missouri was excavated much as now, and yet that the water surmounted the Cretaceous bluffs with sufficient depth to float small icebergs. This conception will also explain why the boulder clay is so thin over the uplands; also, why it should be distributed so far down the Missouri, while it is so thin near the moraine.

Such a thickness of the drift as is found in southwestern Iowa and northern Missouri could seem, perhaps, to have been derived in a similar manner from the Des Moines ice lobe.

PREGLACIAL ELEVATION OF IOWA.

BY H. FOSTER BAIN.

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The long period intervening between the deposit of the Cretaceous rocks of Iowa and the advent of the glaciers has left in this state no record in deposits. Its history must be gathered entirely from the land forms then created, and from inferences drawn from orographic changes known to have taken place in other regions.

Over the greater portion of Iowa the land surface of post-Cretaceous time is now covered by a thick mantle of drift. It is only in the northeastern corner of the state that it is exposed, and it is in this region mainly that the history of the period has been read. It is, however, possible to find in other portions of the state much which confirms the results obtained from a study of the driftless region.

Throughout Iowa the records of well borings show the presence of numerous buried drainage channels, some of which can be traced with a measurable degree of accuracy for a considerable distance. In the course of recent detailed work in connection with the Geological Survey a number of these have been noted. One of the best examples is what may perhaps be called the Washington Channel, as it has been studied most in that county.

In 1888, Calvin* first called attention to this channel in discussing the deep well put down at Washington. This old valley has at this point been cut down 350 feet below the present surface, or to 419 feet above sea level. It has been cut almost entirely through the Kinderhook; and the base is 285 feet below the nearest outcrops of rock (Augusta) on Crooked creek, or 324 feet below the higher rock surface underlying the prairies near Keota. At Washington there is no definite evidence bearing on its width.

In the northwestern corner of the county evidence of a similar erosion is seen. In passing up English river the sharp bluffs of indurated rocks abruptly disappear. The bottom land expands on the south to a width of a mile and half or more. It is bordered by gently rounded hills of drift rising sixty to seventy feet above the river, or to an elevation of about 800 feet. This bottom land extends some six miles, when the hills close in on the river, and within a short distance a rock outcrop is found. A number of wells have been bored on the top of these drift hills, some being carried 100 feet or more below the level of the river, and yet in no case has the underlying rock been encountered.

In the southeastern portion of the county, near the great bend in Crooked Creek, similar relations obtain. There is the same marked absence of rock outcrops, the same soft drift topography, and the numerous deep wells, drawing their supply of water from deeply buried gravel beds.

In the region near Deep River, in Poweshiek county, the limestone surface is usually encountered about 200 feet below the general level of the drift upland, and yet one boring was carried to a depth of 450 feet, or to within about 460 feet of sea level, before encountering rock. There is thus evidence in this region of a broad and deep channel lying at a level of between 300 and 400 feet below the present surface, and running in a northwest - southeast direction.

Towards the southeast the evidence of such buried channels becomes more and more abundant. In Des Moines county, near Kossuth, a channel has been found, the base of which lies 342 feet below the present surface, or 274 feet above tide. A short distance west of Sperry two wells have been driven 360 feet to rock, while neighboring wells encountered the limestone at from

*Am. Geol., I, 28-31. Minneapolis, 1888.

40 to 50 feet. One of the most interesting of these buried channels has recently been described by Gordon,* and the figures given by him bring out in startling contrast the size and volume of this ancient river as compared with its present insignificant successor, the Mississippi.

At Bloomfield and Belknap, in Davis county, traces of a similar channel have been encountered, and in Appanoose such channels are by no means uncommon. At Des Moines there lies between Capitol Hill and the sand ridge upon which the fair grounds are located a broad, level plain, having an elevation of about 800 feet. It stands in marked contrast to the high hills both west and east of it. McGee and Call,† in discussing the loess and associated deposits of this region considered the current opinion that this represented an abandoned channel of the Des Moines river erroneous, and referred its origin to glacial agencies. Since their studies were carried on the work of the numerous mines along its edge, including the Giant, Garver, Standard and others, have conclusively shown that this is a filled channel, and that the bed rock here lies at least 90 feet below the present water level of the Des Moines river, or 120 feet below the surface of neighboring outcrops. Similar channels have been encountered in all portions of the state.

A comparison of the facts show quite conclusively that in preglacial time the land surface of Iowa stood at an elevation considerably above that now obtaining. This is well in accord with results obtained from studies in the driftless area and on the Missouri and Mississippi rivers. In the recent borings for locating the piers of the Pacific Short Line bridge at Sioux City, it was found that the Missouri river channel had been at that point filled in some eighty feet with loose sand and gravel above the hard shale of the Cretaceous. The river is also known to have filled in its channel to an average depth of from 70 to 100 feet between Sioux City and Kansas City. The Mississippi River Commission reported in 1881 that river to have also filled in its channel 100 feet or more with sand and gravel, along the eastern boundary of Iowa, the water now only reaching the rock at two points; the LeClaire and the Keokuk rapids. Throughout the driftless area there is evidence that the region, after being reduced to a base level of erosion, has been elevated and is now being reduced to a second base level,

*Iowa Geol. Sur., vol. III, 237-255, 1895.

†Am. Jour. Sci., (3), XXIV, 202-223, New Haven, 1882.

the inter-stream divides alone remaining to outline the former plain.

At the opening of Cretaceous times the greater portion of Iowa was a land surface. The open sea lay to the west and the drainage was in that direction. As the sea line crept farther inland successive portions of the country were submerged, and at the same time the unsubmerged portion was exposed to erosive agencies. At the close of this period about one-half of the state was probably covered by the newly deposited beds and the remainder was reduced to a monotonous plain barely above sea level. It is known that at that time a very large portion of the United States had been similarly* reduced to a penneplane.

The close of the Cretaceous was everywhere marked by orographic changes. It was a time of elevation and of re-arrangement. The changes which took place in the Rocky mountains at that time had a most important influence upon Iowa, and indeed the whole upper Mississippi valley. The elevation produced a corresponding, though much smaller elevation over the great plains. Upham† estimates this in northwestern Minnesota and westward at from 5,000 to 10,000 feet, decreasing towards the east. This had the effect, as pointed out by Westgate‡, of turning the direction of drainage over this region from the west or southwest to the southeast, and of setting in motion the influences which first blocked out our present drainage system.

During the whole of Tertiary times Iowa was probably a land surface.

Whether the buried channels here described had their origin in the general Tertiary erosion period, or whether they were formed during the second period of base-leveling differentiated by Upham§ at the close of the Tertiary and during early Pleistocene times, cannot now be definitely stated. The width and depth of these channels, so far as they are known, bear out the conclusion reached by Chamberlin and Salisbury and by McGee in studies of the driftless region that the period of erosion was a long one, and may possibly be taken as confirmatory of the belief that the two periods of base-leveling are not here so distinct as elsewhere.

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*Woodworth: Am. Geol , XIV, 209-235. Minneapolis, 1894.

†Am. Geol., XIV, 238. Minneapolis. 1894.

‡Am. Geol., XI, 257. Minneapolis, 1893.

§Op. cit., p. 238.

 PSEUDO-STRATIFICATION IN MASSIVE ERUPTIVE GRANITE. WOODSTOCK. PLATE II.

SECULAR DECAY OF GRANITIC ROCKS.

BY CHARLES ROLLIN KEYES.

The surface of Iowa, and of the neighboring states north and east as well, is strewn with boulders of granite, diabase, porphyry, and other igneous rocks in various stages of decomposition, and of all sizes, from a few inches to 50 feet or more in diameter. These are all more or less rounded or subspherical, though often flattened. They have all been transported by ice from the north. When traced back to their original ledges the latter are usually found to be very smooth and fresh, with practically no indications of decay.

Beyond the glacial boundary southward, and in other parts of the world when undisturbed, massive crystalline rocks similar to those just mentioned are found disintegrated for many feet, frequently as much as 100. It is to some of the phenomena connected with the decay of granitic rocks beyond the drift area that the attention is now called.

On a former occasion* reference was made to phenomena illustrating this subject which were shown with remarkable clearness at Woodstock and Sykesville, on the Potapsco river, in Maryland, a few miles west of Baltimore. It was stated that in the quarries near the former place jointing was conspicuously presented, and that the horizontal divisional planes are particularly prominent, at first glance give the impression of true stratification. These principal joints extended for considerable distances. They were crossed by numerous inclined and vertical planes of natural cleavage, which were usually much less prominent than the major lines just alluded to.

There is another place, and one very much nearer home, in which the same phenomena are shown to even greater advantage. This is in the Iron Mountain region of southeastern Missouri. Reference has been made of them identically by Spencer,

*Proc. Iowa Acad. Sci., Vol. I, pt. iii. pp. 22-24. Des Moines, 1893.

Haworth, Winslow, and one or two others, but they have not received the attention they deserve, since they are nowhere surpassed as examples of certain phases of secular decay of massive rocks. The best locality known is at Granitville, a few miles southwest of Iron Mountain.

The early references to the crystalline rocks of this region allude to a peculiar though imperfect bedding observable in the different exposures; and it is probably this fact more than any other that leads to the general belief that most of the rocks were highly metamorphosed sedimentaries. This imperfectly developed stratification, which is apparent in the granites and porphyries, and in other regions in other massive crystallines also, arises in two ways. In the first place, the Missouri massive rocks are thought to be, in part at least, ancient effusives or volcanics. They are presumably great masses of lava which have been poured out upon an old land surface, or perhaps built up in shallow waters. Almost every exposure throughout the region reveals the presence of seams which impart to the rock a rude stratified appearance. Planes of this kind are widely known in volcanic rocks, and in almost all massive formations which have cooled from the molten state. In the case of effusive masses a decided lamination is frequently produced by successive flows which follow one after another at sufficiently long intervals to admit of a cooling and a partial solidification to take place at the surface of the different outpourings. Planes of separation are also commonly formed through contraction in cooling. Volcanic rocks also show a slight difference in chemical and mineralogical composition in different parts, which gives rise to a banding. When cooling takes place the difference in composition gives rise to divisional planes more or less parallel with one another, and also parallel with the surface.

The second way in which the pseudo-stratification planes have developed in the massive rocks is through crustal movements. Elevation of large areas as the result of orogenic pressure produces great stress, which must be relieved. Folding, faulting, and slaty cleavage are the results when the pressure is very great; only jointing and false stratification arises when the strains are small. The effects are very different with different rock masses. If the body of the rock is hard and brittle, as in the case of quartzites—the Sioux quartzite of northwestern Iowa is a good example—the blocks are small, often scarcely a foot each way. If the rock is granite, diabase or

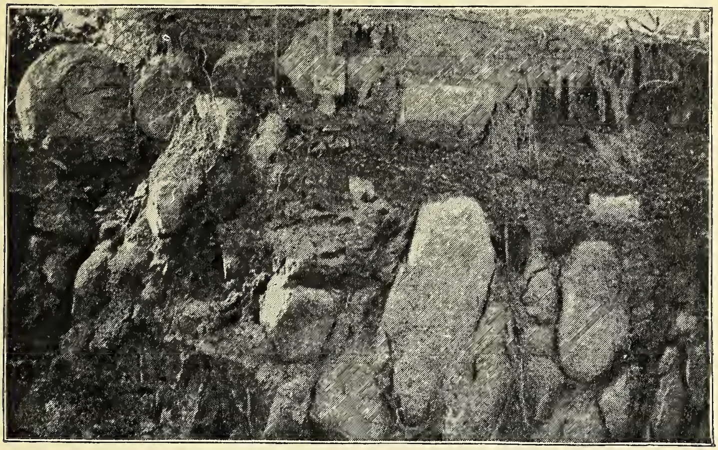

FIG. 1. DISINTEGRATION OF GRANITE MASSES.
IRON COUNTY, MO.

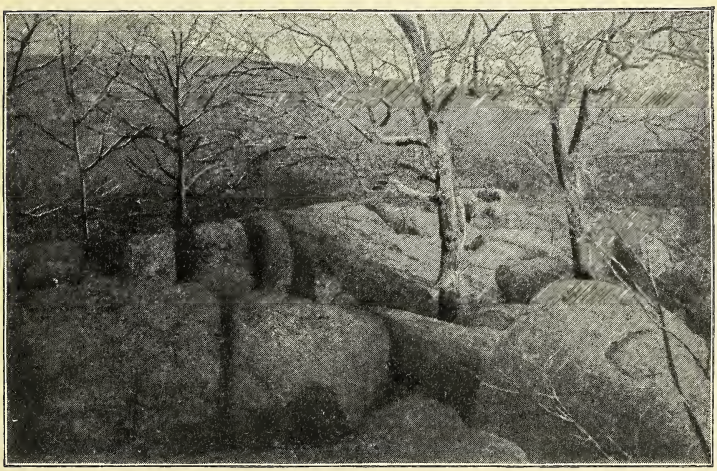

FIG. 2. DECAY OF GRANITE ALONG JOINTING PLANES.
IRON COUNTY, MO.

other tough stone, the blocks may be exceedingly large, sometimes several hundred yards intervening between the different joint planes. Orogenic stresses may sometimes assist strains produced by contraction in cooling, and they operate largely in a single direction, most frequently horizontally, thus giving a well defined bedded aspect to the rock masses. The stratification ascribed to some crystallines may, therefore, be regarded as secondarily acquired, and not as a primary condition obscured through metamorphic action.

Jointing and the development of pseudo-stratification lines may be regarded as the first stages in the process of dissolution. (Plate ii.) In the regions farther north, within the limits of the glacial boundary, where granite or other hard massive rocks occur, the surface presents, as already stated, a remarkable fresh appearance, all the effects of decay being strikingly absent. In comparatively recent times, geologically speaking, the glaciers removed all the loose material over which they passed, and the boulders from the old ledges in the far north now lie strewn over the surface of the country to the southward so far, approximately, as the Missouri and Ohio rivers. Beyond the line thus marked out ice invasions have not effected the rocks, which have long been decaying without serious interruption. In the crystalline area of Missouri all of the various stages of disintegation are well shown from the solid uneffected mass to the incoherent granitic sand.

In addition to the horizontal divisional seams there are certain vertical ones nearly as prominent. They pass from granite to porphyry and other kinds of rock without regard to mass. As stated in the case of the horizontal planes of natural cleavage, the origin of the joints is due in part to contraction of the igneous masses during the original cooling, and in part to subjection to severe torsion. The latter force is in all probability in action at the present time; for as will be shown in another place, crustal movements have taken place in very recent times and probably continue to the present. That systematic jointing may actually arise from strains of this kind, has been satisfactorily proven experimentally by Daubrée*, and appears to find full confirmation in other extensive trials, as well as in the field. The most prominent jointing planes present a remarkable uniformity of direction. The results of a large

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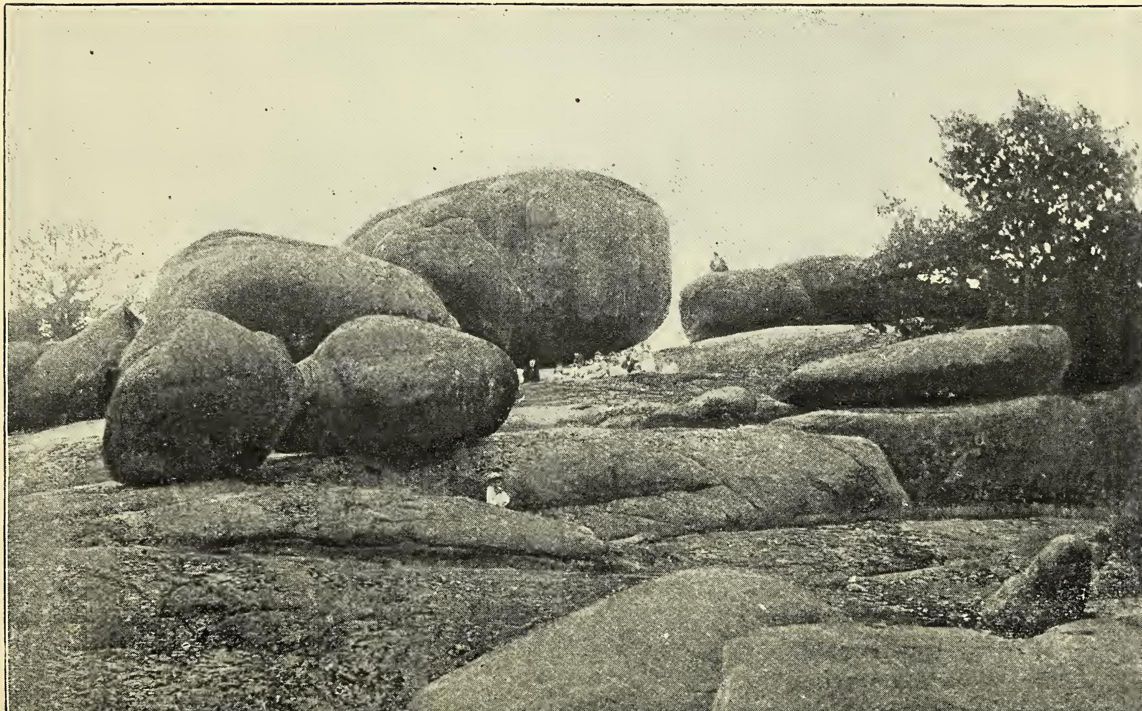
*Etudes syn. de geol. Exper., p. 300. Paris, 1879.

number of observations taken in different places, and by different persons, show, according to Haworth, that they have very slight variations in direction, the planes trending north 60 degrees east. Only in a few cases were the deviations very marked. The various quarries, of course, exhibit the jointing phenomena best, though it is also well shown along the bluffs bordering the streams.

A third series of prominent vertical seams have been made out by Dr. E. Haworth, who has been engaged upon a petrographical study of the rocks of this region, which makes angles of about 80 and 100 degrees with those just mentioned. In some cases joint planes, very much less pronounced than any of the others, have been observed cutting the rock masses into rhomboidal blocks, though these are only locally developed.

With the rock mass subdivided into more or less rectangular blocks of varying size, access of metoric waters is readily permitted and the seams become wider as the blocks begin to break down. The edges being attacked from two directions succumb more rapidly than the sides, and the corners effected on three sides break down still more rapidly. As a result there is eventually formed a more or less spherical mass from each block. These rounded masses or boulders are commonly separated from one another by greater or less thicknesses of granitic sand. (See figure 1, plate iii.)

If undisturbed the process may go on for a depth of many feet, even a hundred or more, as is shown in many localities. A vertical section through a place thus decaying, as is sometimes shown in a quarry, imparts to the ledge an appearance of a great wall of cyclopean masonry. Layer after layer of huge, rounded blocks, rising one above another, with the regularity and precision of human efforts. The interior of the boulders in each case may be perfectly fresh and well adapted for building purposes. As the process of decomposition progresses the amount of interstitial sand gradually increases and the rounded blocks become proportionately smaller. If at these stages running water passes over the region, the blocks with rounded edges, stand out prominently as the sands around them are washed away, giving a striking tesselated appearance to the surface, or a characteristic roches moutonées appearance is imparted. (Figure 2, plate iii.) If the sand is washed away at a later stage the boulders of all sizes are uncovered completely and stand out on the less decomposed ledges beneath. Some of



"ELEPHANT ROCKS." GRANITE BOULDERS OF DISINTEGRATION. GRANITEVILLE.

these exhumed boulders, as they occur at Graniteville, in Iron county, where they are known as "elephant rocks," are shown in plate iv.

The final stage of disintegration is the bed of sand with occasional decomposed pebbles of the original rock scattered through it. In the decomposition of granite the texture may remain in appearance as in the original rock, but upon excavation is found to be soft, incoherent sand.

RECORD OF THE GRINNELL DEEP BORING.

BY ARTHUR J. JONES.

Work was begun on the deep well in October, 1892, but it was not completed until the following year. The ordinary churn drill was used and the hole was first drilled eight inches in diameter, but later the upper portion was enlarged to ten inches. The record has been more carefully kept than is usual in drilling such wells, but cannot be relied upon as absolutely exact. In many cases the fragments of the overlying stratum are mixed with that underneath, and the thickness of each formation cannot be exactly determined. This renders the results only approximately correct, but it is believed that a fair degree of accuracy has been attained.

The top of the well is at an elevation above the sea of 1,023 feet. For 212 feet the drill passed through soil, loess and drift, but no record was kept. At this depth a hard limestone was encountered. The sample consists of small pieces of fine-grained limestone mixed with sand and gravel. A few pieces of coal and bituminous slate, which could hardly have been introduced from the surface, were also present. It had been thought that the coal measures probably extended as far as Grinnell, but no positive evidence of this had been obtained prior to the sinking of this well. The gravel is the base of the lower till and the limestone evidently Saint Louis. At this point a strong flow of water was encountered. It rose to within 90 feet of the surface; higher than at any subsequent flow. The water was unfit for use, being almost yellow and strongly mineral; it had no bad smell and was not of the same quality as the water found in the forest bed.

The next sample was taken at a depth of 220 feet. This is pure limestone with calcareous shale. The formation extends to 240 feet where it passes into dark shale and impure limestone. The sample contains a considerable quantity of iron and is very arenaceous. In it were found numerous small crystals of gypsum, which had evidently crystalized out of the material after it had been placed in the bottle. It probably resulted from the decomposition of iron sulphide, and the consequent action of sulphuric acid on the limestone.

At 270 feet there was found a coarse, impure, hard limestone, dark in color. This resembles the brecciated base of the Saint Louis, and is probably referable to that horizon.

The next sample, considered to be the upper portion of the Augusta, shows argillaceous shale with numerous pieces of fine-grained limestone. This formation still continued at 365 feet, becoming somewhat lighter in color. At 400 feet, however, dark, calcareous shale was found which contained a large amount of iron and silica. This was succeeded by blue, calcareous shale, intermixed with small pieces of soft limestone. Twenty feet below, this merged into fine-grained, calcareous shale which, at 440 feet, passed into darker shale. Following this was light, soft, fine-grained shale. This is probably very near the base of the Augusta, making this formation a little over 200 feet in thickness. No distinguishing characteristics can be discovered in the two adjoining samples, one of which is referred to the Augusta, the other to the Kinderhook. In the well at Sigourney the base of the Augusta was found at 365 feet. Since in this well the level of the top of the Saint Louis is 200 feet lower than it is in the one at Grinnell, it would seem that the base of the Augusta would here be at nearly 420 feet, the exact thickness being dependent upon variations in the thickness of the strata.

If this conjecture is correct the uppermost member of the Kinderhook is represented by twenty feet of light, hard, brittle shale at 530 feet, which in turn passes into dark calcareous shale at 550 feet. The latter continued for twenty feet when limestone was found to occur again. It is fine-grained and associated with light, calcareous shale. There is little probability that this and the succeeding strata are entirely limestone, but are limestone and shale alternating, with, perhaps, considerable more shale than limestone. From 600 to 765 feet occur alternating dark and light shales with carbonaceous matter scattered through them.

The nature of the next sample is such as to place it with Devonian limestones as nearly as can be determined, thus making the base of the Kinderhook at the shales already mentioned. The Kinderhook then, is here nearly 270 feet in thickness. The upper stratum of the Devonian in accordance with this conjecture is fine-grained, compact limestone with drab shale. This was found at a depth of 800 feet. Below this there occurs a series of shales which extend to a depth of 940 feet. At 810 feet there was a fine-grained, calcareous shale followed by darker shale at 850 feet, which showed some indications of the presence of limestone. Below this, light-colored, porous shale made its appearance. At 940 feet limestone is encountered again. It is coarse, dark and impure; with it are pieces of dark shale. The limestone becomes more compact at 949 feet, and is of two kinds, blue and gray. Numerous crystals of iron pyrite are scattered through the it. Twenty feet lower the formation changes to light shale.

The limestones which follow seem to be very closely associated, being strikingly similar in lithological character. It seems better, therefore, to make the base of the Devonian at 990 feet, with the shale last mentioned. The total thickness of the Devonian would thus be nearly 200 feet. No attempt can well be made to separate these strata, for there seems to be no adequate grounds for such a division. It seems best, therefore, to simply refer all to the Devonian and ignore the divisions.

There next occurs a series of cherty limestones extending from 990 feet to 1,200 feet, probably marking the Niagara at 990 feet. The sample shows coarse-grained, hard, blue limestone, with a little chert and shale. This passes into a fine-grained, compact, white limestone with chert, which continues to 1,065 feet where it becomes exceedingly cherty. Intermixed with it are also grains of pure, transparent quartz and rounded pebbles of a purer and harder limestone, somewhat darker in color.

At 1,087 feet the limestone is darker, bluish and impure, with pieces of chert and flint. A finer-grained, light limestone with less chert is disclosed by the next sample at 1,130 feet. Forty-five feet below, this gives place to a dolomitic limestone with some chert and dark shale. This extends to a depth of 1,200 feet.

At this point the nature of the strata seems to change entirely, the limestone giving place to a series of shales, which from their position may properly be referred to the Maquoketa shales, thus marking the base of the Niagara at 1,200 feet. These shales are light-colored and interbedded with thin layers of limestone. Carbonaceous matter was also intermixed with the shale and limestone. This formation can not be far from 150 feet in thickness.

The sample taken at 1,320 feet shows the nature of the strata to have changed again. It is a fine-grained, brown, arenaceous limestone, containing a large amount of iron and magnesium. Lower down it becomes coarser, and at 1,380 feet it gives place to dark shale which continues for twenty feet. From 1,400 feet to 1,475 feet there occurs a fine-grained limestone decidedly dolomitic and very ferruginous. Unfortunately there is no record of the strata between 1,475 feet and 1,610 feet. A drill was lost and in attempting to pass it the samples were forgotten. The dolomitic character of the limestone between 1,320 feet and 1,475 feet would seem to indicate that they belong to the Galena group. If so, then the contact between this and the Trenton is in the gap between 1,475 feet and 1,610 feet.

The first sample of what is called the Trenton resembles ferruginous sandstone, but is in reality fine-grained, highly ferruginous dolomite with small pieces of white chalky matter, nearly pure carbonate of lime. This continued through 1,625 feet, becoming less ferruginous, and gave place at 1,630 feet to coarse, impure white limestone. At 1,640 feet a piece of blue shale about two inches long was brought up with the drillings. This was filled with fragments of the shells of brachiopods and pieces of bryzyoans. There were also numerous crystals of pyrite scattered through it. Fifteen feet lower, at 1,655 feet, the drillings disclosed a layer of dark, impure ferruginous limestone, also dolomitic.

This is considered to be the base of the Trenton group, for the next sample taken at 1,700 feet is gray, slightly calcareous sandstone, becoming lighter-colored, and more nearly pure at 1,740 feet. This evidently represents the Saint Peters sandstone. Here, between 1,740 feet and 2,002 feet there is another gap in the record. As the drill was penetrating the sandstone a roaring sound was heard, and the drillings were washed away by a strong current of water. The water which had remained at a level of nearly 100 feet below the surface immediately sunk, but after some time returned to nearly the same level as before.

The drillings continued to a depth of 2,002 feet, where the sample discloses a white limestone, slightly dolomitic. It is also very arenaceous, containing nearly half its bulk of irregular grains of pure white translucent quartz. It is probable that this is among the lower members of the Oneota limestone.

Up to this time the flow of impure water found at the top of the Saint Louis had resisted all efforts to check it, and hence, all the water found below was tainted by it. A means was at last devised by which it was entirely checked. The water at the lower level was found to be of good quality, and to have a moderate flow, coming to within 230 feet of the surface.

During the month an average of 12,800 gallons were pumped every twenty-four hours; while during the summer months very much more was used without diminishing the flow.

A careful analysis of the water was made by Mr. Verbeck of the department of chemistry, at Iowa College, the results of which are here given:

	GRAINS
Calcium carbonate	7
Calcium sulphate	41.1
Magnesium sulphate	30
Sodium sulphate	27.34
Sodium chloride	.87
Silica iron and alumina	.7
Total solids at 120°C	120.75
Hardness in degree	44

The water is universally liked and very generally used. No bad effects from its use have been noticed.

LANSING LEAD MINES.

BY A. G. LEONARD.

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The mine herein described is located in Allamakee county, about five miles northwest of Lansing (Tp. 99 N., R. IV. W., Sec. 10, Nw. qr.). It is owned and operated by the Lansing Mining and Smelting Company, of which Hon. J. H. Trewin is president.

The mine is of special interest on account of being located in the Oneota limestone. As is well known, the lead and zinc deposits of this state are confined almost wholly to the Galena formation, and moreover, the large ore bodies have occurred in the upper part of this limestone. Thus the Dubuque mines are, with few exceptions, within 100 feet of the overlying Maquoketa shale, many of the shafts passing through from ten to twenty feet of these beds. At Guttenberg, where at one time considerable lead was found, the productive openings are at the base of the Galena, at its juncture with the Trenton.

Previous to the discovery of the Lansing mine lead in paying quantity had not been found in Iowa below this horizon, and it was considered well nigh useless to look for ore in other formations. This mine is, so far as known, the only instance in the entire Upper Mississippi region where an extensive lead deposit occurs in the Oneota limestone, or anywhere below the Trenton.

Another remarkable fact in connection with this deposit is its occurrance as a vertical sheet in a north and south fissure. While these north and south crevices are not uncommon in the state, they are usually of limited extent, and do not contain large bodies of ore. But here the sheet is an extensive one, and does not as yet show any signs of giving out.

The deposits, as a rule, are confined to east and west crevices, where they occur in expansions or openings of the fissures.

The mine was discovered in January 1891, by Capt. Turner, who had reached the conclusion that lead was to be found in the Oneota, and had done considerable prospecting at various points along the Mississippi. This location is on a hillside that slopes to the north and east. While the general direction of the crevices is nearly north and south (S. 10° E. N. 10° W.), its course is not straight, but zig-zags back and forth within certain limits, so that a shaft sunk on the general line of the fissure may be several feet out of the way.

This sheet of mineral has been followed 1,000 feet, and its limits have not been reached, either to the north or south. At the north end of the present workings the fissure is interrupted by a ravine, and the sheet thus outcrops. There is good reason for supposing that this will be found again on the other side. The main body of the sheet has a vertical extent of from 25 to 30 feet, and a width of from 3 to 4 inches. A shaft was sunk 113 feet to the Saint Croix or Potsdam sandstone, and Galena was found in small quantities downward to within 4 or 5 feet of the latter. The bulk of the ore, however, is about 50 feet above the sandstone.

The sheet of lead is either imbedded in the crevice clay, or fills the entire space between the rock walls. Where it extends into the hill to the south, and has been little exposed to weathering agencies, the sides of the fissure have not undergone decomposition, and the sheet is in contact with the rock. In other places where examined an inch or two of clay was found between it and the limestone; the crevice in this case being from 6 to 8 inches wide. Again, the fissure may open out until it has a width of 3 or 4 feet, and is filled with clay and the sheet of ore. The latter lies up against the wall, and almost invariably against the east wall, or toward the lower side of the hill. The sheet does not extend vertically to the surface, but in the upper 8 or 10 feet, curves over toward the east, or down the slope. Evidently there has been a slipping of the hillside which has carried with it the top of the sheet, this bending being a result.

The mine has been worked by means of three or four shafts, from 30 to 60 feet deep. From these, drifts are run in each direction at various levels, and thus the ore is removed. At the north end of the present workings a tunnel has also been cut alongside of the mineral.

Most of the ore is taken out in pieces of considerable size. The Galena does not occur well crystalized, but in the form of "chunk mineral," as it is called. It is filled with numerous cavities often lined with crystals of lead carbonate or cerussite, formed by the alteration of the sulphide. The ore is of excellent quality, one sample showing 80.55 per cent of lead.

Up to the month of April of this year the production had reached 400,000 pounds, with excellent prospects for the future.

There is another locality in Allamakee county where lead was formerly mined in the Oneota limestone, and a brief description of the mines will, perhaps, be in place in this connection. The diggings were on Mineral Creek (Tp. 99 N., R. VI. W., Sec. 13) about two and a half miles south of where it empties into the Oneota river. Near the junction of the two streams a small town, New Galena, sprang up, and during the year of 1856–57, was the scene of considerable activity.

The mines were in the upper part of the Oneota formation, not far from its juncture with the Saint Peter sandstone. Mineral Creek has cut its valley through this sandstone and well down into the underlying limestone, which here has a thickness of something over 100 feet. This latter rock shows evidence of considerable disturbance, being more or less brecciated, and re-cemented by siliceous material. It is full of cherty or flinty matter, and is very impure.

The mines were on a hillside and were worked by means of short drifts. Instead of being in crevices the ore occured scattered through the limestone, necessitating considerable blasting for its removal. None of the drifts extended more than 40 or 50 feet from the surface, as the mineral bearing rock did not reach a greater distance.

To separate the mineral great heaps were constructed with wood intermingled with rock. These piles were set on fire, and the heat was not sufficient to melt the Galena, but only cracked the rock into small pieces. Then this was washed and the mineral was separated. The latter was smelted in a furnace located at the mouth of Mineral Creek. During the two years that the mines were in operation 63 pigs were turned out, and this trifling return represents almost the entire product of the district.

When the locality was visited early in the present year, some prospecting was in progress, but with little chance of success.

Float lead is found quite abundantly in the county, and the Oneota contains more or less of this mineral, but it is doubtful whether as a rule the ore occurs in well defined crevices, and in amount sufficient to make its mining profitable.

HOW OLD IS THE MISSISSIPPI?

BY FRANCIS M. FULTZ.

(Abstract)

In asking this question it is not intended to open for discussion when and how each particular part of the great river came into existence. Nor will it be expected to prove whether or not it is now everywhere following the course it first selected for itself. But the effort will be to show that its prototype must have existed at a certain fixed time in the distant geologic past. In fixing this date it must be understood that the claim is not made that the river course surely dates from that time, but that it existed at least as early as that. It may be much older, but as for that let future discovered evidence tell. That part of the Mississippi to which the evidence in question pertains, lies between the mouths of the Iowa and Des Moines rivers.

The evidence set forth goes to show that the present Mississippi drainage system existed as early as the beginning of the Upper Burlington epoch; and that, although interrupted by frequent and perhaps prolonged submergences, it nevertheless still remains practically the same.

MAQUOKETA SHALES IN DELAWARE COUNTY.

BY SAMUEL CALVIN.

(Abstract.)

From the relation of Delaware county to the great Niagara escarpment it would scarcely be expected that rocks older than the Upper Silurian would be found within its limits. Upper Silurian sediments indeed constitute the rocks that may be said to be normal to the entire county. They cover probably ninety-nine per cent of its area. Without exception all the higher lands are occupied by them, and most of the valleys have a floor of Niagara dolomite. Still some of the valleys have cut through the Niagara limestone down into the underlying shales of the Maquoketa age, and very many of the valleys come much nearer to exposing Maquoketa shales than has hitherto been supposed. The normal dip of the Iowa strata to the southwest is evidently reversed along a line that passes obliquely near the northeast corner of the county, so that the Maquoketa shales are covered with a relatively thin veneer of Upper Silurian dolomite, even as far as the western border of the county in the northwestern corner.

Northeast of Colesburg the valleys of some small creeks, tributary to the Turkey river, have cut through the Niagara, and exposed the Maquoketa shales at an altitude 200 feet lower than the ridge on which the village is situated. A section of the shale more than 50 feet in thickness is exposed in sections 1 and 2 of the northeast township of the county. The shales at this point are composed of blue, plastic clay. They are non-fossiliferous, and are well adapted to the manufacture of pottery, a use to which they are put on a limited scale by Mr. Frank Brock, of Colesburg.

In section 2 a large spring issues from the side of the hill at a level corresponding to the top of the blue shales. Above the level of the shales there are 25 feet of rather thin-bedded,

impure limestone that breaks up on exposure to the weather into many small angular fragments. These are the beds of passage, and they are followed by heavy-bedded dolomite of the Niagara age.

At Colesburg the well at the hotel was drilled through 60 feet of loess, 10 feet of flint and red clay, which evidently embraces the residual cherts and clays of the geest; and through 183 feet of Niagara limestone and beds of passage to the blue shales of the Maquoketa age. Water was found at the top of the shale. The dip at Colesburg is normal. The synclinal axis already referred to evidently lies a little to the west.

About six miles southwest of Colesburg, in the southern edge of section 2, T. 90 N., R. IV W., the valley of Elk creek, has been eroded down into the shale and furnishes some fine exposures. As before the shale is non-fossiliferous, and admirably adapted to the manufacture of pottery. Exposures occur at intervals for a mile or two up and down the creek from the point described above.

At a number of points in the valley northeast of Greeley the beds of passage which lie immediately above the blue shales of the Maquoketa, are exposed and exhibit their usual characteristics.

The shales themselves are not seen. The best example of the beds of passage is seen at the mill at Rockville. At this point they were found to contain a few fossils belonging to Hudson river types, which shows that the lower part, at least, of these beds must be referred to the Maquoketa rather than the Niagara age. Lithologically they resemble some portions of the Niagara, but the contained fauna is Ordovicia or Lower Silurian.

The blue argillaceous shales are not naturally exposed at Rockville, but the water pouring over the dam has excavated a deep pit as the result of the plunge, scooping out great masses of the shaley portions of the beds and piling them up in heaps and ridges a short distance below. These heaps contain many beautiful fossil-bearing shales, and in the multitude of finely preserved individuals we recognize *Orthis testudinaria*, *Plectambonites sericea*, *Strophomena filitexta*, *Strophomena rugosa*, *Zygospira modesta* and *Calymene senaria*. In the varietal characters, mode of preservation and association of the species, the slabs from Rockville could not be distinguished from specimens of corresponding character collected at Cincinnati, Ohio.

Wells drilled on the higher ground at Hopkinton, reach the Maquoketa shales at a depth of 90 feet. The bed of the river at the mill at South Hopkinton, must be within a few feet of the shales. Owing to the reversal of the dip the Pentamerus beds that are exposed at the surface at Hopkinton are found at "Devil's Back Bone," in northwestern Delaware, and the cleft casts of the ventral valve are known to the summer visitors of that somewhat noted locality, as the "Devil's Claws". The same beds extend over into northeastern Buchanan, and anywhere in that region the shales may be reached at a depth of about 100 feet.

The proximity of the shales to the surface over so wide an area is not without its economic significance. The surface of the shales is everywhere a water-bearing horizon, and so unfailing wells may be obtained over many square miles by boring to only a moderate depth. The drouth of last summer has turned the attention of farmers, especially the cultivators of vegetables and small fruits, to the desirability and practicability of irrigation, and there has been manifested a very general desire for information as to the depth at which unfailing supplies of water may be reached. The next summer will witness some practical experiments in this direction, particularly at Hopkinton, and the water supply, it is expected, will be found in the Maquoketa shales.

OCCURRENCE OF MEGALOMUS CANADENSIS, HALL, IN THE LECLAIRE BEDS AT PORT BYRON, ILLINOIS.

BY WILLIAM HARMON NORTON.

This common fossil of the Guelph of Canada has not been noted in the Le Claire beds of Iowa, or their immediate extension into adjacent states. Its occurence, therefore, at Port Byron, Illinois, in the Barrett quarries one and one-half miles north of the town, is of special interest, since it shows a range much further to the west than hitherto observed, and a commingling of the Guelph and Niagara faunas in the Le Claire, similar to that in the so-called Guelph of Wisconsin. The specimens are well preserved, casts of the normal type not conforming to the variety of *M. Compressus.*

REPORT OF THE COMMITTEE ON STATE FAUNA.

BY C. C. NUTTING, CHAIRMAN.

In November last the chairman of this committee sent out a number of postal cards to the zoologists of the Academy, requesting them to forward their notes regarding the appearance of animals new to the state or to certain localities, and any items of interest concerning the geographical distribution of the animals of Iowa. The response was anything but encouraging, as only three members made any answer whatever, and none of these had more than a single note to offer. This will account, in part at least, for the meagreness of this report.

MAMMALS.

No mammals have been reported new to the state.

The timber wolf, *Canis lupus*, seems to be increasing in numbers in the northern part of Iowa.

The red fox, *Vulpes velox*, seems to be getting more common in the southeastern part of the state. The first certain record for Johnson county was a speciman killed by Earl T. Bane, on November 26, 1894, and presented to the State University museum.

The little striped skunk, *Mephitis putorius*, Linn, has been known for several years to be common in Johnson county. The first specimens authoritatively identified, however, were brought to the university by Mr. J. M. Adams, October, 1894.

Franklin's spermophile, *Spermophilus franklini*, Sab., formerly common in Johnson county, is now becoming quite rare. Collectors from the university were unable to secure specimens during the last spring.

Prairie hare, *Lepus campestris*, Bach., is still increasing in the northern part of the state, and invading the southern part.

The first record for Johnson county is based on a specimen killed in January, 1893, by Mr. Wolf. The skull only was kept as a basis for the record.

BIRDS.

Black throated loon, *Urinator arcticus*, Linn. Burlington, Iowa. Paul Bartsch.

Old squaw, *Clangula hyemalis*, (Linn.) Burlington, Iowa. November 29, 1892. Paul Bartsch.

White winged scoter, *Oidemia deglandi*, Bonap., Burlington, Iowa. November 15, 1890. Paul Bartsch.

Piping plover, *Ægialitis meloda*, (Ord) Burlington, Iowa. August 21, 1892. Paul Bartsch. This specimen was killed nearer the Illinois than the Iowa side of the river, and is, therefore, not strictly an Iowa record.

Clarke's crow, *Picicorvus columbianus*, (Wils.) Boone, Iowa. September, 1894. Carl Fritz Henning. This is the most surprising record reported this year. Mr. Henning kindly sent the specimen for identification, and donated it to the university museum.

Bewick's wren, *Thryothorus bewickii*, (Aud,) Burlington, Iowa, April 10, 1893. Paul Bartsch.

The above species of birds have not before been authentically recorded from this state, and all but one were in the collection of Mr. Paul Bartsch, of Burlington, and have been deposited in the Museum of Natural History of the State University of Iowa.

No notes have been sent in regarding the reptiles and batrachia, except a complaint over the scarcity of frogs for laboratory use. This scarcity is due probably, to the unusually dry weather during the past summer.

Mr. H. F. Wickham has kindly furnished the following list of coleoptera new to Iowa.

INSECTS.*

BY H. F. WICKHAM.

COLEOPTERA

Carabidæ.

Cychrus lecontei, Dej., Independence.
Nomaretus cavicollis, Lec., Iowa, (Leng & Beutenmuller.)
Carabus limbatus, Say, Iowa City.
Elaphrus clairvillei, Kirby, Iowa City.
Nebria pallipes, Say, Independence.
Clivina impressifrons, Lec., Iowa City.
Bembidium postremum, Say, Iowa (Reinecke).
Evarthrus sodalis, Lec., Iowa City.
Amara remotestriata, Dej., Iowa (Hamilton).
Diplochila obtusa, Lec., Iowa City.
Platynus picticornis, Newm., Iowa (Reinecke).
—— placidus, Say, Iowa City.
Perigona pallipennis, Lec., Iowa (Horn).
Galerita atripes, Lec., Iowa City.
Callida punctata, Lec., Iowa City.
Pinacodera limbata, Dej., Iowa City.
Helluomorpha bicolor, Harr., Iowa City.
Chlaenius diffinis, Chaud, Iowa City.
—— brevilabris, Lec., Iowa City (Horn).
Harpalus testaceus, Lec., Iowa City (Bailey*).

Dytiscidæ.

Laccophilus proximus, Say, Iowa (Crotch).

Hydrophilidæ.

Hydrochus variolatus, Lec., Iowa (Leng & Beutenmuller).

* [At the request of Professor Nutting, I have prepared the following list of species known from the state additional to those recorded by Professor Osborn, for incorporation in his report. For the species marked Iowa City I am to be considered responsible, the specimens being in my collection; where a locality is given, followed by a name in parenthesis, it is, however, usually taken from a published reference and rests on the authority of the author cited. When the name is that of the collector only, and the identification my own, an asterisk is used. The labor of searching through an immense amount of literature for local references has been borne by my wife, to whom thanks are due for the large number of additions made in this way.]

Silphidæ.

Necrophorus pustulatus, var. melsheimeri, Iowa City.
Prionochæta opaca, Say, Iowa City, Independence.
Ptomaphagus pusio, Lec., Iowa City.

Scydmænidæ.

Scydmænus flavitarsis, Lec., Iowa City.
—— rasus, Lec., Iowa City.
—— minimus, Brend., Linn Co. (Brendel).
Eumicrus motschulskii, Lec., Iowa City.
Euthiodes lata, Brend., Iowa (Brendel).

Pselaphidæ.

Ctenistes zimmermanni, Lec., Iowa City.
Cylindractus crinifer, Casey, Iowa, (Casey).
Decarthron scarificatum, Brend., Cedar Rapids (Brendel).
Batrisus globosus, Lec., Iowa City.
—— simplex, Lec., Iowa (Brendel).
Bryaxis terebrata, Casey, Iowa (Brendel).
—— trigona, Lec., Cedar Rapids (Brendel).
—— inornata, Brend., Iowa (Leconte).
—— truncaticornis, Brend., Iowa (Brendel).
—— canadensis, Brend., Iowa (Brendel).
—— cribricollis, Brend., Iowa (Brendel).
Euplectus confluens, Lec., Iowa City.
—— iowensis, Casey, Iowa (Casey).
—— rufipes, Lec., Iowa (Brendel).

Staphylinidæ.

Echidnoglossa brendeli, Cedar Rapids (Casey).
Homalota festinans, Er., Iowa City.
Trichiusa robustula, Casey, Cedar Rapids (Casey).
Myrmobiota crassicornis, Casey, Iowa City.
Myrmedonia calignosa, Casey, Iowa City.
Thecturota exigua, Casey, Cedar Rapids (Casey).
Ocyusa asperula, Casey, Iowa (Casey).
Thiasophila angustiventris, Casey, Iowa (Casey).
Eurypronota discreta, Casey, Cedar Rapids (Casey).
Polylobus gratellus, Fauvel, Iowa City.
Bolitochara blanchardi, Casey, Iowa (Casey).
Somatium claviger, Casey, Keokuk (Casey).
Dinopsis americanus, Kraatz, Iowa City.
Quedius capucinus, Grav., Iowa City.
—— peregrinus, Grav., Iowa City.
Staphylinus mysticus, Er., Iowa City.
Philonthus confertus, Lec., Iowa (Horn).
—— micans, Grav., Iowa City.
—— quisquiliarius, Gyll., Iowa City.
Actobius sobrinus, Er., Iowa City.
Stenus juno, Fabr., Iowa City.
—— colonus, Er., Iowa City.

—— egenus, Er., Iowa City.
—— gratiosus, Casey, Independence.
—— annularis, Er., Iowa City.
Lathrobium armatum, Say, Iowa City.
Scopæus picipes, Casey, Iowa City.
Stilicus dentatus, Say, Iowa City.
Platymedon laticolle, Casey, Iowa City.
Tachyporus maculipennis, Lec., Iowa City.
Conurus scriptus, Horn., Iowa City.
Bledius nebulosus, Casey, Iowa (Casey).
—— opacus, Block., Iowa City.
Oxytelus placusinus, Lec., Iowa City.
—— suspectus, Casey, Iowa City.
Trogophlœus lepidus, Casey, Cedar Rapids (Casey).
—— phlœoporinus, Lec., Cedar Rapids (Casey).
—— ingens, Casey, Cedar Rapids (Casey).
—— detractus, Casey, Cedar Rapids (Casey).
—— imbellis, Casey, Cedar Rapids (Casey).
Arpedium tenue, Lec., Iowa City.
—— cribratum, Fauvel, Iowa City.

Scaphidiidæ.

Bæocera speculifer, Casey, Keokuk (Casey).
—— congener, Casey, Iowa (Casey).
Scaphisoma pusilla, Lec., Iowa (Casey).
—— repanda, Casey, Iowa (Casey).
—— evanescens, Casey, Iowa (Casey).

Phalacridæ.

Phalacrus politus, Melsh, Iowa City.
—— simplex, Lec., Iowa (Casey).
Stilbus obscurus, Casey, Iowa City.
Acylomus ergoti, Casey, Iowa (Casey).

Coccinellidæ.

Cryptognatha pusilla, Lec., Cedar Rapids.
Hyperaspis pratensis, Lec., Iowa City.

Endomychidæ.

Symbiotes ulkei, Cr., Iowa City.
Phymaphora pulchella, Newm., Cedar Rapids (Brendel).

Erotylidæ.

Mycotretus sanguinipennis, Say, Iowa City.
Tritoma humeralis, Say, Iowa City.

Colydiidæ.

Colydium lineola, Say, Iowa City.

Cucujidæ.

Silvanus bidentatus, Fabr., Iowa City.
Pediacus depressus, Hbst., Iowa City.

Mycetophagidæ.

Litargus 6-punctatus, Say, Iowa City.

Dermestidæ.

Anthrenus varius, Fabr., Iowa City.

Histeridæ.

Hister harrisii, Kirby, Iowa City.
—— depurator, Say, Iowa City.
—— americanus, Payk, Iowa City.
Hetærius brunnipennis, Rand, Iowa City.
Paromalus æqualis, Say, Iowa City.
Acritus exiguus, Er., Iowa City.
Bacanius punctiformis, Lec., Cedar Rapids (Brendel).

Nitidulidæ.

Colastus semitectus, Say, Iowa City.
—— truncatus, Rand, Iowa City.
Epuræa erichsonii, Reitt, Iowa City.
Nitidula ziczac, Say, Iowa City.
Amphicrossus ciliatus, Oliv., Iowa City.
Ips sanguinolentus, Oliv., Iowa City.

Trogositidæ.

Alindria cylindrica, Serv., Iowa City.

Byrrhidæ.

Limnichus punctatus, Lec., Iowa City.

Parnidæ.

Dryops lithophilus, Germ., Iowa (Horn).
Macronychus glabratus, Say, Iowa City.

Dascyllidæ.

Eucinetus terminalis, Lec., Iowa City.
Helodes fuscipennis, Guer., Iowa City.

Elateridæ.

Cryptohypnus obliquatulus, Melsh., Iowa.
Limonius nimbatus, Say. Iowa City.
Corymbites tessellatus, Linn., Iowa City.

Buprestidæ.

Cinyra gracilipes, Melsh., Iowa City.
Agrilus anxius, Gory., Iowa City.

Lampyridæ.

Eros thoracicus, Rand, Iowa City.
Plateros canaliculatus, Say, Iowa City.

Malachiidæ.

Attalus otiosus, Say, Iowa City.

Cleridæ.

Orthopleura damicornis, Fabr., Iowa City.
Necrobia rufipes, Fabr., Iowa City.

Ptinidæ.

Ptilinus ruficornis, Say, Iowa City.
Sinoxylon basilare, Say, Iowa City.
Dinoderus porcatus, Lec., Iowa City.

Lucanidæ.

Passalus cornutus, Fabr., Muscatine (McBride*).

Scarabæidæ.

Aegialia conferta, Horn, Independence.
Geotrupes semiopacus, Jek., Iowa City.
Dichelonycha subvittata, Lec., Iowa City.
Macrodactylus subspinosus, Fabr., Independence (Mrs. Wickham*).
Lachnosterna fraterna, Harr., Iowa City.
—— —— var. forsteri, Burm., Iowa (Horn).
—— marginalis, Lec., Iowa City.
implicita, Horn, Iowa City.
—— spreta, Horn, Iowa (Horn).
—— villifrons, Lec., Iowa (Horn).
Chalepus trachypygus, Burm., Iowa City.
Cremastochilus retractus, Lec., Iowa (Horn).
Trichius piger, Fabr., Iowa City.

Cerambycidæ.

Elaphidion incertum, Newm., Iowa City.
Typocerus badius, Newm., Iowa City.
—— lugubris, Say, Iowa (Leng.).
Liopus cinereus, Lec., Iowa City.
Lepturges facetus, Say, Iowa City.
Oberea flavipes, Hald., Iowa City.

Chrysomelidæ.

Donacia æqualis, Say, Iowa (Leng.).
—— flavipes, Kirby, Iowa City.
Hæmonia nigricornis, Kirby, Iowa.
Bassareus congestus, Fabr., Riverton (Shimek*).
—— —— var. luteipennis, Melsh., Iowa City.
Myochrous denticollis, Say, Eastport (Shimek*).
Typophorus viridicyanea, Cr., West Iowa (Shimek*).
Metachroma angustulum, Cr., Eddyville (Shimek*).
Graphops nebulosus, Lec., Iowa (Crotch.).
Phyllobrotica limbata, Fabr., Iowa (Horn).
Blepharida rhois, Forst., Iowa City.
Hypolampis pilosa, Ill., Iowa City.
Oedionychis limbalis, Melsh., Iowa (Horn).
Disonycha pensylvanica, var. limbicollis, Lec., Iowa City.
—— crenicollis, Say, Iowa City.

Crepidodera rufipes, Linn., Iowa (Horn).
Longitarsus testaceus, Melsh., Iowa City.
Glyptina cerina, Lec., Iowa City.

Tenebrionidæ.

Eleodes suturalis, Say, Western Iowa (McBride*).
Merinus lævis, Oliv., Iowa City.
Haplandrus femoratus, Lec., Iowa City.
Tenebrio castaneus, Knoch, Eddyville (Shimek*).
Blapstinus interruptus, Say, Iowa City.
Tribolium ferrugineum, Fabr., Iowa City.
Uloma mentalis, Horn, Iowa City.
Hoplocephala viridipennis, Fabr., Iowa City.
Platydema picilabrum, Lap. and Br., Iowa City.
Phylethus bifasciatus, Say, Iowa City.
Strongylium tenuicolle, Say, Iowa City.

Cistelidæ.

Hymenorus pilosus, Melsh, Iowa City.
curticollis, Casey, Iowa (Casey).
Isomira iowensis, Casey, Iowa (Casey).
Mycetochares foveata, Lec., Iowa (Casey).

Melandryidæ.

Synchroa punctata, Newm. Iowa City.
Eustrophus repandus, Horn, Iowa City.
Hallomenus scapularis, Melsh. Iowa City.
Nothus varians, Lec., Iowa City.

Anthicidæ.

Mecynotarsus candidus, Lec., Iowa (Liebeck).
Tomoderus interruptus, Laf., Iowa City.
Anthicus cinctus, Say, Iowa City.
—— fulvipes, Laf., Iowa City.

Otiorhynchidæ.

Hormorus undulatus, Uhler, Iowa City.

Curculionidæ.

Apion erraticum, Smith, Iowa (Smith).
robustum, Smith, Iowa (Smith).
floridanum, Smith, Iowa (Smith).
Listronotus appendiculatus, Boh., Iowa City.
Lixus marginatus, Say, Iowa (Casey).
Dorytomus fusciceps, Casey, Iowa (Casey).
—— indifferens, Casey, Iowa (Casey).
Smicronyx constrictus, Say, Iowa (Casey).
—— fiducialis, Casey, Iowa (Casey).
—— perfidus, Dietz, Iowa (Dietz).
—— sculpticollis, Casey, Iowa (Deitz).
Otidocephalus perforatus, Horn, Iowa City.
Anthonomus sycophanta, Walsh, Iowa City.

—— bolteri, Deitz, Iowa City.
—— rufipes, Lec., Iowa (Dietz).
—— subguttatus, Deitz, Iowa (Angell).
—— ligatus, Deitz, Iowa (Angell).
Pseudanthonomus facetus, Deitz, Iowa (Angell).
Tychuis sordidus, Lec., Iowa (Casey).
Ceutorhynchus cyanipennis, Ill., Iowa City.
Baris dolosa, Casey, Iowa (Casey).
—— confinis, Lec., Iowa City.
—— transversa, Say, Iowa (Casey).
Pseudobaris angustula, Lec., Iowa (Casey).
Nicentaus ingenuus, Casey, Iowa (Casey).
Centrinus falsus, Lec., Iowa (Casey).
Limnobaris deplanata, Casey, Keokuk (Casey).
—— confinis, Lec., Iowa (Casey).
Idiostethus ellipsoideus, Casey, Iowa (Casey).
Catapastus conspersus, Lec., Iowa (Casey).
Euryssobia echidna, Lec., Iowa (Casey).

Calandridæ.

Cossonus subareatus, Boh., Eddyville (Shimek*).

Scolytidæ.

Hylesinus opaculus, Lec., Iowa City.
Phlœotribus frontalis, Zimm., Iowa (Leconte & Horn).

A KYMOGRAPH AND ITS USE.

BY W. S. WINDLE.

The science of physiology in its present condition owes much of its advancement to the skillful manipulation of cunningly devised apparatus. Without the successful invention of delicate mechanical appliances many of the profound researches of Foster, Du Bois, Raymond, McKendrick, Martin and others would never have been possible. It must be granted, however, that invention and skill in manipulation have been supplemented by clear and comprehensive interpretation of results obtained, and it is to the latter that most credit is due. In emphasizing the value of scientific apparatus and its use, we recognize the imperative need of a fundamental knowledge in anatomy, histology, chemistry and physics, which the pupil must necessarily possess before entering upon advanced work in the science of physiology. It is true that the general student versed in these branches may secure a fair working knowledge of physiology simply from a good text, supplemented by ample anatomical demonstrations, complete diagrams and charts. But far more comprehensive will his views of the science be if a well-chosen list of experiments be worked by his own hand in a fully equipped physiological laboratory.

A good proportion of students may usually be found in the college and university who are eager for such work and will pursue it with much enthusiasm, and if properly directed will obtain many satisfactory results. But it is a fact to be regretted that only the few in our larger universities are offered facilities for such a desirable course in this most interesting department of the biological sciences. This condition of affairs is chiefly due to two reasons. First, the expense of proper equipment is larger than most institutions can or desire to bear at present, especially so when other and more elementary subjects must first be provided for. Second, the number of teachers who possess adequate training in physiology is unfortunately limited. But it is gratifying to note the recent increase in this class of instructors since the growing demands for more extended work in physiology have become apparent.

A few days ago it became my interesting duty to examine the catalogues of all the colleges and universities in Iowa, and among other points the comparative courses in physiology were noted. Seven institutions, only, offer work beyond the elementary study. Four of these offer one term of 10-12 weeks, while three submit a well planned course of one semester. That advanced physiology is one of the neglected studies in Iowa colleges is a fact conclusively shown in the above. There is not only a need for decided advancement along this line, but an ample opportunity is found in the urgent demand repeatedly expressed for it by our most progressive pupils. If the financial resources were unlimited such demands would soon be met, but since full supplies cannot be readily offered, the enterprising professor or pupil should not despair, for the requirements may often be met quite satisfactorily by humble methods. Many simple pieces of apparatus may be easily and quickly constructed at a very small expense, that may answer the purpose of others more elaborate and expensive.

Instead of a kymograph or myograph of foreign manufacture, a revolving upright cylinder may be constructed for taking a continuous record upon paper or smoked surface. With the assistance of a jeweler or other skillful mechanic, this and many other simple devices may be made for experimenting upon muscles, nerves, circulation, respiration, etc., all with but little expense.

During recent work in phsiology at Penn College a recording apparatus became very desirable, and steps were taken to construct an economical one suitable for the occasion. The instrument, which was finally completed by the aid of jeweler, locksmith and tinner, cost $7.50. It served its purpose admirably, and because of its extensive utility and easy manipulation, it was deemed advisable to submit a detailed description of the machine with the hope that it may assist some one, or be the means of exciting interest in such instruments and calling out suggestions for their improvement.

The kymograph, as the instrument is termed, consists essentially of a firm stand upon which two cylinders are mounted in an upright position. The larger cylinder is connected with a clock train so that it may be made to rotate upon its axis at different velocities, varying from one-half to three revolutions per second.

The stand is of one and one-half inch poplar; length, sixteen inches; width, twelve inches. It rests upon four legs which are seven inches in length. The cylinders are held upright one inch above the stand, by means of a small steel pillar, from which an arm extends to the upper ends of the axis of each. The cylinders are hollow and light, constructed of sheet brass bent upon and soldered to brass frames at each end. Through the centers of these frames the axes extend so as to project one inch or more beyond the ends of the cylinders. The small cylinder is five inches high and three inches in diameter. It is placed near the front side of the stand, with the lower end of its axis resting in a brass socket, the upper end held by the horizontal arm in such a way that it can be rotated easily. The larger cylinder is five inches in depth and six inches in diameter. The upper end of its axis is supported by a horizontal arm, while the lower end connects by means of a joint with a shaft which extends through the top of the stand to the clock train below. This clock train is a part of an eight-day movement. The steel spring communicates by a train of three wheels, with an adjustable fan, attached to a three-sixteenth inch shaft, which extends below the brass frame. See plate V

The fan consists of two veins of sheet brass two by one and one-half inch, arranged upon a horizontal shaft, so that they may be turned edgewise to the air to admit of very rapid motion, or flatwise to admit of very slow motion. The movement of the large cylinder is further controlled by means of a lever, which may be applied against a smaller wheel in the train. When applied the machine stops running readily. A number of improvements are contemplated which will increase the number of uses for which the instrument is adapted. It will then, in all probability, possess many points of superiority over the foreign instrument.

In plate V the instrument is represented as a kymograph. A chronograph pen should be represented below the mercury manometer. A roll of paper four inches wide is supported on a pivot near the end of the stand opposite the large cylinder. The paper is then passed round the smaller cylinder to be fastened by a wire clamp to the larger. When the machine is in motion the paper is slowly drawn round the smaller cylinder and wound about the larger. In addition to the study of normal pressure of the blood, records of other interesting and instructive experiments, may be secured as in the following:

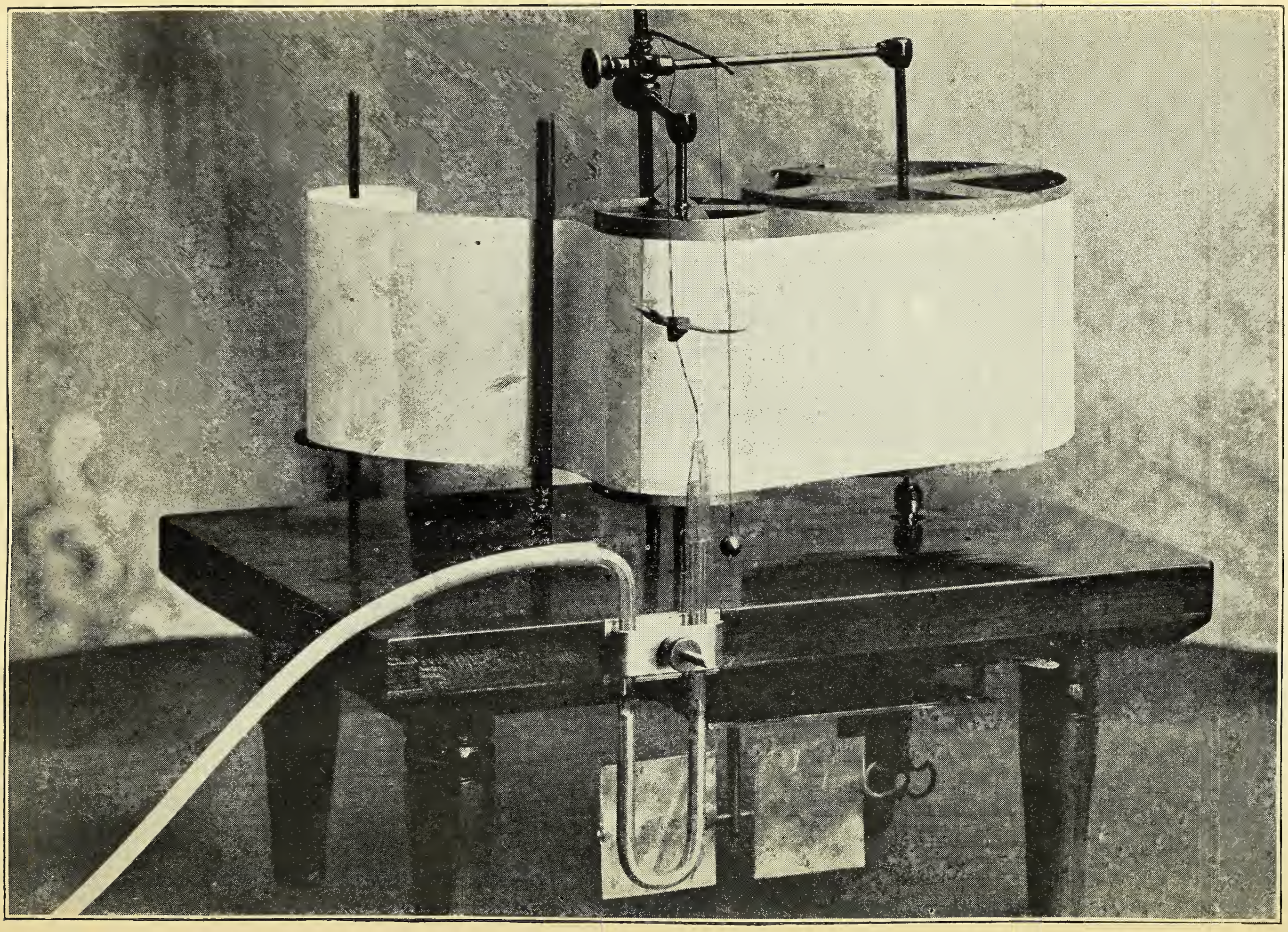
1. Effect of stimulating the depressor nerve.
2. Effects of stimulating the vagus nerve.
3. Effects of severing one or both vagus nerves.
4. Effect of various poisons upon the circulation.

To use the instrument as a pneumograph or myograph, all parts may be removed from the top of the stand except the larger cylinder and its support. This cylinder is then taken from its position, covered with smoked paper, then replaced, ready for use in the study of respiration as muscularation. With Marly's tambour the instrument becomes a pneumograph and records may be taken of:

1. Movements of various regions of the chest in normal respiration.
2. Effect of cutting or stimulating the vagus nerve.
3. Effect of cutting or stimulating the laryngeal nerves.

Effects of negative and positive ventilation also are recorded by proper levers, etc.

The single cylinder with smoked surface forms a good myograph, when experiments like the following may be performed:



KYMOGRAPH.

PLATE V.

1. Effect of various stimuli upon motor nerve or curarized muscle, as thermal, mechanical, electrical and chemical.

2. Effect of electrical stimuli of varying intensities.

3. Effect of repeated stimuli—followed by tetanus.

4. Result of continued fatigue.

5. The "Maker" shock compared with the "Break."

6. Conditions affecting degree of muscular contraction, as amount of resistance, temperature, poisons, etc.

Numerous other uses will occur to the student in advanced physiology, in which the recording apparatus will be of service.

To some it may be interesting to note that the tracings upon smoked paper may be preserved indefinitely, by carefully removing it from the cylinder, and passing it through an alcholic solution of white shellac, then allowing it to dry. If the tracing thus preserved be oiled, it becomes thin enough to be used for printing blue print copies of it.

VOLATILITY OF MERCURIC CHLORIDE.

BY ABBOTT C. PAGE.

[Abstract.]

Solutions of mercuric chloride were evaporated on a water bath with the following results:

SOLUTION.	AFTER ADDITION OF	EVAPORATED TO	LOSS OF $HgCl_2$.
A 50 cc	....	dryness	.0133 grm
A 50 cc	50 cc water	25 cc	.0036 grm
A 50 cc	20 cc dil HCl	25 cc	.0063 grm
A 50 cc	1 grm KCl	dryness	.0008 grm
A 50 cc	1 grm plus 50 cc water	25 cc	.0002 grm
B 12.5 cc	.0354 grm KCl plus 2 cc HCl	5 cc	.0001 grm

Solution A contained .2322 gram mercuric chloride in 50 cc, and solution B .1295 gram in 12.5 cc. The author considers that these results indicate the probable existence of the compound $K\,Hg\,Cl_3.\ H_2\,O$.

CHANGES THAT OCCUR IN RIPENING CORN.

BY C. F. CURTISS.

The great importance of corn as a forage and grain crop has induced the writer to record some observations in noting the successive changes that occur in the ripening process of this plant. These observations have been confirmed and emphasized by the generally unsatisfactory experience of the present season in the use of forage made from the immature corn plant.

It is well known that the corn plant in the process of ripening undergoes rapid and important changes. In order to note some of these changes equal areas, comprising one-fifth of an acre each, of uniform well-grown corn on the Iowa experiment station grounds, were cut and shocked in successive stages of growth at intervals of a week extending from September 17th to October 13th, 1892. This period took the corn in what is commonly termed the "dough stage" of the kernels, with stalks and leaves entirely green, and ended with the fully ripened ear, and stalks and leaves nearly all dead or dry, in the natural process of ripening without killing frost. These plots of corn were put into large, well-built shocks of 144 hills each on the dates named, and allowed to stand until the middle of December, the usual time of storing corn fodder under practical farm conditions. This was purposely included as one of the features of the investigation. To have been more scientifically accurate would have required immediate analyses at the time of cutting; however, all plots were treated alike, and the comparison undisturbed. The chemical work of this investigation was done by Prof. G. E. Patrick.

The yield of husked ear corn ranged from 53.6 to 64.3 bushels per acre. At the time of the first cutting the ear corn constituted 48 per cent by weight of the total crop; at the second, 49 per cent; at the third, 52 per cent; at the fourth, 53 per cent; and at the fifth, 54 per cent. There was then a steady increase of the proportion of corn to stover as ripening progressed. The total dry matter in the crop increased from 3,489 pounds in the stover and 2,728 in the corn at date of first cutting to 3,856 in the stover in the second cutting and 3,194 in the corn in the third cutting. The total dry matter in the crop increased from 6,217 pounds in the first cutting to 6,782 pounds in the second, while the third and fourth fell short of this about 200 pounds, owing to a loss in stover not wholly compensated for in increase of corn, although the yield of corn and total dry matter contained to increase steadily until the fourth cutting, or for two weeks after the stover had reached its maturity. The marked increase in dry matter of both stover and corn between the first and second cutting indicates that the corn plant elaborates material rapidly at this stage, and the decrease of dry matter in stover and increase of that in corn afterward, furnishes evidence that there is considerable translocation of plant material after the stalk has attained its growth.

In noting the specific changes in composition it was found that the protein of the stover fell off rapidly after the second cutting, which continued steadily until the last and that there was an increase, although not a corresponding one, in the corn, until the third cutting, after which it also fell off. Carbhydrates and fat also fell off steadily in the stover after the second cutting and increased in the corn from the first to the fourth.

One sample of stover was left standing uncut in the field until December and then taken for analyses the same as the others. The total dry matter secured in this sample was 1,940 pounds against 3,856 from the plot of second cutting September 26th. A part of this, however, was due to mechanical loss, and the remainder to exposure to wind and weather.

At the Pennsylvania Station it has been found that both the total nutrients and the digestibility of a crop of corn increases as ripening progresses. Our observation seems in the main to agree with this, although there was a slight falling off of total dry matter in both corn and stover between the last two cuttings which would indicate that loss from exposure begins immediately or very soon after complete maturity has been attained. It is probable, also, that digestibility declines quite as soon if not before loss of nutrients sets in.

CHEMICAL ANALYSIS OF SOILS.

BY G. E. PATRICK.

There is hardly a subject upon which the opinions of chemists differ more widely than upon that of the utility of soil analysis, as a means of judging of the present crop-producing power of soils, or of ascertaining in what particular element or elements their store of available plant-food most needs replenishing in order to restore or increase fertility. This difference of opinion is not because any one questions the efficiency of chemical analysis in determining the total amount of the several plant-food elements present in the soil. That is easily done. The difficulty lies in determining how much of this total amount is in such condition, or combination, as to be readily available to the growing plant. This the chemist is as yet unable to do with certainty.

It is not my intention to imply that there is a hard and fast line separating these two groups, the available and the unavailable plant-food materials of the soil; for as regards the mineral matters, at least, availability is a matter of degree; and moreover, certain stores of plant-food, in one and the same soil, seem more available to the one class of plants than to another. Nevertheless the distinction, as ordinarily made, is entirely valid; the debatable ground is narrow; on one side of it are the compounds readily soluble in the root juices of all plants — the distinctly available; on the other side are the great stores of food material in forms nearly insoluble in the root-sap of all the higher plants — the unavailable.

Evidently some means of distinguishing between these two groups is much to be desired, to enable the chemist to ascertain with certainty the needs of any particular soil in respect to readily available plant-food; and the hope of finding such a means has been the motive of a number of researches in recent years.

The solvent that for many years has been employed for extracting the soluble portions of soils, is hydrochloric acid, sometimes dilute, but more frequently quite strong (twenty-three to twenty-five per cent), sometimes hot, sometimes cold, acting for periods ranging from one to forty-eight hours*.

Now hydrochloric acid of this strength, or anything approaching it, is a much more powerful solvent than is the root-sap of plants. It is not surprising, therefore, that the results obtained by chemical analysis have not been found reliable measures of the relative amounts of the different plant-foods existing in readily assimilable form in the soils analyzed, except possibly in the case of new (virgin) or nearly new soils, where a large "total" of any element may be assumed to indicate a large supply of that element in available form, and *vice versa.* (Hilgard.)

Since the sap of plant roots is mildly acid with vegetable acids it seems reasonable, not to say evident, that in our attempts to discriminate between the available and the unavailable constituents of the soil we should imitate nature by employing weak solutions of some kind of vegetable or organic acid. But what acid, and how weak the solution? These are questions that at present need answering. Some work has, however, been done on these lines.

In 1872 H. von Liebig† reported some work on the soils of the Rothamsted wheat plots, in which he used "dilute" nitric and acetic acids as solvents; but the extent of dilution was in neither case stated. Each plot had received annually the same treatment as to manuring—the treatment recorded below—for nearly thirty years. All had been cropped continuously with wheat. The soil samples examined represented the first and second depths of nine inches each for each plot. Results were as follows:

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* Of sp. gr. 1.115 (=23.4 per cent strength) for thirty-six hours at the boiling point of water. (Ass'n of Official Agricultural Chemists, 1893).

Of 25 per cent strength, at ordinary temperature for forty-eight hours; or of 10 per cent strength at temperature of boiling water for three hours. (Ass'n of Agr. Expt. Stations of Germany, 1890).

Of sp. gr 1 15 (=30.3 per cent strength), at boiling temperature for one hour. Wahnschaffe, Brannt's translation, 1891).

Of about 15 per cent strength, on water bath for five hours. (Fresenius.)

† Quoted in Jour. Ch. Society, London, 1894, p. 117.

TABLE I.

SOILS.	Potash soluble in dilute acetic acid	Phosphoric acid soluble in dilute nitric acid.
	Percent.	Percent.
No. 3. Continuously unmanured—		
1st 9 inches	.015	.075
2d 9 inches	.018	.047
No. 10 A. Ammonium Salts only—		
1st 9 inches	.013	.076
2d 9 inches	.019	.047
No 5 A. Mixed mineral manures without nitrogen—		
1st 9 inches	.038	.108
2d 9 inches	.022	.058
No. 7 A. Mixed minerals and ammonium salts—		
1st 9 inches	.039	.126
2d 9 inches	.018	061
No 2 Farm yard manure—		
1st 9 inches	.041	.093
2d 9 inches	.026	.065

These results are striking, especially those for potash soluble in dilute acetic acid. The surface soils that had annually received supplies of available potash (in the mineral and barnyard manures) showed two to three times as much potash soluble in acetic acid as did the soils not thus reinforced; while the subsoils showed much smaller differences. Unfortunately the amounts soluble in strong HCl were not reported in the abstract to which I have access, if determined at all.

In 1881, Deherain* observed that in the neighborhood of Grignon, France, where phosphatic manures had but little or no effect, the soil contained no more than an average amount of phosphoric acid, and yet gave up to acetic acid from one-fourth to one-half of the total amount present. Later, having followed up his studies in the use of acetic acid as a means of distinguishing between assimilable and non-assimilable phosphates, he finds that "while the plots manured with phosphatic manures yield appreciable quantities of phosphoric acid to the action of acetic acid, the phosphate-exhausted soils yield only insignificant quantities." These last would, of course, have yielded very considerable quantities to strong hydrochloric acid, by the usual mode of analysis.

In 1882, A. Vogel† suggested that if a sample of soil tested with acetic acid yields no indications of phosphoric acid, its

*Quoted in Jour. Chem. Soc., London, 1894, p. 119.

†Loc. cit. quoted from Bied. Centr., p. 852. 1882.

percentage of phosphates should be regarded as abnormally low.

In 1884, Stutzer* endorsed the suggestion previously made by Tollens, of using a dilute solution of citric acid in place of the usual ammonium citrate solution, in estimating the available phosphoric acid of fertilizers; claiming that thereby the actual manurial value was much better approximated than by the old method. He adopted and recommended a one per cent solution of citric acid.

Later A. Thomson† endorsed Stutzer's recommendation. "Neither Stutzer nor Thomson, however, appeared to give any reason for the strength of citric acid solution adopted, beyond the fact that the results obtained with a solution of this strength (one per cent), showed a fair correspondence with the comparative efficacy accredited by practical experience to the fertilizers examined." Their suggestions related to the testing of fertilizers, not soils.

In March of the present year Bernard Dyer‡ published the results of an extended investigation in which he applied to soils the method recommended by Stutzer for application to phosphatic fertilizers. The soils with which he worked were those of the famous experimental barley plots at the Rothamsted Experiment Station, England.

In order to decide intelligently upon the strength of the citric acid solution to be used in the work, Dyer first made approximate determinations of the acidity of the root-sap of a large number of plants, belonging to twenty different natural orders, and including most of the ordinary agricultural plants, garden vegetables, as well as field crops. From about 100 determinations he obtained an average acidity of a trifle less than one per cent, calculated as crystallized citric acid. The average for 100 plants was .85 per cent. Averaged first by orders, the average of these averages was .91 per cent. Speaking of these sap-acidity determinations, Dyer says: "Obviously these determinations, numerous and laborious as they have been, can only be regarded as being in the nature of a tentative and preliminary enquiry of a very crude kind, if criticized from the botanical or physiological standpoint. But they appear to be sufficient to indicate that the ratio of the soluble free acid in

*Chem. Ind. Feb., 1884. Quoted in Jour. Ch. Soc., 1894, p. 121.

†Chem. Ind., 1885. Quoted in Jour. Ch. Soc., 1894, p. 122.

‡Jour. Chem. Society, London, March, 1894.

the roots of plants to the moisture contained in them — which is here called sap-acidity — probably generally falls within, and not very far within, one per cent, calculated as crystalized citric acid. Citric acid is chosen to express the acidity, partly on account of its being an organic acid, and in that sense kindred to other root-sap acids; partly because it is the acid generally used by those who have attempted to determine the available phosphoric acid in manures by means of weak acid, in particular by Tollens, Stutzer, A. Thompson, and L. Wagner; and partly because it is at hand in every agricultural laboratory in a state of purity, and therefore a convenient acid. On the whole these sap-acidity determinations, however desultory and imperfect in a scientific sense, seemed to confirm the wisdom of Stutzer in adopting (Tollens had suggested various strengths) a one per cent solution of citric acid as a standard test of the availability of phosphates in manures, though he appeared to have lighted on that strength by experimental enquiry based on quite other grounds."

The several plots of soils which Dyer examined by the method indicated, had each received the same fertilization continuously for thirty-eight years—some phosphatic, some potassic and some mixed; all had been cropped continuously with barley. The soils were sampled to a depth of nine inches. Two hundred grammes of the air dried soil were treated with 2,000 c. c. of the one per cent solution of citric acid, and left in contact therewith for seven days, with frequent shaking. For comparison with the citric acid results, determinations of potash and phosphoric acid soluble in strong hydrochloric acid were also made. The averages for phosphoric acid were as follows:

Percentage of total phosphoric acid—soluble in strong HCl. —in the eight plots receiving no phosphates, was .106; in the eight plots receiving phosphates, .178. These numbers are nearly in the ratio 1 : 1.7. Percentage of phosphhoric acid dissolved by citric acid from the eight plots receiving no phosphates, was .00078; from the eight plots receiving phosphates .0463. These figures are in the ratio of nearly 1:6. "The difference in the percentages of the phosphoric acid soluble in dilute citric acid is thus comparatively overwhelming."

Striking as these results are, those obtained in the potash determinations are even more so. The average percentage of HCl-soluble potash in the eight plots receiving no potash, was .195; in the eight plots receiving potash, .266. These figures are in the ratio 1 : 1.36. The average percentage of potash dissolved by citric acid from the eight plots receiving no potash was .0038; while from the eight plots that had received potash, it was .0348. These figures are in the ratio 1 : 9. Again, an "overwhelming" difference.

The results of Dyer's work upon the Rothamsted soils, the treatment of which had been such as would naturally cause wide differences in the amounts of available plant food present, suggested the desirability of trying his method upon soils whose treatment had been that of ordinary agricultural practice. Therefore I resolved to try the method upon some samples of Iowa soils that I had in process of analysis last spring for the state geological survey; and I also resolved to apply the method to the nitrogen of the soils, as well as to the phosphoric acid and potash.

Correspondents in different parts of the state had each sent me two samples of soil, one representing the "best" and the other the "poorest" soil occurring over any considerable area in his vicinity. Each sample was (or according to directions was to be) a composite sample from five different spots in the field or area which it was intended to represent. The directions were that every sample should be taken to a depth of exactly nine inches. The methods of Dyer were followed except in some details of the determinations, where the official methods of the Association of Agricultural Chemists were preferred.

With these explanations the table of results will be intelligible. (Table II.) The total nitrogen, also potash and phosphoric acid soluble in hot HCl (*i. e.*, by the Association method) have been determined on eight samples, and for comparison these results are included in the table.

TABLE II.

PERCENTAGE IN AIR-DRIED SOILS.

SAMPLES.	PHOSPHORIC ACID P_2O_5		POTASH K_2O		NITROGEN.	
	Soluble in HCl	Soluble in citric acid	Soluble in HCl	Soluble in citric acid	Total.	Soluble in citric acid
A { Best	.20	.0118	.27	.0039	.179	.0032
A { Poorest	.15	.0235	.33	.0060	.301	.0150
B { Best	.18	.0196	.33	.0139	.278	....
B { Poorest	.13	.0133	.26	.0095	.154	.0028
C { Best	.16	.0146	.34	.0092	.236	.0087
C { Poorest	.15	.0091	.34	.0058	.109	.0031
D { Best	.16	.0192	.38	.0117	.245	.0109
D { Poorest	.22	.0131	.30	.0056	.225	.0075
E { Best	....	.0376	....	.0129	....	.0075
E { Poorest	....	.0070	....	.0027	....	.0029
F { Best	....	.0562	....	.0112	....	.0092
F { Poorest	....	.0520	....	.0046	....	.0176
G { Best	....	.0517	....	.0209	....	.0134
G { Poorest	....	.0281	....	.0141	....	.0118
H { Best	....	.0141	....	.0056	....	.0124
H { Poorest	....	.0132	....	.0028	....	.0124
I { Best	....	.0139	....	.0048	....	.0115
I { Poorest	....	.0083	....	.0036	....	.0099

It will be noticed in the results on the first four pair of samples where the old and new methods of analysis can be compared, that as a rule the differences shown between the best and the poorest soils are relatively much greater by the new than by the old method. Usually the differences are in the same direction, by the two methods; but there appear to be exceptions to this, namely, in respect to the phosphoric acid of samples A and D. Such a condition might reasonably be expected in comparing a soil originally more fertile, but much worn, with one originally less fertile, but little worn. In the cases here recorded I can not state the history of the soils.

It will also be noticed, in comparing the figures obtained by the new method for each pair of soils, that in every case there is a wide difference in regard to at least one of the three plant nutrients reported upon—the three in which a soil is most likely to be deficient. These wide differences probably, in most of the cases, reveal the causes of the observed differences in fertility; I say, probably, because the work here reported is purely chemical, and little account has been taken of the mechanical condition, or physical constitution, of the soils—a factor second only to chemical composition in determining fertility. Physical condition or constitution, rather than chemical, seems to be the controlling factor in the case of the "poorest" of the first two soils of the list—marked A. This soil contains decidedly more citric acid-soluble $P_2 O_5$, $K_2 O$, and N, than does its mate marked "best"; also more of these elements soluble in HCl, except $P_2 O_5$ —and respecting this the difference is only slight.

In order to find the explanation in this case—the only exceptional one in the list—I made inquiry of the sender (Mr. J. O. Overholt, of Havelock, Pocahontas county) to which he replied: "The sample marked 'poorest,' is soil that needs tile drainage, and on wet years is difficult to farm. The one marked 'best' is high land, and is productive every year, wet or dry." These facts explain the apparent anomoly, and forcibly illustrate the necessity of considering the physical as well as the chemical constitution of soils, in studying the conditions affecting fertility.

The tentative conclusions to which Dyer was led by his work on the Rothamsted soils are as follows: "It would perhaps not be unreasonable to suggest that, when a soil is found to contain as little as about .01 per cent of phosphoric acid soluble in a one per cent solution of citric acid, it would be justifiable to assume that it stands in immediate need of phosphatic manure." Concerning potash he says it is difficult "to draw from the figures any fairly plausible suggestion as to what percentage limit of citric-acid-soluble potash should be regarded as marking the non-necessity of special potash applications. Probably this limit lies below .005 per cent." How far below he does not venture an opinion. Nor can we draw any more definite conclusion from the results on the Iowa soils. So far as they bear witness, however, they seem to justify Dyer's tentative conclusions. Evidently it will require much careful work — chemical work correlated with field observations — to fix the exact limits below which the several elements may, with certainty, be declared deficient for the porposes of immediate crop production; and doubtless any such limits will have to be qualified by conditions as to the physical constitution of the soil.

Although much remains to be done in the future along this or some similar line of research, before the desired end will be attained, sufficient has already been learned to justify the opinion that the citric acid method of soil analysis, as proposed by Dyer, is a distinct advance upon the method commonly in use for ascertaining deficiencies in available phosphoric acid and potash. With reference to available nitrogen its adaptability cannot be pronounced upon without further research.

The acknowledgements of the writer are due to Mr. O. H. Pagelsen and Mr. D. B. Bisbee, for their assistance in the above recorded work.

NITROGEN COMPOUNDS OF THE SOIL.

BY D. B. BISBEE.

(Abstract.)

In examining for ammonia a soil-extract, prepared by digesting soil for three days in dilute HCl, the author noticed that Schloesing's method (distilling the extract with excess of MgO) gave a continuous separation of ammonia, amounting in this case to .0024 per cent. Another portion of the extract was filtered after the addition of MgO and before boiling. In it the separation of ammonia ceased after boiling a comparatively short time, and the total separated was .0017 per cent. The evident inference is that "part of the amides in Schloesing's extract can be precipitated by magnesia; and, by the second method 'results are obtained which are much nearer the truth in respect to the ammonia of the soil than by the original Schloesing's method.'"

Kjeldahl's process for determining the total nitrogen in a soil-extract consists in boiling the extract with H_2SO_4 and salicylic acid till colorless, adding HgO and $KMnO_4$, and distilling with NaOH. The same results were obtained by reducing the nitrates, preferably with a zinc-copper couple, and distilling with a strong excess of alkaline permanganate.

From experiments with citric acid it was found that "a one per cent solution of citric acid dissolves a part of the nitrogen of the soil as amides and none as ammonia. If ammonia is in the soil citric acid either does not dissolve it or else converts it into amide-like bodies. These amides dissolved in citric acid are volatile at least in part. The volatile part is converted into ammonia by long boiling with dilute HCl, or by boiling a short time with alkaline permanganate."

A CHEMICAL STUDY OF HONEY.

BY W. H. HEILEMAN.

It has long been known that honey is composed chiefly of dextrose and levulose (reducing sugars), with a small per cent of sucrose. These, with water and ash, are generally all that is given in an analysis, and their sum invariably falls from three to ten per cent below one hundred. The results of analyses vary with different examples, as shown by the following summary of results, obtained by different observers:

Reducing sugars	58 per cent to 82.5 per cent;	average, 77 per cent.
Dextrose	22.2 per cent to 44.7 per cent;	average, 35 per cent.
Levulose	32.2 per cent to 46.9 per cent;	average, 39 per cent.
Sucrose	0 per cent to 8.9 per cent;	average, ---- -------
Water	10 per cent to 20 per cent;	average, ------ -----
Ash		average, 0.15 per cent.

Solutions of genuine honey, with few exceptions, exert a left-handed rotation on polarized light, ranging in amount from 0° to 20°, at a temperature of 20° C.

I analyzed by ordinary methods the following four samples:

No. I. Extracted buckwheat blossom honey, produced in 1892 and belonging to the entomology department of the Agricultural College; the sample was taken in May, 1893; the honey was much crystallized, dark in color and strong in flavor.

No. II. Extracted clover and basswood honey; history like No. 1; it, too, was nearly all crystallized. It had a golden color and fine flavor.

No. III. Bought in May, 1893, at the grocer's, in Ames; it was put up by J. M. Jacobs, of De Witt, Iowa. It was said to be strained honey. It had a bad flavor and taste, but a rich brown color.

No. IV. A sample of comb honey. in one-pound brackets, sold by a local apiarist. It presented a golden color, a fine taste and flavor, and was undoubtedly a pure honey. The analyses showed the following results:

SAMPLE NO.	Hours dried	Per cent moisture.	POL. READINGS. Normal.	Invert'd	Sucrose, per cent	Reducing sugar, per cent	Acids (formic) per cent.	Ash. per cent.	Total. per cent.
I	27	18.95	-11.60	-17.53	4.46	75.30	.13	.10	98.94
II	13	17.09	- 4.46	-13 63	3.74	77.01	.07	.14	101.25
III	16	18 18*	-19.66	-24 22	3 36	74.09	....	.14	95.77
IV	20	16.90	-12.80	-19.60	3.60	76.10	....	.30	96.90

*Lay in desiccator over sulphuric acid one year and six weeks, and had then lost 18.22 per cent moisture.

The plan of analysis was as follows:

A normal charge for the Soliel-Ventske Polariscope (26.048 grams) was put into 100 cc of solution, defficated with Aluminum cream and polariscope readings taken in a 200 mm tube; part of the solution was inverted with acid at 67° to 70° C, cooled, and readings taken at the same temperature as those of the normal uninverted solution. Corrections were made for acids and defficator at the required times and all final figures given are for solutions of normal charge.

For the determination of sucrose the double polariscope readings figured by Clerget's formula were used.

$$\frac{\text{Difference bewteen Pol. readings x 100}}{144-\frac{1}{2}\text{ T}}=\text{C}$$

Cleget's formula is an abbreviated expression from which to determine the per cent (C) of sucrose in the presence of glucose sugar. The figure 144 is the greatest range of deviation that can be produced by the inversion of a normal solution of sucrose into invert sugar at zero degrees C. Since, however, levulose is present in invert sugar and its optical activity changes as the temperature increases or diminishes, and it is found that the range of 144 divisions decreases one division for each two degrees rise of temperature from zero, it is necessary to subtract from the greatest range such a figure as will express the loss of optical activity of the levulose, due to rise of temperaature above 0° C. The formula is based upon the fact that if the solution in question were a normal one of cane sugar it would read 100 divisions in the polariscope.

The figure thus obtained by Clerget's formula will not be a true one should any other sugar than sucrose be present and become inverted during the inversion. In honey there is a possibility of dextrin being present, this substance might after continued inversion be changed into dextrose. I feel safe in assuming, however, that dextrin, even if present, would not become inverted in fifteen minutes at 70° C. Allen (Volume I, article 635) mentions that it is only after continued inversion at 100° C with acid that it changes finally to dextrose. The presence of Maltose in honey would after inversion produce an untrue percentage if calculated as sucrose. We have, however, been unable to determine its presence in the honey studied.

For the determination of reducing sugars in honey Fehling's solution was used. In titrating, an approximate one per cent solution of honey was added to 10 cc of undiluted Fehling's solution until the copper was completely reduced. Gravimetric determinations were also made which correspond well to the volumetric. For standardizing alkaline copper solutions chemically pure dextrose gave results which accord well with inverted C. P. sucrose determinations.

The results obtained in the determination of moisture in the above samples are very unsatisfactory. In none of the samples were constant weights obtained, even when dried for twenty-seven hours—weights taken every three hours. The figures given merely signify that drying was discontinued at that point. For moisture ordinary flat bottomed aluminum dishes were used. A sample of about five grains was dried at water-oven temperature, and stirred with a rod at intervals, the temperature being kept at 100° C.

The ash was determined by a careful ignition of the sample at low redness until charred, and then heating to bright redness until the carbon was all consumed. The ash of pure honey gives an alkaline reaction, and its analysis is often used as a detection for adulteration.

All the honeys examined gave a slight acid reaction; this was figured as formic acid. Besides the regular analysis of the above mentioned honeys, No. IV was studied with reference to inversion by fermentation. For the fermentation, invertin was added; it is a soluble ferment which readily inverts cane sugar, but does not effect maltose, dextose, levulose, and likely not dextrin. To the solution to be inverted thymol was added to protect other sugars than sucrose from other organized ferments. A period of thirty hours of fermentation at 20° C showed a slight inversion, after fifty-four hours the results were practically as at thirty hours, and a longer fermentation gave no more favorable results. The fermentation did not produce results in comparison to acid inversion.

The preceding table of analyses, with outline description of methods employed, indicate somewhat the difficulties that must be overcome in order to obtain a satisfactory analysis of honey. The intricacies present themselves in the separation of dextrose and levulose, the total determination of moisture, and also the questions as to the presence of dextrin, maltose, or other sugars, organic matter not sugar, acids and volatile matter.

For special study upon some of the above problems one of the honeys analysed, namely, No. II, was taken. The object of the special study on this particular sample being that of determining, if possible, its total composition, by the application of either old or new methods.

The determinations of total reducing sugar with Fehling solution, as previously described, gave results very satisfactory. Sample No. II gave results as follows on three determinations:

1 grm. honey contained .7706 grm. Red. sugar=77.06 per cent.
1 grm. honey contained .7701 grm. Red. sugar=77.01 per cent.
1 grm. honey contained .7654 grm. Red. sugar=76.54 per cent.
Mean per cent of Red. sugar.................76.87.

The desire for a complete separation of the reducing sugars into levulose and dextrose, caused me to study very carefully several methods.

Allen's* slaked lime method, in which the levulose is brought down at 0° C as a calcium compound, while the calcium compound of dextrose remains soluble, was a partial success. The dextrose was ascertained in that way, but the continuous failure to estimate the levulose after its precipitation, due to partial loss of rotary power, also the difficulty of completely separating it from its calcium compound, caused me to discard the method and seek another.

Sieben's† process, in which he destroys the levulose with acid, gave variable results. The temperature of boiling water in a six times normal acid honey solution destroys, not only the levulose, but part of all other sugars as well.

In another process, published by Wiechmann and originated by Winter†, the solution of honey is treated with an ammoniacal solution of lead-acetate which precipitates lead compounds of dextrose and levulose. In this method the dextrose is separated with CO_2 and estimated as dextrose, while the lead of the levulose compound of lead which remains after

*Commercial Organic Anal. Allen, Part I, p. 291.

†Sugar Analysis, Wiechmann, p. 59 and p. 60.

the separation of dextrose is precipitated with hydrogen sulphide. This leaves a solution of levulose which, when concentrated, is supposed to be capable of estimation in the polariscope, or by gravimetric process. The method does not, however, appear to be applicable to honey analysis. The products sought are destroyed in the reactions, and the results obtained were far from correct. We think the method quite applicable, however, where little reducing sugar is present.

Allen's method* for the determination of levulose by taking readings in the polariscope of a normal solution of honey at different temperatures, and calculating the amount of levulose that must be present, gave figures quite reliable and apparently accurate.

The results for levulose by range of temperature on three determinations gave a mean of 32.93 per cent.

The results for dextrose by precipitation with slaked lime on three determinations gave a mean of 43.58 per cent.

The sum of the two sugars estimated separately is 76.51 per cent. The total reducing sugars present by Fehling's solution is 76.87 per cent, a difference of 36 per cent in favor of the copper reduction.

For the determination of moisture a paper coil method was substituted for the open pan method. A comparison of results gives the following figures:

Dried in open dish	8 hours,	15.50 per cent moisture.
Dried in open dish	13 hours,	17.09 per cent moisture.
Dried in paper coils	2 hours,	17.53 per cent moisture.
Dried in paper coils	3 hours,	18.39 per cent moisture.
Dried in paper coils	4 hours,	18.59 per cent moisture.

It is generally stated that honey contains no dextrin; this sample, however, contained .36 per cent of dextrin. The method employed was the separation with absolute alcohol.

For the determination of organic matter not sugar, acetate of lead was used as proposed by Wiechmann.† The result gave .14 per cent non-sugar material. An analysis of sample No. II gave .12 per cent of material as non-crystallizable, non-diffusible.

Should a sample contain non-crystallizable sugar, and also organic matter not sugar, these two methods would serve for the determination of such products, and might thus be useful

*Allen's Com. Organic Anal., Vol. 1. p. 291.

†Sugar Analysis, Weichmann, p. 83.

in work upon adulterated samples. In this sample they check each other, and are only accounted for in the final summary as Organic Matter not sugar.

For the purpose of making an estimation of volatile matter at 100° C., I prepared an apparatus consisting of a condenser attached to a retort which was hung in a water bath, and so arranged that a constant current of heated air could pass into the retort to facilitate the work. The outer end of the condenser dipped into a flask of alcohol (cooled in a jacket of ice water) which retained all the volatile matter, and from which the final estimation was made. In this manner, after fifteen hours .14 per cent of volatile matter was obtained. A test for formic acid upon this product gave a negative result.

The final result then of a complete analysis as given in outline above is as follows:

	PER CENT.	GRAMS.
Water	18.59	4.83
Dextrose	43.58	11.36
Levulose	32.93	8.58
Sucrose	3.74	.97
Dextrin	.36	.09
Organic matter not sugar	.14	.04
Volatile at 100° C.	.14	.04
Acidity	.18	.05
Ash	.14	.04
Loss and undetermined	.20	.05
Total	100.00	26.05

Since the Sp. R. P. of all sugars found in this sample are known, it will now be easy to compare the results obtained by the different methods with the original polariscope readings.

The reading of a normal change of honey No. II in the polariscope was –9.9°; the same solution after inversion read, –14.88°. This by Clerget's formula gave 3.74 per cent sucrose in the sample or .97 grams when compared to a normal (26.048 grs.) charge. This .97 grams when thus compared will give such a reading on the polariscope as the inverse ratio it bears to a normal change; as:

26.048:.97 :: 100° : x (x=degrees sugar units.)
x=3.74°.

The Sp. R. P. of dextrose is 52.7. The grams dextrose required for 100 sugar units in 100cc of solution are as the proportion

52.7 : 66.5 :: 26.048 : x
x=32.87 grams.

32.87 : 11.36 (table) :: 100 : x
x=34.62° (Plus reading on sugar scale).

The plus reading due to dextrose in sample No. II is therefore equal to 34.6°

The Sp. R. P. of dextrin is 200; by the above method we have the following proportion:

200 : 66.5 :: 26.048 : x

x=8.66 (grams dextrin required to 100° sugar units).

8.66 : .09 (table) :: 100° : x

x=1.04° (Plus reading on sugar scale).

The Sp. R. P. of levulose is 98.8, the reading due to levulose would therefore be as the proportion:

98.8 : 66.5 :: 26.048 : x

x=17.54

17.54 : 8.58 (table) :: 100 : x

x= —48.91° (Minus reading on sugar scale).

The rotary power of the sample is as follows:

Sucrose	+ 3°.74
Dextrose	+34°.60
Dextrin	+ 1°.04
Levulose	—48°.91
Total, calculated	— 9°.53
Observed	— 9°.9
Difference	0°.37 sugar unit.

This difference corresponds to .01 gram honey in the charge taken.

I propose the following outline method for ordinary honey analysis:

For determination of moisture use the paper coil (Josse) method.

For sucrose, double polarization and Clerget's formula.

For levulose, range of temperature as proposed by Allen.

For dextrose, gravimetric precipitation with slaked lime (Allen).

For volatile material, plan as proposed in this paper

For non-crystalizable material, any good diffusion apparatus—using flowing water.

For Organic Matter not sugar, method as given by Wiechmann.

For dextrin, separation by absolute alcohol.

For ash, ignite at low redness until gray or white residue remains.

For acid, titrate with $\frac{n}{10}$ alkali and figure the result as formic acid.

NOTE—For literature upon the subject of honey analysis see:

Jour. Chem. Society, June 1894, p. 269.
Jour. Chem. Society, 1872, 25, p. 906.
Jour. Chem. Society, 1878, 2, p. 969.
Jour. Chem. Society, 48, p. 444.
Jour. Chem. Society, 1886, 50, p. 282.
Analytical methods for honey, J. Sieben. Fres. Zeit. f. a. Chem., 1884, 24, 137.
Chem. Cent. Blatt, 1893, II, p. 893.
Zeit. ges. Brauw. 16, p. 349.
Pharm. Jour. Trans., Nov. 1, 1884, p. 343.
Analyst, 1878, 3, p. 267. 1884, 9, p. 64. 1889, 14, p. 20.

EFFECTS OF HEAT ON THE GERMINATION OF CORN AND SMUT.

BY F. C. STEWART.

Bunt and smut of oats are successfully combatted by treating the seed with hot water previous to planting. Since the discovery of this method by Jensen, a great many experiments have been made both in Europe and America. The success with bunt and oats smut naturally directed the attention of investigators to hot water treatment for corn smut, but experiments made by Pammel* and others proved it to be ineffectual.

Very few tests have been made to determine the thermal death-points of different smuts. Hoffman and Schindler have tested several economic species. It is evident that nothing can be accomplished by treatment with dry heat, for the corn smut spores are capable of withstanding a much higher temperature than the corn itself. Hence the investigations recorded in this paper may be of little practical importance, but considering that the literature on the subject is exceedingly meager, they may have some interest. Much work has been done in testing hot water and chemicals for other smuts.†

*Iowa Agricultural Experiment Station Bulletin, No. XVI.

†J. Kuehn, Bot. Zeitung, 1873, p. 502.

Kellerman and Swingle, Kansas Agricultural Experiment Station, 1889. Second Annual Report, pp. 213-288. Also Bulletins Nos. 12 and 15.

Kellerman, Kansas Agricultural Station Bulletin, Nos. 21, 22 and 23.

Sorauer, Pflanzen Krankheiten. pp. 203-208

H. L Bolley, North Dakota Agricultural Experiment Station, Bulletin No. 1.

J. C. Arthur, Indiana Agricultural Experiment Station, Bulletin Nos. 28, 32 and 35.

Fletcher, Central Experimental Farm, Ottawa, Canada, Bulletin No. 3.

J Fremont Hickman, Ohio Agricultural Experiment Station, Bulletin No. 6, Vol. III, Series II, and Bulletin No. 1, Vol. V, Series II.

Ustilago Maydis, Pammel, Experiments with Fungicides. Iowa Agricultural Experiment Station, Bulletin No. 16, p. 316.

Tilletia caries. Dry heat 80° C. for two hours did not destroy all of the spores. Above 95° C. spores no longer germinated. Schindler. Euber den Einfluss verschiedener Temperaturen auf die Keimfahigkeit der Steinbrand Sporen. Fortschritte auf dem Gebiete der Agriculturphysik, Vol. III. Heft 3, 1880. Zoph, Die Pilze, p. 216.

Ustilago carbo and *U. destruens*. Dry heat 104-128° C. *U. Carbo* is destroyed with moist heat between 58.5° and 62° C. *U. destruens* is destroyed when heated to 74-78° C. for one hour; for two hours the maximum temperature is 70-73° C. Hoffman, Jahrb fur Wissenschaftl. Botanik II, 1860, p. 267. Zopf. l. c., p 216.

OBJECT OF THE INVESTIGATIONS.

It was desired to obtain four thermal death-points:

1. The temperature at which spores of corn smut lose their power of germination when immersed for fifteen minutes in water kept at that temperature.

2. The temperature at which spores of corn smut lose their power of germination when subjected for fifteen minutes to that temperature in a dry oven.

3. The temperature at which corn loses its power of germination when immersed for fifteen minutes in water kept at that temperature.

4. The temperature at which corn loses its power of germination when subjected for fifteen minutes to that temperature in a dry oven.

Further it was desired to obtain information regarding:

(*a*) The temperature at which the young corn plant first shows injury due to the seed having been immersed for fifteen minutes in water at that temperature.

(*b*) The temperature at which the young corn plant first shows injury due to the seed having been subjected for fifteen minutes to that temperature in a dry oven.

METHODS AND MATERIALS.

The corn smut used was one year old, and all from the same ear of corn. It was germinated in sterilized cistern water in rubber cells. The corn used was of the variety, Iowa Gold Mine, and of high germinating capacity. In all cases the check kernels were from the same ear as the treated kernels. The corn was germinated in boxes of ordinary garden earth. For the determination of the thermal death-point of corn (dry heat) the kernels were placed in the drawer of a Naples bath. For determining the thermal death-point (wet heat) of both corn and smut, the drawer of a Naples bath was filled with water, and the corn and corn smut immersed in it when it became of the proper temperature.

To obtain the thermal death-point of corn smut (which is above 100° C) it was necessary to use a dry sterilizing oven. The smut was placed in a small tin thimble fastened to the end of a string, and when the thermometer in the top of the oven indicated the temperature desired, a cork in the top of the oven was removed, the thimble lowered quickly into the oven and the cork replaced.

RESULTS.

SPORES OF CORN SMUT IMMERSED IN WATER FOR FIFTEEN MINUTES.

Temperature of water Centigrade.	Length of time spores were in cell.	Number of good cells.	Germination.
57.5-58 5	72 hours.	1	None.
57 -58	72 hours.	2	None.
55	96 hours.	2	None.
54 -54.5	120 hours.	3	None.
54 -54.5	72 hours.	3	None.
54	71 hours.	2	None.
53 -53.5	72 hours.	3	None.
53 -53.5	71 hours.	2	None.
52 5-53	120 hours.	2	None
52.5	120 hours.	3	None.
52	120 hours.	5	None.
51.5	144 hours.	3	A few in one cell germinated.
51 -51.5	71 hours.	2	Several germinated.
50	71 hours.	2	Several germinated.

SPORES OF CORN SMUT HEATED FIFTEEN MINUTES IN DRY OVEN.

Temperature of oven Centigrade.	Length of time spores were in cell.	Number of good cells.	Germination.
106 5	120 hours	10	None.
105 5-106	120 hours.	8	None.
105	120 hours.	5	A few in each cell germinated.
104.5-105	48 hours.	1	Several germinated.
101	72 hours.	1	Several germinated.
100	72 hours.	2	Several germinated.
96.5-97	53 hours.	1	Germinating vigorously.

GERMINATION OF CORN WHICH HAD BEEN IMMERSED IN HOT WATER FOR FIFTEEN MINUTES.

I.

Temperature of water Centigrade.	Percentage that came up.	Average height twelve days after planting.—Inches.
Check	100	4.55
55	100	4.6
57 -58	100	4.5
57.5-58.5	100	4.5
60.5-61	95	4.1
61.5-63.5	95	3.14
63 -64 5	85	2.55
67.5-68	20	1.33
69 5	00	
69.5-70	5	Barely came through.
69 5-70.5	5	Nine days in coming through.
70.5-71	00	
70.5-71 5	00	
76 -76.5	00	
77 -77.5	00	

II.

Temperature of water Centigrade.	Percentage that came up.	Average height at end of nine days.—Inches.
Check	100	3.9
62	100	3 75
66	50	3
68 -69	16	3
68 -69.5	50	1.6
69 -69.5	4	1
69 -70	40	2.8
70.5-71.5	00	

GERMINATION OF CORN AFTER BEING HEATED IN DRY OVEN FIFTEEN MINUTES.

I.

Temperature of oven.	Percentage that came up.	Average height at end of seven days. —Inches.
Check	100	4.2
65	100	3.55
67	100	3.8
69	100	3.6
71	100	3.35
73	100	3.8
74.5	100	3.7

II.

Temperature of oven.	Percentage that came up.	Average height at end of eight days. —Inches.
Check	100	6.12
76	80	1 7
76-76.5	65	1.8
76.5	65	1.6
77	30	1
77.5	60	1.6

III.

Temperature of oven.	Percentage that came up.	Average height at end of five days. —Inches.
Check	80	1.5
75–76	80	.75
76–77	70	.75
77–78	60	Showed decided injury.
78–79	00	Only 3 sprouted in 11 days.
79–80	00	Only 1 sprouted in 11 days.

IV.

Temperature of oven.	Percentage that came up.	Growth.
Check	100	At end of 6 days 6 inches high.
77.5–78	00	At end of 6 days 40 per cent sprouted.
78 –78.5	00	At end of 6 days 38 per cent sprouted.
78.5–79	00	At end of 6 days none sprouted.

V.

Temperature of oven.	Percentage that came up.	Growth.
77.5	70	Barely got above surface.
77.75	15	Barely got above surface.
78.	00	Only two had sprouted.

CONCLUSIONS.

1st. The thermal death-point for corn smut spores immersed in water for fifteen minutes is 52°C.

2d. The thermal death-point for corn smut spores heated in a dry oven for fifteen minutes, 105.5-106°C.

3d. Corn is unable to push its plumule through an inch of soil if the seed has been immersed for fifteen minutes in water at 70.5° or more.

4th. Corn is unable to push its plumule through an inch of soil if the seed has been heated in a dry oven for fifteen minutes at a temperature of 78°C or more.

5th. The young corn plant shows injury if the seed has been immersed for fifteen minutes in water at 60.5°–61°C or more.

6th. The young corn plant shows injury if the seed has been heated for fifteen minutes in a dry oven at 65°C or more.

REMARKS.

The experiments show that corn heated, either dry or in water, may be considerably injured and still retain the power of germination; it may show a fair percentage of germination and be unable to push through an inch of soil. Hence, mere germination does not show the condition of the seed as regards vigor.

Bacteria in the cell cultures are a source of much annoyance. If a cell in which the spores do not germinate is found to contain large numbers of bacteria they may be the cause of the failure of the spores to germinate and the experiment must be repeated.

Spores of *Fusarium* when in immature condition so closely resemble the sporidia of corn smut spores that they are easily mistaken for them. It is not safe to conclude that the spores in a cell are germinating unless the promycelia are actually seen coming from the spores.

PLANT LICE INFESTING GRASS ROOTS.

HERBERT OSBORN AND F. A. SIRRINE.

During the fall of 1889 the senior author of this paper determined that a species of plant louse, infesting roots of annual grasses was identical with the "Dogwood plant louse" (*Schizoneura corni* Fabr.), carrying the work far enough to prove that the winged forms could be transferred from grass roots to dogwood, on which they colonized. As he found the root forms principally on annual grasses which were of no economic value, it was naturally a question of interest to determine whether they might affect forage plants. Furthermore, the occurrence of non-migratory forms on certain of the grasses examined, left some questions which it seemed very desirable to follow up. In order to obtain winged forms and determine positively which of the annual grasses they migrate from, the following varieties: Barnyard grass, *Panicum crus-galli;* Old Witch grass, *Panicum cappilare;* Crab or Finger grass, *Panicum songuinale;* Foxtails, *Setaria glauca* and *viridis*, and some species of *Eragrostis*, were covered with large lantern globes during the fall of 1892. The globes were sunk into the ground around the plants and the tops closed by tying bunting over them. These traps failed to catch any winged forms, though at the time they were put out plenty of wingless forms could be found on the roots of the Barnyard grasses and Foxtails. It appeared from this that some mistake had been made, or that the work was not done with sufficient care. During the season of 1893, with a view to determine this matter, if possible, the "Dogwood louse" was bred in confinement and artificial transfers made. The wingless brood from the eggs was found on Dogwood or Silky Cornel (*Cornus asperifolia*, Michx.) May 17th, and confined by covering with cheese cloth. Young plants of Foxtail (*Setaria viridis*) were transplanted to flower pots and put in the green-house, lantern globes with tops closed with cheese cloth being put over the plants. In one jar a colony of the small field ant (*Lasius brunneus*) var. *alienus*, was put. This was done because these ants are usually found with root lice. On June 3d winged specimens of the second (?) brood were found under nets on Dogwood and transferred to jars containing Foxtail, by cutting off the twigs and inserting them into the dirt by the sides of the plants. They were left on the twigs because they are delicate to handle and, besides, in the case of the ants, it was a means of supplying the lice their natural food-plant for a few days till the ants could transfer them to the grass roots, in case the latter were essential to the migration. They have been observed carrying winged root lice out of doors during this season of the year. Both these transfers proved a failure, the lice refusing to colonize on the grass and dying. This may have been due to confinement, but seemed to indicate the wrong species of grass.

At the same time that the artificial breeding was being carried on observations were kept up in the field. On May 24 a root louse was found on Shepherds' Purse (*Capsella bursa-pastoris*, Mench.) and Knot weed (*Polyganum aviculare*, L.), which resembled *Schizoneura*, though of a different color than the apterous specimens found on Dogwood at the same time, and having five instead of six jointed antennae. Plants of Shepherd's Purse containing the root lice and their attendants were transplanted to the green-house. No winged forms were obtained from these, the plants maturing and dying.

Winged specimens of root lice were found on roots of Foxtail (*Setaria viridis*) in field with ants June 24th. The venation of the wings showed them to be related to the *Schizoneura*, but they were not as large nor of the same color as the winged forms found on Dogwood. (Color dirty white, antennae, head, thorax and wing callosities slightly dusky, seventh and eighth abdominal segments each with a dusky band, sometimes with pulverulent area on abdomen. Joints III, IV, V and VI, each with one sensorium.) Furthermore, all winged forms had disappeared from Dogwood before June 15th. A few days later, June 28th, a plant of Foxtail was found containing pupæ and wingless root lice; this, with the colony of ants, was transplanted to root cage and kept in laboratory. July 3d winged individuals were obtained from root cage identical with winged forms found out doors on Foxtail June 24th. Winged specimens; taken in colonies on roots of Pigeon grass (*Setaria glauca*, Beauv.) at the same time, were apparently identical with those of the Foxtail. These latter were depositing their larvæ on the grass roots without apparent attempts to migrate.

The latter part of August, as the annual grasses commenced to die from the effects of dry weather, lantern globes, also tents made of bunting, were placed over the same species of grass as in the preceding fall. On August 30th ants were observed, apparently removing wingless root lice from one of the traps. This they accomplished by mining under the lantern globe. This fact may account for the failure to obtain winged forms from covered grass roots the previous fall. Examination of the roots of grasses earlier in the fall showed that the *Setarias* were most infested. Later in the season, when these grasses commenced to die, the lice were found more abundant on the Panic grasses.

Winged specimens of *Schizoneura corni*, Fabr., were found returning to Dogwood (*Cornus asperfolia*, Michx.), September 8th. As we had been watching annual grasses, it seemed more than evident that they could not have migrated from those, for no winged forms had been found on the roots since July 3d.

On September 22d a root louse, of a decided ochre yellow color, especially in the wingless and pupal forms, was found on roots of "Beard Grass" or "Blue Joint" (*Andropogon furcatus*, Muhl.), and "Cord Grass" or "Bull Grass" (*Spartina cynosuroides*, Willd.). A few winged forms were also found. These agreed more closely with those found on Cornus at the time than any previous root forms taken from grass. A similar root louse was found September 25th on roots of "Drop Seed" (*Muhlenbergia racemosa*, Michx.). Specimens of these perennial grasses, with root lice and ant colonies, were transplanted to pots and kept in the laboratory. At the same time, specimens of the same grasses were covered in the field with traps, the same as the annual grasses. From those covered out of doors and also those transplanted, winged forms issued and rested in large numbers on the sides of the traps. In color markings and structural characters these agreed with *Schizoneura corni*.. A plant of Dogwood (*Cornus sericea*, L.) had been covered with bunting early in the fall. To this, numbers of these winged forms were transferred, where they willingly deposited their brood of wingless males and females.

In examining the roots of the annual grasses, in one or two instances wingless lice were found, of a yellow color, but not of such marked character as those on the perennial grasses. On September 25th a few winged specimens were found on roots of Pigeon grass (*Setaria glauca*, Beauv.), one of which, from the wing characters, appeared to be a typical *Schizoneura corni*, but the ends of its wings had been gnawed off. The natural supposition was that the ants had captured it and made it a prisoner, or had transferred it from a perennial grass. The other specimens, taken at the same time, resembled the forms already mentioned as taken on this grass in July, except that the wing venation was very variable, as shown in figs. 7 and 7½. These were also transferred to Dogwood, where they perished.

At the time the winged *Schizoneura* were found on "Drop Seed" a wingless form of a dirty white color was found with them, resembling the wingless form on Foxtail. These latter forms could be found on roots of Panic grasses (*Panicum crus-galli* and *sanguinale*) and *Muhlenbergia racemosa* as late as November 10th. No eggs had been found so far on the roots of any of these grasses, that is, attached to the roots. In 1889 the eggs were observed in the earth in breeding jar.

During the spring of 1894 the following additional notes were made:

On April 12th large numbers of a *Schizoneurini-like* louse, which resembled the large wingless forms taken the preceding fall (Sept. 25) on roots of "Drop Seed" were found in an ant's nest (*Lasius latipes?*), stored under an old rotten stick. Roots of "Blue Grass" covered and penetrated this stick. A few were apparently attached to the roots. The majority were old fundatrici, apparently full of pseudova. A few specimens of larval forms were present. April 18th the same louse, apparently, was found with the same species of ant on strawberry roots. They were also found on roots of Blue Grass, with another species of ant (*Lasius flavius?*). Specimens of each were confined to root cages, but no winged specimens were obtained.

April 18th, found eggs of plant lice stored in chambers of the nest of *Lasius flavius?* The color was such that they closely resembled the light brown "mite" that is to be found on roots, especially around decaying and diseased roots. These were taken to the laboratory, where on April 23d they hatched into *Schizoneura-like* Aphids.

April 24th, found what is apparently the same larval root form of louse, as bred from eggs obtained in ants' nest, on roots of *Spartina cynosuroides* with *Lasius flavius?* Also found a few eggs. These differ slightly in color from the larval forms found earlier in April on Blue Grass roots and under the decaying stick. They are not as light colored, and are more hairy. A few days later these larval forms were quite plenty on roots of annual Panic Grass, or *Setarias.*

May 24, found pupal winged form and fundatrici of what appeared to be the same *Schizoneura* as taken the previous spring on roots of Setarias. Winged specimens similar to these latter were obtained on roots of *Panicum*, *Muhlenbergia*, and on *Œnothera biennis* in field June 2d, 8th and 26th.

Apparently none of the *Schizoneura corni* which were colonized under netting during the fall of 1893 survived. In fact, this species was very hard to find in any locality during the spring. A few colonies were located on some low protected cornus shrubs. Winged specimens were obtained from these colonies as early as May 28. A few winged specimens were found as late as June 15. Perennial grass roots were watched from the last of May till the middle of July, and the nests of

*Osborn, U. S. Dept. of Ag., Div. of Ent., Bull. 23, p. 25.

Lasius latipes and *flavius* examined on numerous occasions, but not a *Schizoneura corni* could be found. Even some artificial transfers proved a failure.

The latter part of August a winged specimen of *Schizoneura corni* was found on cornus. The peculiar conditions to which this species of *Schizoneura* was subjected, viz.: a warm spell in March, followed by freezing weather, and then the drouth of a midsummer, nearly annihilated this Aphid.

Although numerous descriptions of some stages of *Schizoneura corni* have been published, it seems desirable for sake of comparison to give full description of the root forms*.

Schizoneura corni root-type from perennial grasses, September 23d.

Adult winged viviparous form, from: *Andropogon furcatus:* Expanse of wings, 6.61mm. Length of body, 2.25mm. Width, 1.22mm. Length of antennæ, .87mm. (Joint I, .087mm; II, .06mm; III, .3mm; IV, .11mm: V, .13mm; VI, with unguis, .17mm.) Eight sensoria on joint three, two each on IV and V, one on VI. (It is doubtful if the roughened areas near apices of IV, V and VI are true sensoria, if not, then IV and V have one each.) Antennæ and head dusky to black, membrane of articulations, yellow; prothorax and margin of thorax, dusky; callosities, black; abdomen, yellow. A dusky brown patch covers the fourth, fifth and sixth, and sometimes base of third segments; a band of same color extends across the seventh and eighth segments, also spots of the same color occur on the connexivum. Eyes, brick red; wing insertions, yellow; distance between points of insertion of first and second discoidals and base of cubital approximately equal. The latter obsolete at base, furcal starting about midway between base and apex. Stigmal with slight compound curve. Stigma .435mm x .18mm†. Legs, dusky; apical portion of femora and tibiae darker.

After migrating and depositing pseudova the yellow colors are not so marked, while the dusky markings are darker, The shrinking of the abdomen causes the dusky patch to appear to cover the whole dorsal surface.

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*Since plant lice are subject to slight variations in color markings. wing venation and sensoria markings, though probably no more than other insects, if examined with compound microscope, and as many species are covered with pulverulent and flocculent secretions, or with hairs, it would be a help, and avoid some error in comparison if authors would state under what conditions the descriptions are made. If examined with naked eye or hand lens, and held so the light is reflected, the pulverulent matter and hairs produce one color effect; if held between the observer and the light, enough light is transmitted through the thin body walls to give a different effect. If the specimens are mounted in balsam, and examined with compound microscope, different shades of color will be produced from those noted when examined before mounting. These latter will vary according to whether transmitted or reflected light is used. Unless otherwise stated the color markings as given are from mounted specimens with reflected light, and the measurements from transmitted light.

†The length of the stigma as given means distance from point of union of costal and subcostal veins and apex.

Adult winged viviparous form, from *Muhlenbergia racemosa.*

Color markings, venation, and length of antennæ and wings approximately the same as form on Andropogon, but the sensoria on joint III, vary from five to seven.

Apterous viviparous form, from roots of Muhlenbergia.

Length of body, 1.89mm. Width, 1.20mm. Length of antennæ, .86mm. Sensoria, one each on joints III, IV, V and VI. Whole body yellow; a few dusty brown bands on abdomen. Antennæ and legs, dusty brown; eyes, red.

Pupa: Length of body, 1.83mm. Width, .91mm. Length of antennæ .70mm. Sensoria not distinct except on joints V and VI.

Apterous viviparous form, from roots of Timothy (*S. corni ?.*)

Length of body, 2.00mm; width, 1.43mm; length of antennæ .42mm. Sensoria on joints IV and V, one on each joint. Color in balsam decidedly yellow. Beak reaching only to second coxæ, antennæ apparently five-jointed.

All the perennial grass root forms agree in having beak reaching slightly beyond second pair of coxæ, color of same varies from black in adult winged form, to light yellow in pupa. In adult winged forms there is a dusky brown patch before the anus, while in the apterous forms it is a continuation of the dusky bands on the eighth segment. (Possibly these bands and the quadrate patch are the location of dermal glands and the flocculent material is removed by the ants.) The legs and antennæ are hairy; body also slightly hairy.

Schizoneura corni[2], Spring migrant (second generation). From Cornus:

Expanse of wings, 6.00mm: length of antennæ, .69mm; (Joints I and II each, .05mm; III, .26mm: IV, .087mm; V, .095mm; VI, with unguis, .139 mm). Only two sensoria on joint III, one each on IV, V and VI. Venation as in fall migrant. Stigma .348mm by .174mm. Color and markings as in autumnal migrant, except the abdomen is reddish brown and without distinct quadrate patch, and the membranes of articulation are green. (Described with the exception of colors which were taken from notes, after clearing in balsam, and too shrunken for measurements and location of markings of body.)

Pupa: Length of body, 1.80mm; width, .87mm; length of antennæ, .53 mm; (joint I, .06mm; II, .065mm: III, .135mm; IV, .07mm; V, .087mm; VI, with unguis, .113mm). Sensoria on joint III, four; on IV, V and VI, one each. Color, head, wing callosities and margins of thorax, with wing pads white, or greenish white; thorax, yellowish brown; antennæ and legs, dusky white; abdomen light brown with two series of whitish dots on

[2]This form has previously been described by Kaltenbach; Monographie der Famlien der Pflanzenlause, 1872, p. 168.

each margin; two yellow spots on head. No quadrate patch. Simply a dusky band on eighth and ninth abdominal segments.

Apterous adult (Fundatrix): Length of antennæ .52mm (joint I .069mm, II .06mm, III .13mm, IV .052mm, V .087mm, VI with unguis. 12mm). Length of body 1.82mm: width variable. Color light brown antennæ and legs dusky brown.

Larval fundatrix: Fresh moulted specimens yellow, older specimens light brown, antennæ five jointed.

Schizoneura corni var (?) *panicola*, Thos.—Root-type from roots of annual grasses:

Winged vivip. form bred from *Setaria*, June 24, 1893 (probably spring migrant): Expanse of wings, 4.20mm: length of body, 1.67mm; width, .84mm; length of antennæ, .63mm. Joint III with one, and in a few specimens two sensora; joints IV, V and VI, one each. Color, grayish or greenish white; antennæ, head, prothorax and callosities dusky; seventh and eighth abdominal segments with dusky bands; some specimens show slight indications of pulverulent area; eyes red, legs dusky. Stigmal vein nearly straight. Cubital issuing close to second discoidal, in some cases following the latter a short distance. Point of issue of furcal variable, from two-thirds to three-fourths the distance from base to apex of cubital. Stigma, .32mm×.16mm. Contents of the body sometimes of a slight yellow tinge.

Apterous viviparous form: Length of body, 1.65mm; width, 1.13mm; length of antennæ, .57mm; sensoria only on joints V and VI. Color similar to winged forms. Antennæ and legs slightly dusky. Sixth, seventh and eighth abdominal segments with dusky bands; head slightly dusky.

Pupa: Length of body, 1.51mm; width, .78mm; length of antennæ, .52mm. Sensoria, one each on joints V and VI. Color nearly white.

In these forms the dusky bands on seventh and eighth abdominal segments extend entirely around on the ventral surface. Antennæ and legs hairy; body slightly hairy. In most cases the beak reaches third coxæ, and in apterous forms slightly beyond.

Dr. Forbes[3] quotes Thomas' description for *Schizoneura panicola* and adds:

Head and thorax are black; the abdomen pale, with imperfect dusky bands on the first and second segments, a quadrate dusky discal blotch, two terminal dusky bands, a series of quadrate dusky lateral spots, and two rows of black specks between these and the discal blotch. The antennæ are dusky throughout, sparsely pilose but not scabrous; .57mm long; the legs are black, and tip of abdomen and the band upon the preceding segment are also black. The beak is long, reaching to the abdomen; the body measures 1.57mm by .7mm, and the wing is 1.7mm. The tip of the abdomen is hairy, the tail is minute, the cornicles wanting being represented by a simple pore on the surface, measuring .13mm in diameter, and having the appearance of a black circlet within the dusky patch. Found on roots of Setaria and Panicum June 13th.

A late form from roots of corn October 13, 1891.

[3] 13th Ill. Rept. 1884, pp 51-54.

Expanse of wings, 4-92mm; length of body, 1.827mm; width, 1mm length of antennæ, .70mm. Joint III, two or three sensoria; IV, V and VI, one each. Other characters as in Schizoneura on Setaria.

Apterous viviparous form; length of body, 2mm; width, 1.36mm; length of antennæ, 0.65mm; no sensoria on joint III, in some cases one on IV, one each on V and VI. Body distinctly ovate.

The apterous form found late during the fall of '93 on roots of Drop seed (Muhlenbergia) and early in the spring of '94 on ants' nests are distinguished by being nearly twice as large as apterous forms found on annual grasses, by having the thorax margined and provided with a spine, by having very indistinct eyes, by the remarkably long rostrum which reaches to nearly the middle of the abdomen, and by having a rather large blunt cauda. This probably corresponds with what is generally described as Tychea.

From the results obtained thus far and the observations made by the senior author in 1889[4], also from the description as given as well as from those given by Dr. Thomas[5] and Prof. Forbes[6] for *Schizoneura panicola;* it seems that there must be two distinct root forms of *Schizoneura* infesting grasses. The true *Schizoneura corni* occurring mainly on roots of perennial grasses from June 15th to October, and the *panicola* form found in the ground at all seasons. The former is characterized further by having the habit of the brood next to the last migrating from the grass roots to Dogwood and depositing a brood of wingless males and females on the leaves, the females depositing their eggs on the rough bark. The eggs hatch about the middle of May. We have observed that the first brood feeds upon the tender stems, base of leaves and in flower clusters in Dogwood. This fact was noted in 1891[7]; also by Kaltenbach[8]. The second brood, as far as observed, feed together in the flower clusters until full grown, when they develop wings and migrate from June 1st to 15th, undoubtedly to perennial grasses, and locate upon the roots. The latter, the form described by Dr. Thomas as *Schizoneura panicola*, occurs throughout the whole season on roots of annual grasses. Whether this should be considered a distinct species we think still an open question, From the facts gathered in 1889 it was thought to be identical

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[4]Osborn. U. S. Dept. of Ag , Div. of Ent., Bull. No. 22, pp 32-41.

[5]Thomas. Eighth Report, St. Ent., Ill., pp 131-139.

[6]Forbes. Thirteenth Report, St. Ent., Ill , 1884, pp 51-54.

[7]Osborn. U. S. Dept of Ag., Div. of Ent., Bull. No. 26, p 59.

[8]Kaltenbach. Monographie der Famlien der Pflanzenlause, p 168.

with corni, with the probability of a dimorphic form that remained on grass roots, or in the ground during winter. The observations of the past two seasons, however, seem to indicate a more distinct separation even than this. The fact that the *panicola* form has a fairly constant difference in color of the apterous individuals, is found quite constantly on annual grasses only, and its pseudogynes failed to colonize on Cornus, or the spring migrants from Cornus to colonize artificially on roots of annual grasses, favor the conclusion that it has become established as a variety at least, if not a distinct species. On the other hand the identity of almost all structural details and the fact that undoubted *corni* has been bred from *Setaria* and colonized on *Cornus*, also that one specimen of *corni* was taken on *Setaria* the fall of 1893, along with the extreme variability of the wing venation in the form found on grass roots seem to indicate a close relationship between the two.

There seems to be excellent reason for believing that the *panicola* form, if not a dimorphic one, is a variety which has arisen from *corni* as its antecedent and which, by the fostering care of ants, or possibly by selection of food plants, or some other condition, has become established as a permanently subterranean form.

The variability of the structural characters, especially the venation; the number of its food plants; its dependency upon ants and the occurrence of winged forms without migration, all seem to point to comparatively recent origin for this form[8].

Whether a variety or a dimorphic form, from the observation of Prof. Forbes, the facts gathered in 1889, and from those gathered the past season, it seems that their life cycle is as follows:

The eggs are probably deposited in the soil, though they have not been found on the roots of annual grasses, and stored by ants in their chambers. In the spring the eggs, or newly hatched lice, are gathered and carried by ants to the roots of young Panicums and Setarias, possibly to the roots of Spartina cynosuroides Œnothera biennis, where they feed till the middle of May, or till the first of July, at which time they are transferred to roots of Foxtail and corn. As the Foxtail dies early in the autumn they are again transferred to the Panicums, in

[8] One fact which is very strongly in favor of its being a distinct species is its habit of producing winged forms, principally in the spring. This habit has been noted in *Melonoxanthus flocculosus*, *Chaitophorus spinosa* and in a sedge infesting form.

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the earth around the roots of which they deposit their eggs. Corn is given as one of the plants infested as it is so recorded by Prof. Forbes[9], and specimens were received here from Mr. Jabez Bower[10], of Norway, Iowa. We have not found them on corn in this locality.

RECORD OF HOST PLANTS FOR BOTH FORMS.

Schizoneura corni.

Aerial type. Cornus sericea and C. asperifolia (Weed[11] gives C. sangiunea, which is not listed as occurring in this country). Buckton[12] gives C. sanguinea as its host plant in Europe.

Subterranean type. Observed at Ames, Iowa; Andropogon furcatus, A. scoparius, Spartina cynosuroides, Muhlenbergia racemosa, Panicum virgatum (?),* Phleum pratense (?).*

Recorded by Lichtenstein[13] *Schizoneura venusta ? Setaria viridis, S. verticillita.*

Recorded by Lichtenstein[13] *Schizoneura venusta* ? *Setaria viridis, S. verticillata.*

Schizoneura corni var.(?) *panicola.*

Subterranean type. Observed at Ames, Iowa. *Setaria glauca S. viridis, Panicum crus-galli. Eragrostis major?, Capsella bursa-pastoris* [?],* *Polyganum aviculare* [?] Spartina cynoseroides Œnothera biennis?) and corn (*Zea mays*).

Recorded by Thomas[14] *Panicum glabrum.*

Recorded by Passerini, *Setaria glauca, S. viridis, S. italica, Panicum glabrum, Fragrostis megastycha* and *Ceratochloa australis.*

Recorded by Forbes[15] *Setaria, Panicum glabrum,* Corn (*Zea mays*) and Sorghum.

NOTES ON SYNONOMY.

In the 13th report of the entomologist of Illinois, Forbes gives *Schizoneura venusta* as probably identical with *Schizoneura*

[9] Forbes. Thirteenth Report, St. Ent., Ill., 1884, p 52.

[10] Osborn. U. S. Dept of Ag, Div. of Ent, Bull., No. 26, p 59.

[11] Weed. Psyche. Vol. V, 1888, p. 129.

[12] Buckton. Monograph of British Aphids, Vol. III, p. 107.

[13] Forbes. Thirteenth Report St. Ent., Ill, 1884, p. 52.

[14] Thomas. Eighth Report St. Ent., Ill., p 139.

[15] Forbes. Thirteenth Report St. Ent. Ill, 1884. p. 52.

* The winged forms have not been obtained from these plants, but the apterous forms on Panicum virgatum and Timothy seem to agree with the *corni,* and those on annual plants with *panicola.*

panicola Thos., which was also suggested by Thomas, but so far as descriptions can be relied upon *venusta* seems to be more closely related to *corni*. Quoting from the American Entomologist, 1880, page 129, he also says: "This species, *Pemphigus boyeri* Pass., is believed by Lichtenstein to represent two of the stages of *Schizoneura corni* Koch," but Lichtenstein, in his monograph in 1885, gives "*Pemphigus boyeri* Pass. = *Aphis radicum* Boyer, *Amycla fuscifrous* Koch., forme souterraine du *Tetraneura ulmi*."*

Buckton says: "M. Lichtenstein has hazarded the supposition that *Schizoneura venusta* is the underground form of *Schizoneura lanuginosa*." He also gives *Anœcia corni* Fabr. But Lichtenstein, in his Mon. Des Aphideans, 1885, gives *Anœcia corni* Koch. as a synonym of *Schizoneura Kochii* Licht. Koch's figures of *Anœcia corni* is not colored to represent a typical *Schizoneura corni*.

SYNONYMS.

Schizoneura corni Fab.

(1794) *Aphis corni* Fabricus, Ent. Syst., IV, 214.

(1857) *Schizoneura vagans* Koch, Die Pflanzenlause Aphiden, 268.

(1857) *Anœcia corni* (?) Fab., Koch, Pflanzenlause Aphiden, 275.

(1860) *Schizoneura venusta* Passerina (?), Gli Afida, p. 38.

(1852) *Eriosoma fungicola* Walsh, Proc. Ent. Soc., Phll., I, 304.

(1862) *Eriosoma cornicola* Walsh, Proc. Ent. Soc., Phil., I, 304.

(1872) *Schizoneura corni* Fab., Kaltenbach Monographie der Familien der Pflanzenlause, p. 168.

Schizoneura corni var (?) *panicola* Thos.

(1879) *Schizoneura panicola* Thomas, 8th Rep. Ill. Ent., p. 138.

(1889) *Schizoneura corni* Fab., Osborn Bull. 22 Div. Ent. U. S. Dept. Ag., 1889.

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* At the time I prepared my article on this subject in 1889 I overlooked the references to the subject in Am. Entom. and in Forbes' Report, and while I was aware that Lichtenstein had been at work upon the migrations of some species, notably those infesting elm, his works were not at the time accessible to me, and I was entirely unaware that any suggestion even had been offered that *Schizoneura corni* had a subterranean form, H.O.

ECONOMIC CONSIDERATIONS AND REMEDIES.

Working as these forms do, on the roots of grasses, their injury is not noticed. The form that infests annual grasses is of but little economic importance unless they are transferred to corn by ants. Thorough cultivation will check this tendency, as the ants do not like to have their formicaries disturbed, and doubtless a proper rotation of the corn crop would avoid most of the injury. Though the perennial grasses, on which the migratory forms were most commonly found, are not used much in some parts of the state, they are the best native grasses we have. In localities where they are used the vitality must be greatly reduced by the juices being pumped away from the roots by these small pests. If timothy proves to be commonly infested, the importance of the pest is great. The most practical remedy at present seems to be the destruction of the worthless Dogwood shrubs. Spraying in the spring with kerosene, emulsion, would be effectual if these shrubs were not scattered around in every hedge row and fence corner in the country, but as the Dogwood possesses no value except possibly in some instances as an ornamental shrub, it would seem the part of wisdom to destroy them entirely. They should be cut up from the roots in late autumn, in winter, or early spring (at latest before blossoms open), and burned.

SUMMARY.

Schizoneura corni spring migrant failed to colonize artificially on annual grasses.

Schizoneura panicola failed to colonize artificially on Cornus when transferred in autumn.

Schizoneura from perennial grasses gave fall migrants that colonized readily in numbers when artificially transferred.

There are two, if not three, distinct forms on roots of grasses, one occurring mainly on perennials and migrating in autumn to Cornus, the other occurring on a variety of annual plants and remaining for the most part under ground, but depositing eggs each season, while the third hibernates in chambers of ants.

Schizoneura corni, root form, occurs on wild grasses and probably timothy.

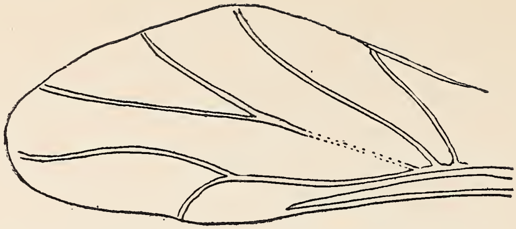

Fig. 1. *Schiz. corni* from roots of *Andropogon furcatus.*

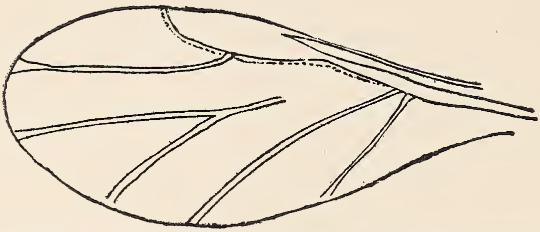

Fig. 2. *Schizoneura* from roots of *Letaria* and colonized on *cornus* in 1889.

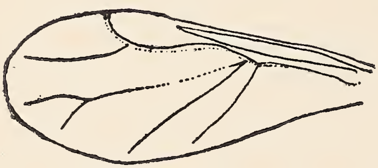

Fig. 3. Roots of *Setaria viridis.* 6-24-93.

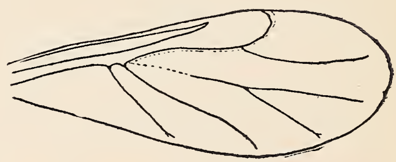

Fig. 4. Bred from roots of *Setaria glauca.* 7-3-93.

Fig. 5. Roots of *Setaria glauca.* 8-25-93.

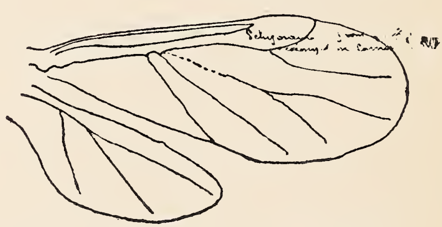

Fig. 6. Roots of Corn. Norway, Iowa. 10-13-91.

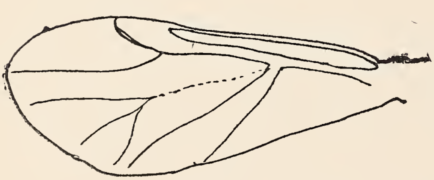

Fig. 7.

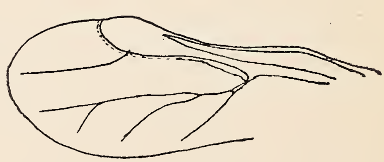

Fig. 71.

Abnormal variations in spurs from *Panicum crusgalli.*

VARIATION OF SCHIZONEURA.

Schizoneura panicola is permanently root-inhabiting unless a dimorphic form, and occurs on roots of weeds, and also on corn and sorghum.*

Both forms are of economic importance, and may at times cause serious injuries.

The aerial form of corni may be destroyed by burning the Dogwood bushes in late autumn, winter or early spring.

The panicola form may be prevented from injury to corn or sorghum by a rotation of crops and by thorough cultivation.

EXPLANATION OF FIGURES OF VENATION OF SCHIZONEURŒ FROM GRASS ROOTS.

1. *Schizoneura corni*, from roots of *Andropogon furcatus*, (typical venation of *S. corni* on Cornus leaves.)

2. *Sch. corni.* From roots of Setaria, (specimen colonized on cornus in autumn of 1889, shows typical *corni* venation.)

3. *Schiz. corni*, var. *panicola.* Thos. From roots of Setaria viridis, June 24, 1893. Typical venation for the *panicola* form, but third discordial is forked a little nearer the base than in average specimens.

4. *Schiz. corni*, var. *panicola.* Thos. From roots of Setaria glauca, July 3, 1893. (Differs from No. 3 in point of furcation of third discoidal.)

5. *Schiz. corni*, var. *panicola.* Thos. From roots of Setaria glauca. Sept. 25, 1893. (Shows variation in point of origin of discoidals, all three starting close together.)

6. *Schiz. corni*, var. *panicola.* Thos. From roots of corn, Norway, Iowa, Oct. 13, 1891.

7 and 7½. *Schiz. corni*, var. *panicolu* (?). From roots of Panicum crus galli, autumn of 1892. (Showing variations from normal venation. The costa of lower figure was probably distorted slightly in mounting.)

In 1 and 2 the veins are drawn with double lines, as they were too robust to represent correctly by single line.

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* The apparent failure to find *S. corni* on perennial grasses should not be taken as conclusive that there is another set of food plants besides the perennial grasses and cornus. As already stated, the scarcity of this species made it difficult to locate them. Not over 500 specimens were seen during the whole spring. When these were scattered by the winds at the time of migration, what few were picked up by the ants would still be harder to find. The work was given up after July 15.

SOME BRED PARASITIC HYMENOPTERA IN THE IOWA AGRICULTURAL COLLEGE COLLECTION.

BY ALICE M. BEACH.

This list is prepared from the material in the collections of the Iowa Agricultural College and the Iowa Experiment Station, and may be considered a preliminary record of the parasitic Hymenoptera of the state. In its preparation the notes and records made by Prof. C. P. Gillette, while entomologist of the Experiment Station, have been freely consulted and largely drawn upon. The list is still incomplete for much material yet remains to be classified and records to be filled out.

Family ICHNEUMONIDÆ.

Parasites	*Hosts.*
Ichneumon cincticornis Cr.	*Pieris rapæ?* Taken on cabbage infested with larvæ of *Pieris rapæ.* (not reared)
Ichneumon torvinus Cr.	*Ægeria syringæ.* Issued June 2, 1880.
Ichneumon lætus Brulle	One specimen from box-elder leaf-gall. Issued June 26, 1888.
Cryptus extrematis Cr.	Cocoons *Platysamia cecropia.* Brookings, S. D., June 22. 1893.
Linoceras sp.	Cells of *Eumenes fraternus*, July 31, 1893.
Orthopelma occidentalis Ashm.	Gall on *Rosa rubiginosa*, May 9, 1890, Toronto, Canada. Gall on *Rosa multispinosa*, Minn.
Ophion macrurum, Linn.	Cocoons of *Telea Polyphemus* kept in laboratory over winter. Issued May 12, 1889.
Nototrachys sp.	Plums infested with curculio or gouger. Issued August 22–28, 1890.
Heteropelma sp.	Ovipositing in larvæ of *Datana* ap., one-third grown and feeding on apple. Aug. 20, 1890.
Limneria dubitata Cr.	Larva of *Pyrameis cardui.* Issued June 23, 1889.

Limneria sp.	*Anthonomus scutellatus ?*, September 6, 1889.
Angitia sp.	Plums infested with curculio or gouger, April 4, 1890.
Bassus sp.	Syrphus fly puparia collected on corn, September 18, 1888.
Pimpla annulicornis Cr.	*Orgyia leucostigma.* Issued May 4.
Pimpla conquisitor Say.	*Orgyia leucostigma* .
Pimpla notanda Cr.	*Walshia amorphella.* Issued May 22, 1889.
Glypa rufiscutellaris Cr.	*Pædisca scudderiana.* June 5, 1890.
Lampronota americana Cr.	Cut-worms. Issued September 19, 1889.
Family BRACONIDÆ.	
Bracon sp.	Galls of *Trypeta obliqua* on *Aster novaangliæ*, Oct. 7, 1889.
Bracon near cookii Ashm.	*Meromyza americana*, July, 1889.
Bracon sp.	Plums, July 14, 1890.
Bracon xanthostigma Cr.	Plum curculio, July 4, 16, 18, 22 and 28, 1890.
Rhogas intermedius Cr.	*Acroncyta lepusculina*, Oct. 13, 1890.
Rhogas rileyi Cr.	*Nephelodes violans*, June 11, 1887.
Sigalphus canadensis Prov.	*Anthonmus scutellatus*, Aug. 27, 1889.
Sigolphus curculionis Fitch.	*Anthonomus scutellatus*, Sept, 27, 1889; from plums infested by curculio, July 4, 16, 28, 1890.
Schizoprymnus texanus Cr.	Galls of *Trypeta solidaginis*, June 27–29, 1893.
Apanteles xylina Say.	Cutworm, May 3, 1890.
Trioxys rapæ Curtis (piceus Harr).	*Aphis brassicaæ*, Oct. 2 and 10, 1890.
Meteorus sp.	Galls on underside of midrib of leaves of *Quercus rubra*, July 7, 1888.
	Rose gall (*Rhodites ignota ?*) 1890.
Coelinius meromyza Forbes.	*Meromyza americana.*
Lysiphelebus sp.	Aphides on chrysanthemums, Feb. 1, 1889.
Family CHALCIDIDÆ—	
Phasgonophora sp.	Hickory wood, July 2, 1890.
Eurytoma sp.	Galls of *Acraspis macrocarpœ*, Oct. 10, 1888.
Eurytoma sp.	Curculio-marked plums, July 28, 1890.
Eurytoma punctiventralis Walsh.	Galls of *Holcaspis globulus.*
Eurytoma sp.	Small leaf-gall on *Quercus rubra.*
Decatoma dubia Walsh.	Galls of *Holcaspis duricoria*, March 16, 1889.
Decatoma simplistigma Walsh.	Galls of *Andricus flocci*, Mar. 5, 1889.
Syntomaspis citriformis Ashm.	Galls of *Acraspis villosus*, July 9, 1888; do. *Holcaspis duricoria*, July 7, 1888. *Amphibolips inanis*, July 7, 1888.
Syntomaspis racemariæ Ashm.	*Amphibolips inanis*, July 7, 1888.

Syntomaspis albitarsis Ashm.	Galls of *Amphibolips cookii*, April 20, 1889.
Syntomaspis dimorphii Ashm.	Galls of *Andricus scitulus?* on *Quercus rubra*, July 6, 1888.
	Galls of *Andricus tumifica*, July 7, 1888.
	Galls of *Biorhiza forticornis*, Mar. 5,1888.
	Fuzzy, brown, single-celled gall on leaves of *Quercus alba*.
Syntomaspis sp.	Galls *Andricus scitulus?* July 6, 1888.
	Amphibolips sculpta, July 9, 1888.
Torymus dura O. S.	Dipterous Aster gall (probably *Trypeta obliqua* Say), Oct. 24, 1888.
Torymus sp.	*Amphibolips inanis*, July 7, 1888.
Ormyrus sp.	Gall at base of a corn shuck, May 30, 1890.
Ormyrus sp.	Galls of *Acraspis macrocarpæ*, Oct. 10, 1888.
	Galls of *Andricus piger* Bass., March 16, 1889.
Eupelmus basilis Ashm.	Gall of *Biorhiza macrocarpæ*.
Blastothrix longipennis Hwd.	Cabbage aphidid, Oct. 10, 1890.
Copidosoma sp.	Cutworm, June 21, 1890.
Pachyneuron sp.	Syrphus fly pupæ, Sept., 1888.
Amblymerus n. sp.	Secondary parasite from *Orgyia leucostigma*, Apr. 24, 1889.
Tetrastichus cinerea Ashm.	Red Oak leaf-gall (probably *Dryophanta populi*) July 10, 1888.
	Gall of *C. poculum* O. S., Mar. 20, 1889.
	Fuzzy, brown, single-celled galls of *Quercus alba*, May 18, 1889.
	Andricus petiolicola, July 3, 1888.

A STUDY OF THE PHYSICAL PROPERTIES OF SOLUTIONS OF LITHIUM CHLORIDE IN AMYL ALCOHOL.

BY LAUNCELOT W. ANDREWS AND CARL ENDE.

There can be no doubt that much light can be thrown upon the nature of electrolytic processes by a systematic examination of electrolytes containing no water; for the principles of the Electrolytic Dissociation Theory, if general, must be valid, not only for solutions in water, but also for all others, and conclusions derived from the study of the former can best receive independent confirmation or rebuttal by a careful investigation of the latter. The questions upon which such an investigation should bear are chiefly these: 1. Does Ostwald's Law of Dilution hold good for non-aqueous solutions? 2. In what way is the translation velocity of the ions related to the nature of the solvent? 3. Is the relatively high resistance of non-aqueous solutions of salts and acids chiefly due to higher internal friction, or to a lower grade of electrolytic dissociation? 4. Do the general physical properties of such solutions point to molecular aggregation, to dissociation, or to both?

Non-aqueous electrolytes have been subjected to investigation by Koblukoff (Zeitschr. f. phys. Chem. 4, 429), Wakemann (*l. c.* 11, 49), Wildermann (*l. c.* 14, 231 and 247), Schlamp (*l. c.* 14, 272), Völlmer (Diss*., Halle, 1892), Bouty (C. R. 106, 595 [1888]), Fitzpatrick (Phil. Mag. (5), 24, 377 [1887]), Vicentini (Mem. Acc. Torino 36 [1884], from Beibl. Phys. Chem. 9, 131 [1885]), and Andrews (Iowa Acad. of Science, I, iii, 12).

For such studies it is desirable to select a solvent that can be, with relative ease, obtained and preserved free from water, and a binary salt which is freely soluble, and whose aqueous solutions have already been examined electrolytically.

Further, the solutions must be sufficiently conductive to be capable of exact measurement, and the substances employed

* Unfortunately not accessible to us.

should be of such a character as to preclude, so far as possible, the occurrence of any chemical reaction. For these reasons solutions of lithium chloride in amyl alcohol were selected as objects of the present investigation. For each solution the following physical constants were determined: specific gravity, specific viscosity, refractive power for sodium light and electric conductivity.

MATERIALS AND METHODS OF RESEARCH.

The amyl alcohol employed was boiled with concentrated caustic potash to decompose any compound ethers which it might contain, then washed with water and then with a solution of phosphoric acid to remove possible traces of organic bases, then dried with fused potassium carbonate, and finally fractionally distilled and again dried with amhydrous copper sulphate and once more distilled. A sufficient amount of the distillate coming over between 130.5° and 131.0° was preserved to answer for all the measurements described in the present paper, so that the latter are strictly comparable among one another.

The amyl alcohol prepared in this way had the specific gravity $D\frac{21.6^0}{4^0}$=.80949, $D\frac{26.4^0}{4^0}$=.80571; index of refraction (D line) at 18.3°=1.40767; specific viscosity=3.50 at 21.1° (water=1); resistance at 25° = 4.524×10^7 ohms per cubic millimetre, laevo-rotary power for polarized light = 1.95 degrees.

The lithium chloride was prepared from a carefully purified sample of carbonate which showed in the spectroscope traces of sodium, but no other impurity. Its strongly acid solution was evaporated to dryness on the water bath, the residue moistened with concentrated hydrochloric acid and dried at 110°. By digestion of this salt with amyl alcohol a concentrated solution was made from which all others were prepared. After filtration, which was extremely slow, and during which the moisture of the air was, of course, carefully excluded, a knowledge of its concentration was arrived at by independent determinations of the contained chlorine and lithium, which afforded at the same time a needed guarantee that no notable amount of basic salt was present. To obtain further evidence on this point, 5 c.c. of the concentrated and perfectly clear solution was shaken up with water, colored with the methyl orange, and titrated with tenth-normal hydrochloric acid. The first 0.10 c.c. of the latter imparted an acid reaction to the mixture. Therefore basic salt was either absent or present in quantities too small to affect the quantitative results obtained.

For the analyses and for dilution, known quantities of the solution were obtained by weighing, since the high viscosity of solutions of lithium chloride in amyl alcohol, stand in the way of accurate measurement by volume.

Determination of Cl. I. 1.1563 grams of sol. taken. Required 17.66 c.c. Ag NO_3 sol. (of which 1 c.c. = 3.532 Mg Cl) = .0747 gram Li Cl; ∴ 1 gram sol. contains .0646 gram Li Cl. II. 1.5110 grams of sol. taken. Required 23.00 Cl; Ag NO_3 sol. = .0973 grams Li Cl; ∴ 1 gram sol. contains .0644 gram Li Cl.

Determination of Li. For the purpose of this determination the lithium chloride was converted into sulphate after evaporation of the alcohol, every precaution against mechanical loss by spirting being observed. III. Taken 3.3586 grams solution: obtained .2813 grams., Li_2 SO_4=.2177 grams Li Cl. ∴ 1 gram sol. contains .0648 gram Li Cl. IV. Taken 5.5111 gram sol., obtained .4618 gram Li_2 SO_4=.3574 grams Li Cl. ∴ 1 gram sol. contains .0649 gram Li Cl. V. Taken 5.0798 gram sol., obtained .4261 gram Li_2 SO_4=.3298 gram Li Cl. ∴ 1 gram of the sol. contains .0649 gram Li Cl.

The mean of the five determinations gives .0647 grams as the amount of lithium chloride contained in each gram of the solution and the close agreement of the results as calculated from the chlorine with those as calculated from the lithium is satisfactory evidence of the absence of foreign substances and of lithium oxide. Another nearly saturated solution made and analyzed in the same way was found to contain .06681 grams Li Cl per gram. According to Gooch (Fres. Zeit. 26, 356) 1 c. c. of a cold saturated solution of lithium chloride in amyl alcohol contains .066 grams of the salt.

The first solution mentioned above is of $\frac{m}{.775}$ concentration and from it was made the $\frac{m}{1}$ solution by diluting 65.5023 grams with amyl alcohol to 100 c. c. The higher dilutions were prepared from the $\frac{m}{1}$ by mixing, in a stoppered tube made for the purpose, having one graduation mark at 50 c. c., and another at 100 c. c. The $\frac{m}{.88}$ and $\frac{m}{1.5}$ solutions only were independently made from the stronger solution mentioned above. All solutions were carefully guarded from moisture and several of those first examined were again tested at the close of the whole series of measurements and found not to have appreciably altered in conductivity.

SPECIFIC GRAVITY.

In making the density determinations a Sprengel's piknometer of about 10cc capacity, with thermometer fused in, was employed. The thermometer in this instrument was divided into one-tenth degrees and fiftieths could readily be estimated. The density of every solution was determined at two temperatures, from which that at 25^0 was calculated by interpolation. All weighings are reduced to vaccuo, but no correction is applied for varying moisture of the air.

VISCOSITY.

The determinations of fluid friction were made by the method and with the apparatus described by Ostwald (Lehrbuch, 1891, B. I, p. 549).

The observations for each solution were repeated at several different temperatures, above and below 20°C. The time of flow at the latter temperature was then calculated by means of the interpolation formula $V_{20^\circ}=V_{t^\circ}\frac{k+20}{k+10}$ in which

V_{20°=time of flow at 20°C.

t°=temperature of the observation.

V_{t°=time of flow observed at t°.

k=constant for each solution, its value lying between 4 and 10 according to the concentration of the solution.

Each value for V_{20° obtained in this way represented the mean result of from four to fifteen independent observations, based upon the time of flow of amyl alcohol taken as 100.

To deduce from these numbers the relative viscosities, each must be multiplied by the density found for the same solution.

In spite of the care taken to secure accurate results, it is believed that those actually obtained are only approximate, in consequence of the fact that all the solutions exhibited from the time of preparation a constantly diminishing viscosity. This change was more noticeable in the more concentrated solutions, and was not noticed until the series of observations was nearly complete. The cause is entirely unknown, but the most likely supposition is that a gradual breakdown of more complex molecular aggregates at first formed occurs. The phenomenon recalls that of "birotation," which has been observed in freshly prepared solutions of many optically active compounds.

REFRACTIVE POWER.

Pulfrich's "*Refractometer fur Chemiker*" was used for the determination of the refractive index for the complete series of solutions. Three or four observations, at least, were made upon each solution; and the mean used in the calculation of the refractive power, $N = \frac{n-1}{D}$, for sodium light. An inspection of the tabulated results (see Table I) shows that the most highly concentrated solutions have a lower refractive power than that of the solvent, which, however, increases with the dilution until at v = 64 a maximum is reached.

In the last column of the table will be found values for the refractive equivalent of the dissolved lithium chloride calculated by Landolt's formula for mixtures,

$$p\,\mathbf{N} = p_1\,\mathbf{N}_1 + p_2\,\mathbf{N}_2, \text{ in which}$$

p = weight of the solution.
$\mathbf{N}$ = its refractive power.
p_1 = weight of the solvent.
$\mathbf{N}_1$ = its refractive power.
p_2 = weight of the lithium chloride.
$\mathbf{N}_2$ = its refractive power.

Further, for the refractive equivalent, we assume

$$R_D = 42.38\ \mathbf{N}_2.$$

The value of R_D as deduced from the more concentrated solutions is 14.9. Gladstone found (J. B., 1869, 173) for the refractive equivalent of Cl, 10.7; for the Li, 3.8; which gives 14.5 for the salt—a fair agreement. The values of R_D derived from the high dilutions are materially affected, of necessity, by accumulated experimental errors, but the latter cannot wholly account for the great increase which the table exhibits.

TABLE I.

PHYSICAL PROPERTIES OF SOLUTIONS OF LITHIUM CHLORIDE IN AMYL ALCOHOL.

DILUTION V=LITRES PER GRAM MOL.	p.	MOL. CONDUCTIVITY AT 25° u	k	RELATIVE VISCOSITY. AMYL ALCOHOL=100 AT 20°.	DENSITY $D \frac{25°}{4°}$	REFRACTIVE POWER= N = $\frac{n-1}{d}$	R_D.
0.537	—.898	....	....	1.314.0	....	....	....
0.775	—.368	0.14	0 00114	.. ..	0.84655	0.49217	14.83
0.88	.0185	0.21	0.00228	614 0	0.84318	0.49348	14 95
1.00	0.000	0.28	0.00363	525.0	0 83922	0.49439	14.89
1.50	.587	0.46	0.00680	3[illegible]9.0	0.82976	0.49690	14.92
2.00	1.000	0.51	0.00634	241.0	0.82438	0.49824	15.08
4.00	2.000	0.58	0.00417	155.6	0.81561	0 50043	16.12
8.00	3.000	0 61	0.00232	123 6	0.81147	0 50126	16.48
16.00	4.00	0.69	0.00152	114 4	0.80951	0.50176	18.24
32 00	5 00	0.81	0.00108	105 6	0.80813	0.50212	24 32
64.00	6.00	1.03	0.00092	102.8	0.80769	0.50238	39.04
128.00	7.00	1.34	0.00085	....	0.80726	0.50225	45
256.00	8.00	1.73	0.00080	....	0.80704	0.50234	92
512 00	9.00	2 22	0.00078	... .	0.80700	0.50227	107
1,024.00	10.00	2.87	0 00087	....	0 80706	0.50225	225
2,048.00	11.00	3.50	0 00097	....	0.80699	0 50199	....
4,096.00	12.00	4.04	0 00111	....	0.80706	0.50190	....
∞	∞	4.79	[.001]	100.0	0.80699	0 50200	....

EXPLANATION.

v=number of litres which contain 42.33 grams of lithium chloride.

$p=\frac{\log v}{\log 2}$

k=dissociation constant (see p. 100).

n=refractive index of the solution for sodium light.

N=refractive power of the solution for sodium light.

R_D=refractive equivalent of the dissolved Li Cl for sodium light.

Mean error of D= ±.00005.

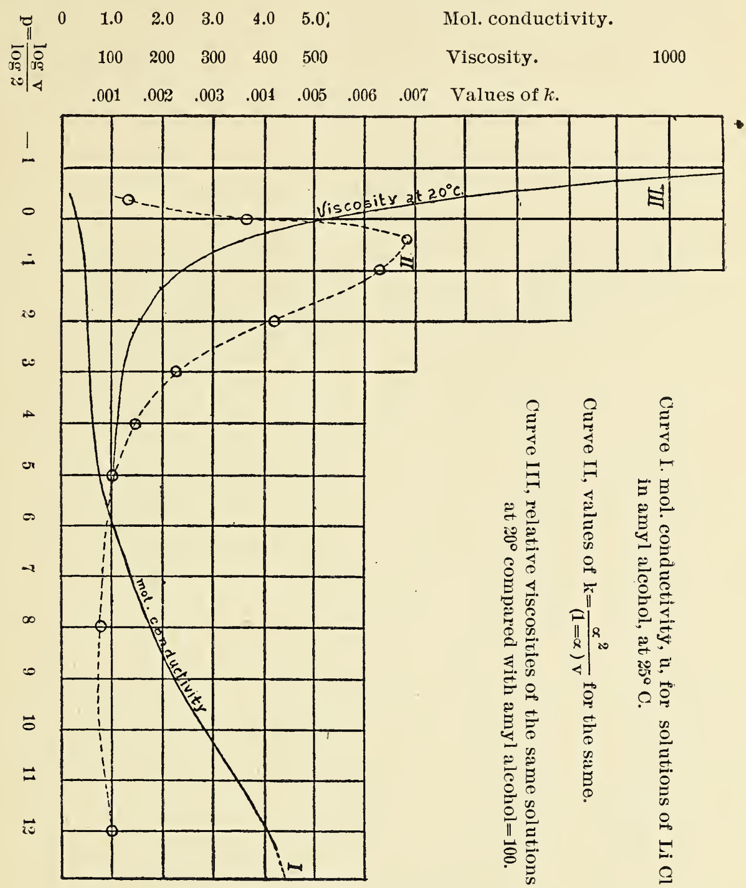
Mean error of N =±.00007.

CONDUCTIVITY.

Resistances were determined by Kohlrausch's method, the arrangement being that described by Ostwald (Zeit. phys. Chem. 2, p 561). In consequence of the high resistance of the more dilute solutions, a special electrolytic cell was constructed for this research, possessing an unusually low factor of resistance. In this cell one of the electrodes of heavy sheet platinum is doubled so as to include the other between its two leaves. A number of glass rivets, passing through all three plates and fused to them, aid in preserving a constant distance between them. They stand in a vertical plane in a glass tube 5.5 c. m. in diameter. This arrangement has been found to answer very well, and the conductivity constant (k=8.44 in mercury units), showed no material alteration during a period of use covering several months.

All the molecular conductivities were corrected for the conductivity of the solvent. The corrected values are given in the following table (I.), and also in the curves (*q. v.*).

In order to cover the whole range of observations without drawing the curves upon too large a scale, the abscissæ are taken proportional to powers of the dilution. Thus, if m =



number of grams of Li Cl per litre, M = molecular weight of Li Cl = 42.37, we have m = $M(\frac{1}{2})^p$, in which p is the desired convenient measure of the dilution.

The molecular conductivity for infinite dilution (u_∞) was calculated from the conductivity at the three dilutions that seemed best suited to that purpose (viz.: v = 16, v = 32, v = 64) by the dissociation formula, $k = \dfrac{\left\{\dfrac{u_v}{u_\infty}\right\}^2}{\left\{1-\dfrac{u_v}{u_\infty}\right\}v}$ and the mean taken as the nearest attainable approximation to the truth. The value so obtained for u_∞ was 4.79, from which the corresponding values for k were calculated as recorded in the table. They show a fair constancy, in spite of the rather questionable calculation of the maximum conductivity, for all solutions more dilute than $\frac{m}{16}$. Above this point they increase rapidly, reaching a maximum at $\frac{m}{1.5}$, whence they fall off again very fast for the most concentrated solutions.

For the more dilute solutions the mean value of k is about .001.

The peculiar behavior of k suggests the, *a priori* very probable, supposition that in the more concentrated solutions an association of molecules takes place, resulting in the formation of $Li_2\ Cl_2$ or higher aggregates. In order to get more light upon this, a series of molecular weight determinations by the boiling point method were undertaken, Beckman's apparatus being used. The thermometer (by "Geissler's Nachfolger") was divided into $\frac{1}{50}$ of a degree C, and $\frac{1}{500}$ could be estimated with more or less certainty. The elevation constant for amyl alcohol was ascertained by a series of observations with solutions of salicylic acid. (*Confer.* Schlamp, Zeit. ph. Chem. 14, p. 278.)

TABLE II.

MOL. B. PT. ELEVATION OF SALICYLIC ACID IN AMYL ALCOHOL.

GRAMS PER 100 OF SOLVENT—g	RISE OF B. PT.—D	MOLECULAR RISE—S.
0.6504	0.120	25.4
1.3296	0.260	26.9
2.0248	0.400	27.1
2.7760	0.535	26.5
3.4736	0.670	26.7
		26.5 mean.

MOL. B. PT. ELEVATION OF LITHIUM CHLORIDE IN AMYL ALCOHOL

$$M = S\frac{g}{D}$$

v=LITRES PER G. MOL. OF SOLVENT.	GRAMS PER 100 OF SOLVENT =g	RISE OF B. PT.-D	$M=S\frac{g}{\Delta}$
.88	6.060	2.298	71.5
1.00	5.333	2.060	69.2
1.50	3.536	1.872	50.
2.00	2.650	1.230	57.
4.00	1.318	.871	40.
8.00	0.658	.438	40.

These results clearly show that association occurs in the more concentrated solutions.

It is intended to extend the examination, as soon as circumstances permit, to the more dilute solutions in order to secure further evidence as to the degree of dissociation occurring there.

The work recorded in the present paper was all completed previous to June, 1894, with the exception of the viscosity determinations.

DISTRIBUTION OF SOME WEEDS IN THE UNITED STATES, ESPECIALLY IVA XANTHIIFOLIA, LACTUCA SCARIOLA, SOLANUM COROLINEUM AND SOLANUM ROSTRATUM.

BY L. H. PAMMEL.

One of the interesting parts dealing with geographical botany is the question of the distribution of plants over the earth's surface, where man has played an important part. Many changes have occurred in the character of our North American flora since it has been occupied by man. In many cases it has become quite impossible to tell when and where plants were first introduced. We have, it is true, in some cases records when plants were introduced, but in the vast majority of cases there were no records at hand. Early collectors in many cases simply mentioned vague localities with dates, but say nothing as to whether the plants are indigenous or introduced. Papers dealing with the spread of certain weeds have been made by several investigators in both Europe and America. Franz Buchenau has carefully traced the spread of *Leersia oryzoides*. L. H. Dewey that of *Salsola kali*, var. *Tragus*.*

Who can attempt to trace the spread of *Portulacca oleracea* in the United States, or in any given state or territory, or such cosmopolitan weeds as *Polygonum aviculare* and *Plantago major?* No one has attempted to record the earliest appearance of these weeds in any part of the United States.

The writer has for several years been interested in studying the distribution of several of our weeds. I shall attempt to

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* Russian thistle. Its history as a weed in the United States with an account of the means available for its eradication. Bulletin No. 15, Division of Botany, United States Department of Agriculture, p 26, Washington, 1894.

give the distribution and history of these weeds from information obtained from various floras, catalogues of plants, correspondence, and especially the larger herbaria of this country as Gray herbarium, Harvard University; Columbia College, herbarium; Missouri Botanical Gardens, Parry herbarium, U. S. Department of Agriculture, and those of the Agricultural College. I wish to express my thanks to correspondents who have responded to requests for information.

MARSH ELDER.

Iva Xanthiifolia, Nutt.

DESCRIPTION. An annual weed one to seven feet tall, leaves all opposite, hoary withminute down, ovate rhombic or the lowest heart-shaped, doubly serrate or cut-toothed or obscurely lobed; heads small, crowded in axillary and terminal panicles.

In Gray's Manual, 6th edition, the distribution of this weed is given as follows: Northwest Wisconsin to Minnesota and Kansas westward. It must indeed originally have been quite local in many places in this region. It is only recently that this weed has attracted attention. I have known of the weed in southwestern Minnesota, near La Crescent, since 1884, where it occurred as an introduced plant along the embankments of a road. Strange to say, this weed did not occur on the east side of the Mississippi river as late as 1890. In 1889 and 1890 this weed was growing in considerable quantity in a few places in the city of Boone, Iowa. The weed has made but little progress east of Boone. Ames is but fourteen miles distant, but as yet the weed has not been found in this city. West of Boone, especially at Woodbine, in Harrison county, and in Crawford county, it is a very common weed. In Monona county it occupies many of the vacant lots. The writer has also observed it in Cerro Gordo county, but evidently it is just getting a foot-hold. J. C. Arthur writes me that he observed it in Charles City, Floyd county, in 1871. This county joins Cerro Gordo on the east. The writer has also received it from Fremont county, in southwestern Iowa. It is common in the Red River Valley of the North and other parts of Minnesota and Dakota, and in parts of Iowa along the Missouri river, as well as in Colorado. It is a very aggressive weed, as accounts by Upham, Bolley, Crandall and Bush indicate. At Missouri Valley, as far north as Onawa in the Missouri river bottoms, I have observed this weed in such abundance occupying waste places, streets, and old neglected buildings, that it may be fairly called a nuisance. It is seldom, however, that this weed gives the farmer much trouble, as it may be eradicated very easily. The weed reminds one very much of the great Ragweed of the Mississippi valley.

Marsh Elder was originally native from northwest Wisconsin to New Mexico, as Fendler collected it in the latter place as early as 1847, but since the cultivation of the prairies it has become much more common. It was undoubtedly confined to alluvial soils, and from thence spread to neighboring farms, especially old barns and neglected buildings.

In regard to the distribution, Conway McMillan (Metaspermae of the Minnesota valley, 533) says: "Minnesota valley throughout, especially south central and southwest districts, roadsides, banks and waste places."

Upper Louisiana plains, (Bigelow) 1853.

Yellowstone and Upper Missouri, July and August, 1854. (Hayden.)

American Plains. Latitude 41. Hall and Harbour, American Plains Flora No. 269, 1862.

Iowa, Minnesota, 1848 (Parry). Probably not in Iowa.

Upper Missouri near Fort Mandan, Prince Neu-wied to the Rocky Mountains; Nuttall (Torrey and Gray, Flora North America, 2, 286).

Upper Missouri, S. M. Rothammer.

Comanche Plains, Bigelow, September, 1853.

Yellowstone Expedition, 1873 (Allan).

Rocky Mountain Latitude. 40–41, 1868. Alluvial grounds or along streams, Saskatchewan and Nebraska to New Mexico. Utah and Idaho, first collected by Nuttall (Gen. II, 185, Gray, Synoptical Flora of North America, Vol. I, Pt. II, p. 246; Nuttall, Trans. Am. Phil., Soc. VIII, p. 347; Gray, Pl. Wright, II, p. 85).

ARIZONA. 1869 (Edward Palmer).

CANADA.—In alluvial soil along rivers and small streams. Reed lake west of the old Wier's lakes of Setter's farm, (Cypress hills) and on slope of high bank between Fort Edmunton and the river. (Macoun) Swift Current Creek, C. P. R. crossing, Fort Qu Apelle, close to the Hudson Bay Co's store (J. M. McCoun, C. P. R. R. (MacCoun Catalogue Canadian plants, part II, p. 240). McCoun, Flora Canadensis, Saskatchewan Plains, August 21, 1872. Saskatchewan (E. Bourgeau) 1857–8.

COLORADO.—A western plant ranging from New Mexico to Idaho. It has been reported from Iowa and from northern Michigan, and is undoubtedly extending westward. The plant produces seed in considerable quantity and propagates only by seed. It is in many places a serious pest in cultivated fields because of its abundance and rapid growth. (C. S. Crandall, Bulletin No. 23, Col. Agr'l. Exp. Sta. 1893, p. 9). From head waters of Clear Creek, Platte valley, 1868. (C. C. Parry). (Powell's Colorado exploring expedition to the Rocky mountains, Lat. 40–41°). 1868, George Vasey. Sunset Canon (Penard). Big Muddy river. Colorado Springs, (Torrey.) Platte valley, (C. C. Parry.)

DAKOTA, NORTH.—"In all parts of the state in rich soil and waste places, common throughout the Red River Valley as much as *Ambrosia trifida* is in Illinois, but only a waste place weed." (H. L. Bolley.) "The most abundant and rank weed in rich soil, waste places, roadsides and about stables and deserted dwellings, throughout the Red River Valley and westward." (Upham, Proceedings of Boston Soc. of Nat. History, Vol. XXV, 1890, p. 160.)

WESTERN DAKOTA AND NORTHERN MONTANA.—*Iva xanthifolia.* Nutt. Common in Minnesota, is replaced by *I. axillaris* Pursh; (John B. Leiberg, Notes on the Flora of western Dakota and eastern Montana, adjacent to the Northern Pacific Railroad. Rep. Minn. State Hort. Soc., 1884, p. 365.)

SOUTH DAKOTA.—Distribution quite general throughout the state. Brookings, (Thomas A. Williams.)

ILLINOIS.—(Athens, 1863, Hall.)

INDIAN TERRITORY.—(C. H. Thompson.)

IOWA.—In all places mentioned extremely abundant, occupying waste places in streets, near neglected buildings, a tall, coarse and homely weed, in many cases eight to ten feet high.

Arthur (Contributions to Flora of Iowa. A Catalogue of the Phaenogamous Plants, p. 18. Appendix to Flora of Iowa, 1876, p. 40).

Charles City (Arthur, History of Floyd county).

Boone (Pammel, Report Comm. on State Flora. Proceedings Iowa Acad. of Sciences, Vol. I, Part II, p 17).

Boone, 1890 (Pammel). Keokuk, 1890. (Rolfs.)

Boone, 1894 (Pammel). Woodbine, 1894. (Pammel.)

Vale, 1894 (Pammel). Mason City, 1894. (Pammel.)

Missouri Valley, 1894 (Pammel). Turin, 1894. (Pammel.)

Onawa, 1894 (Pammel). Carroll, 1894 (Pammel). Charles City, 1876 (Arthur). Humboldt (F. L. Harvey).

KANSAS.—Hamilton, Sedgwick and Riley counties, Loti (Hitchcock). "It grows abundant about Manhattan and I have also seen it growing at Winfield, Cowley county, 1894." (Hitchcock.)

Southern part of the state. (C. H. Thompson.)

Manhattan, August 28, 1888. (Kellerman.)

Leavenworth, Lawrence. (C. H. Thompson.)

Topeka, North Topeka, Onago, Washington. Potwin Place.

Arkalon, 1891. (M. A. Carleton in Holzinger, Contributions. U. S. Nat. Herb., Vol. I, No. VI, p. 208).

MICHIGAN.—Keweenaw county, near coal-houses, 1889.

Clifton (Wheeler).

Keweenaw county, Farwell (Beal & Wheeler, Flora of Michigan.)

MINNESOTA. — "Frequent southeastward, abundant southwestward, extending north to Todd county common, and in the Red River Valley to Grand Forks (Upham) and St. Vincent." (Scott, Havard.) (Upham, Catalogue Flora of Minnesota, including its Phænogamous and Vascular Cryptogamous Plants, Indigenous, Naturalized and Adventive; Geological and Nat. Hist. Survey of Minn., Pt. VI of Ann. Rep. of Progress for 1883, p. 18.) "A new weed that is steadily gaining ground, traveling eastward and possibly southward. It is a candidate for the same situation as the large Ragweed, prefers the edges of fields and along roadsides and streets, but especially about barns. If circumstances are unfavorable it can blossom when only a few inches high, while under more fortunate conditions it reaches much above one's head. It closely resembles the Cockle-bur when young, but as it grows older has more the appearance of the common sunflower. With flowers, however, after the pattern of the Ragweed." (Arthur, in Upham, Cat. Flora of Minn., p. 79.)

Fort Snelling, (Means) Lake Pepin Valley (Sarah Manning, The wild flowers of Lake Pepin Valley. Minnesota Hort. Rep., 1884, p. 101).

Red River Valley (Upham), Goodhue Co., (Sandberg, 131,) Montevideo (Moyer, 132, Conway McMillan, The Metaspermæ of the Minnesota Valley; p. 533.)

La Crescent, Minnesota, 1884 (L. H. Pammel).

St. Paul, 1861 (T. J. Hale).

MISSOURI.—Common (S. M. Tracy, Catalogue of the Phænogomous and Vascular Cryptogramous Plants of Missouri, 1886, p. 45. Under *Parthenium xanthiifolia.*

Atchison, Platte counties in the river bottoms in considerable quantities. "In Jackson, and I suppose must be found all along the Missouri river bottoms, from Hamburg, Iowa, to Independence." (Bush, 1894,) Kansas City. (Pammel, 1889.)

MONTANA.—Columbia Falls. "Common throughout the state." 1894. (R. S. Williams.) "Found in this state, but not abundant." 1894. (Kelsey.)

NEBRASKA.—"Occurs quite frequently in vicinity of Lincoln." (Bessey.)

"Common from Omaha to Lincoln and Fremont." (Shamel, 1894.

Lincoln. (Webber, Sept. 1887.)

Wahoo, Whitman, Grant county. Thedford. Thomas county, 1893. (P. A. Rydberg.)

Western part. (Sweezey.)

(Webber, Flora of Nebraska. Rep. Nebraska State Board of Agrl. 1889, p. 287.)

NEW MEXICO.—Rock Creek. Aug. 17, 1847, (Fendler.)

From New Mexico to Idaho and the Saskatchewan. (J. M. Coulter, Manual of the Botany of the Rocky Mountain Region. 1885, p. 179.)

NEW YORK.—Seneca.

OREGON.—Union county. (W. E. Cusick.) Clearwater (Rev. Spaulding).

TEXAS.—Comanche Plains, 1853 (J. M. Bigelow).

UTAH.—Salt Lake City. Altitude 4,300 feet. (M. E. Jones, August, 1879.)

WASHINGTON.—W. Klickitat county bottom lands of Columbia river (W. N. Sucksdorf, Sept., Oct., 1884).

WISCONSIN.—Northwest Wisconsin and northwestward, T. J. Hale (Gray Manual of Botany of Northern United States, fifth edition, 1868, p. 250.)

(Sweezey, Catalogue of the Phænogamous and Vascular Cryptgamous Plants of Wisconsin. Wisconsin Geol. Survey, Vol. I, p. 384.)

Northwest part, T. J. Hale (Bruhin, Vergleichende, Flora Wis. K. K. Zool. Gesel, Vienna, April 5, 1876, p, 255.)

Menonimee Valley, Runge (W. M. Wheeler, Flora of Milwaukee Co. Proc. of the Nat. History Soc. of Wisconsin, p. 172, April, 1888, pp. 157, 172.)

PRICKLY LETTUCE.

Lactuca Scarolæ, L.

DESCRIPTION. An annual or winter annual, pale green glabrous; the lower part of the stem has soft prickles; leaves four to six inches long, vertical because of the twisting, lanceolate to oblong with a row of soft spinulose denticulate prickles on the margins, occasionally sinuate toothed, sometimes pinnatifid. Midrib beneath beset with soft prickles; base of leaf sagittate, clasping. Heads in an open panicle, 10—18 flowered, flowers pale yellow; beak of fruit as long as the akene, the latter being striate nerved. Pappus slender of capillary bristles arranged like a parachute.

It took twenty-one years for Prickly lettuce to become common. It was first observed near Hovey's Garden in 1863–64. From 1863–1894 it was reported from Ohio, Illinois, Wisconsin, and other states.

During the past summer much interest has been manifested on the appearance of this weed in many localities, so much so that Prof. Morrow, of Illinois, issued a press bulletin, and Dr. J. C. Arthur an extended account of this weed[1]. It would be almost superfluous to publish more on the distribution of this weed, as Dr. Arthur has such a full and excellent account, but it may not be out of place to bring the localities together, collectively, along with the other weeds of this paper. Dr. Gray (Synoptical Flora of North America, Vol. I, pt. II, p. 442), makes this statement: Waste ground becoming common in Atlantic states near towns and habitations.

IDAHO.—Sweet 1894 (Thomas J. Coonrad). Moscow. Pernicious weed in northern part of state, 1894 (F. L. Henderson). Blackfoot; August, 1893 (Edward Palmer). Blue lakes, August, 1893, (Dr. Edward Palmer).

ILLINOIS.—First saw a few specimens in 1884, is now common everywhere. (Brendel).

Cook county, "Roadsides and dooryards, infrequent, 1891." (Higley and Raddin, "The Flora of Cook County, Illinois, and a part of Lake County, Indiana. Bulletin, Chicago Academy of Science, Vol. II, No. 1, p. 71).

Evanston, 1883, (C. S. Raddin), catalogue of the Phænogamous Plants of Evanston and Vicinity for 1883, p. 15).

Chicago. Roadsides and dooryards everywhere, 1893. (Pammel.)

[1]Wild or Prickly lettuce. Bulletin No. 52, Vol. V, Nov., 1894.

Chicago. Lincoln Park, north and south sides, abundant everywhere, 1885, in waste places and streets. (Pammel.)

Wayne, Dupage county, Illinois, 1894. (Pammel.)

Andover, (Anderson); Rockford, 1879, (M. S. Bebb.)

Peoria, 1886, (Brendel, Flora Peoriana, p. 38). Fairbury, 1894 (Thomas S. Morris). Warner, 1894 (W. W. Warner).

INDIANA. (See Bulletin 52, Vol. V, 1894).

Found in this state somewhat later than in adjoining states. At the present time generally distributed in the towns and cities of the northern half of the state. In some sections has invaded the country and become a farm and roadside weed. Diligent search in some counties of the southern part of the state has not revealed it, but it is known to be firmly established in twenty-nine counties. (Arthur.)

Crown Point, Lake county, July, 1894; (Bartlett Woods and Jerome Dinwiddie).

Kendallville, Noble county, August, 1894, (J. S. Conlogue.)

Valparaiso, Porter county, September, 1894, (I. C. B. Suman).

Shipshewana, La Grange county, July, 1894, (Elias Wight).

Furnessville, Porter county, September, 1894, (E, L. Furnes).

Walnut, Marshall county, June, 1894, (Arley Body).

Hagerstown, Wayne county, July, 1894 (E. S. Bunnel).

Logansport, Cass county, Sept., 1894 (Dr. Robert Hessler,)

Crawfordsville, Montgomery county, Aug., 1894 (Prof, M. B. Thomas).

Indianapolis, Marion county, Aug., 1894 (John S. Wright).

Clinton county, Aug., 1894 (Lane, Bewsey and Maisch).

Bloomington, Monroe couuty, Aug., 1894 (Prof. D. M. Mottier).

Terre Haute, Vigo county, Sept., 1894 (W. S. Blatchley(.

Ft. Wayne (S. Basch.). Bourbon (J. D. Chaplain).

Westville (E. S. Smith). Huntertown (T. M. Andrews).

IOWA.—Mt. Pleasant. Very thick west of town a few years ago, and has almost disappeared, 1889 (J. H. Mills).

"Waste places; becoming frequent," Ames, 1889 Hitchcock—A Catalogue of the Anthophyta and Pteriodophyta of Ames, 1891. Trans. St. Louis Acad. of Sci., Vol, V, No. 3, pp. 487–532, also separate p. 505. Bowling Green, 1893 (G. W. Smith).

Waste places becoming frequent, Iowa City (Hitchcock).

Davenport and LeClaire, Scott county (W. F. Rolfs, C. B. Weaver and I. C. Brownlie).

Little Rock, Lyon county (J. R. Ball). Keokuk county (Hursey).

Mitchell county (Whitney). Jasper county (I. J. Mead).

Iowa City, 1889 (T. H. McBride). Cedar county (C. B. Weaver).

Polk county (Johnson). Humboldt county (Sherman).

Roland, Story county (Kimble). Story county (Pammel and Combs).

Warren county (Lang.). Marshall county (Eckles).

Grundy county (Steelsmith). Pleasantville, 1894 (Metcalf).

Streets of Ames, 1887 (Halsted). Muscatine, 1891 (Reppert).

Marshalltown, 1894 (Stewart and Pammel). Keokuk (P. H. Rolfs).

Cedar Rapids, 1890, (Pammel). Des Moines, 1890 (Pammel).

Alden, Hardin county C. T. Stevens.

Ames, 1870 (J. C. Arthur, Fourth Biennial Rep. Iowa Agr. College). Earliest record I can find in state.

Ida county, 1894, first time observed (Needham).

Kansas.—McPherson, Sumner, Riley and Butler counties Hitchcock). All through the state as far west as Sherman county. (Hitchcock).

Introduced within three years and rapidly taking possession of dry places along the railroad. (Smith, Addition to the Flora of Kansas, Transactions Kansas Academy of Science, Vol. XIII, p. 97).

Massachusetts.—Near Hovey's garden, Cambridge, 1863-4. (Murray).

Cambridge, waste grounds and roadsides. (Gray, Manual of Botany, 5th edition. p. 281).

Michigan.—A bad weed, spreading and becoming rapidly introduced everywhere along lines of railroads, etc. (Beal and Wheeler, Michigan Flora, 13th annual report of Secretary, Michigan State Board Agr., pp. 180, 108). Durand (J. M. Fitch).

Cambridge (Mrs. F. A. Dewey). Decatur (Mrs. F. A. Dewey). Erie (A. J. Keeney). Union City (D. V. Groesbeck).

Note.—Pammel Rep., Iowa, Agrl. Soc., 1893, p. 449. Thirteenth Biennial Rep. Iowa Agrl. College, 1887-1889, p. 45. Bull. No. 26, Iowa Agrl. College Experiment Station.

MINNESOTA.—Northern Minnesota. "I was greatly surprised to find, some eight years ago, that it was even growing on the confines of civilization." 1886. (L. H. Bailey.)

St. Paul, E. J. Hill, 1889 (Arthur, Bulletin 52, Vol. V, Indiana Agric. Exp. Station, p 90).

St. Anthony's Park, 1888 (J. H. Schuette).

Minneapolis, Minnesota (J. H. Sandberg, 1891) Ft. Snelling (Means).

MISSOURI. * "It was found in St. Louis in 1878 by Mr. I. C. Martindale, and was seen by local collectors even earlier; a specimen of the plant in the herbarium of the Purdue University, collected by Mr. H. Eggert, is labeled 'waste places, St. Louis, July 18, 1877.' Mr. G. W. Letterman said in 1886 that it had been 'thoroughly naturalized in St. Louis during the past eight years, and has now taken to the woods.' In 1880 it was 'extremely abundant (in St. Louis) in waste places,' according to Dr. Geo. Engelmann." (Ind. Agl. Exp. Station Bull. 52, Vol. V, p. 88.) Tracy, Catalogue of the Phænogamous and Vascular Cryptogramous Plants of Missouri, 1886, p. 52.)

Quite common in Kansas City, Mo,, 1889. (Pammel.)

St. Louis. (Engelmann, July, 1875.)

Jackson county. (Bush, 1890).

Springfield. (Dewart, 1892).

NEW JERSEY.—Ballast and made land near Communipaw Ferry, July, 1879. (Addison Brown). (Britton: A Preliminary Catalogue of the Flora of New Jersey, 1881, p. 56).

NEW YORK.—"Abundant all through the state so far as I have seen." (L. H. Bailey). Trumansburg Point, Cayuga Lake, gravelly field a few rods south of the landing, where it is abundant, 1886. (W. R. Dudley, The Cayuga Flora, Bull. Cornell University; Science, Vol. II, p. 55). Starkey, New York: (Comm. Torrey Botanical Club, Poggenburg, Britton, Sterns, Brown, Porter, Hollick, Preliminary Cat. of Anthophyta and Pteridophyta, growing spontaneously within one hundred miles of New York city, p. 31). Brooklyn: Ballast. (B. D. Halsted). East Buffalo: An adventive well established. (1882, David F. Day, Bull. of the Buffalo Soc. of Nat. Sciences, Vol. IV, No. 4, p. 261. The Plants of Buffalo and its Vicinity, 1883, p. 197). Elmira, Syracuse, Clyde, and rapidly spreading at Albany. (Charles H. Peck, letter to L. H. Dewey.)

* Indiana Agricultural Exp. Station, Bull. 52, Vol. V, p. 88.

Ohio.—Columbus. "Sparingly about the culvert, but is spreading rapidly, and is now found in several places along roadsides. July 9, 1892." (Moses A. Craig: A Catalogue of the Uncultivated Flowering Plants Growing on the Ohio State University Grounds, Bulletin of the Ohio Agr'l Exp. Station, Vol. I, No. 2. Technical Series, p. 88. May, 1890.)

Sulphur Grove, August 12, 1892: "Frequent, especially along ditches." (Geo. H. Shull.)

Columbus, 1892. (Lazenby, Agricultural Student, I, 1894.)

King and Neill avenues. (Freda Detmers, Journal of the Columbus Hort, Soc., Vol. V, No. 3, p. 53, plate IV.)

Cleveland. (Halsted, Proc. American Assn., Adv. Sci., Indianapolis meeting, p. 308.)

Painesville, 1879. (W. C. Werner, Journal Columbus Hort. Soc., Vol. V, p. 54.)

Cleveland. (W. C. Werner.)

Cincinnati, July, 1890. (Lloyd.)

Summit county. (Claypole.) Toledo. (Sanford.) Toledo, 1878. (Werner; Journal Columbus Hort. Soc., Vol. V, p. 54.) Centre, (Charles Duckwall.) Mt. Blanchard. (L. Frank Hay.) Oak Harbor. (Albert Overmeyer.)

Oregon.—Eight Mile, 1884. (Andrew Ashbaugh.)

Pennsylvania.—Gettysburg. (Thomas Meehan.)

S. Bethlehem. (Porter.) E. Bethlehem. (S. G. Walker.) Lancaster, July, 1879. (J. H. Small.)

Tennessee.—Nashville, September, 1894. "Seen for the first time." (A. Gattinger.)

Texas.—Dallas, June, 1894, (Ex. Herb., J. Reverchon.)

Northern Texas. 1887. (Pammel.)

Utah.—Salt Lake, 1880. "M. E. Jones tells me that he found it at Salt Lake when he went there in 1880, and it is now abundant at all of the settlements from Logan to Mantz." (L. H. Dewey.)

Virginia, West.—Monangalia, near Laurel Point where it has become a troublesome weed, (Millspaugh, Flora of West Va., p. 396).

Washington.—Rock Island, 1893 (J. B. Leiberg.) Along the Great Northern R. R., Egberk Springs, Nilson Creek, Wenatchee, 1883, (J. B. Leiberg.)

Wisconsin.—Common in waste places, spreading rapidly along railroads, (L. S. Cheney and R. H. True, On the "Flora of Madison and Vicinity," a Preliminary Paper on the Flora of

Dane County, Wisconsin. Transactions of the Wisconsin Academy of Science, Arts and Letters, Vol. IX, part 1, p. 82.) Mukwonago, Forty miles west of Milwaukee, (David F. Day, Bot. Gaz., Vol., VIII, p. 159).

Vernon county, near La Crosse, 1886. (Pammel, Prairie Farmer, January 29, 1887.)

Madison, 1883. "Quite common." (Pammel. Goff, Bull. No. 39, Wis. Agrl. Experiment Station, p. 18, fig. 6.)

Neenah, Elkhart lake, August, 1892. (J. H. Schuette.) S. E. Wisconsin, 1886, (Parry.)

BUFFALO BUR, SPINY NIGHT SHADE, SAND BUR.

Solanum rostratum, Dunal.

DESCRIPTION. An annual, somewhat hoary or yellowish, with a copius wholly stellate pubescence, one to two feet high, spreading specimens occasionally five feet across, globular, leaves interruptedly bipinnatifid or only once pinnatifid, lobes roundish, obtuse and repand, armed with straight bristles, corolla yellow, about an inch in diameter, slightly irregular, short lobes broadly ovate, calyx prickly, adhering to the fruit, at least fitting very closely. Stamens, as well as style, declined, anthers taper upward, linear -- lanceolate, dissimilar the lowest one much longer and larger with an incurved beak.

*In Gray's "Synoptical Flora" the distribution is given as "Plains of Nebraska to Texas (Mexico)." In Gray's Manual, sixth edition, the statement is made "spreading eastward to Illinois and Tennessee." Plains (Nuttall Gen. I, p. 129). (Pursh, Fl. I, 156, T. 7).

The writer has been familiar with this weed in the northwest for a number of years. It was first observed in a lot in Watertown, Wisconsin, in 1887. I saw occasional specimens in St. Louis in the fall of 1886. It was apparently well established in Nevada, southwest Missouri in 1888, as large specimens were found growing in many vacant lots. The same summer I saw a great deal of it growing in Ft. Scott, Kansas, and various towns along the M. K. & T. R. R. in Indian territory. How long it had been established here I was, of course, unable to say. It had the appearance everywhere of being thoroughly at home. In Texas, from Denison south to Hempstead in Waller county, and west to San Marcos in Hays county, the weed was met everywhere, growing in many places to the

* Vol. II, Part I, p. 231.

exclusion of all other plants. It showed evidences of long having been established. Since 1889 I have received specimens from Illinois and Iowa. The U. S. localities and dates, when reported, are as follows: Upper Missouri, Hayden, "very abundant about old trading posts, along old roads, and in prairie dog villages on the Upper Missouri." (Transactions Am. Phil. Soc., 1861.)

"I see no difficulty in supposing that it is native to the region of the plains. It likes barren places; abounds where the grass is scant. In that may be found a reason why it appeared more in Iowa of late years." J. E. Todd. We may assume that it has always been a native to the prairie states, especially west of the Missouri river. Early collectors—Geyer, 1839, who found it at Pierre, now South Dakota. Bexar: Texas, 1828. Rock Creek: Fendler, 1847. El Paso: Wright, 1849. North of the City of Mexico: Hartweg, 1837. Washita, Indian Territory, 1868, Dr. E. Palmer. Abundant about Boulder and Denver from 1873 to 1876, Prof. Henry. Abundant at Denison, Texas, for twenty years, Munson. At least twenty to twenty-five years at Ennis, in north central Texas, Hogan. Thus far it has made but little progress in the timbered region of southeastern Texas. It has not been reported from Louisiana, and there are few indications of its occurrence in the Gulf states. Cultivation, and the transit of cars from western states has caused the species to become abundant in the states that border on the Missouri river—Kansas, Nebraska, Western Missouri (where it was abundant in 1886, Tracy), eastern Kansas, eastern Nebraska and western Iowa. That it was not abundant throughout the plains may be assumed from the fact that in eastern North Dakota the plant is an occasional oddity, Bolley. It seems to have increased in number from the southwest to the northwest. Of its occasional appearance in the United States, outside of the territory indicated, it is reported more frequently from Illinois than elsewhere. Its migration there comes from Missouri and Nebraska. undoubtedly conveyed by stock trains. It seems to have been in parts of Tennessee, according to Gattinger, for thirty years, but has never become a serious pest. From present indications it may be many years till it will become a weed pest in states east of the Mississippi.

Upper Missouri.—1839. (Nicollet's Northwest Expedition. Charles A. Geyer.)

Upper Arkansas.—1869. (Bristol.)

Ranges from New Mexico to Wyoming and across the plains. It has migrate eastward, being common in Iowa and Missouri, and is reported from Illinois, Indiana, Ohio and New York. It is everywhere recognized as a bad weed. Here, from its abundance, it ranks as one of the worst. (Eastern and Western Weeds. Halsted, Bull. Torrey Botanical Club, XIX., Feb. 1892, p. 46.) (Proc. Am. Ass'n Adv. of Science, Indianapolis meeting, Vol. XXIX., p. 308.) (Check List of American Weeds, No. 4,561.)

ARIZONA.—By Loew. (Rothrock Botany, G. M. Wheeler's Geographical Surveys West of the 100th Meridian, p. 207).

CANADA.—Ottawa. "Spontaneous within the limits of the city of Ottawa for a number of years." (Fletcher in Macoun Catalogue of Canadian Plants, part II., p. 348.)

COLORADO.—Denver, 1873—1876. "When I was in Colorado from 1873 to 1876, I found *S. rostratum* growing almost everywhere on the plains in the vicinity of Denver. Plants occupied dry ground, and grew from ten to twelve inches high, many being not more than six or eight." (W. A. Henry.)

Fort Collins. "My first acquaintance with the plant dates from 1890, my first year in Colorado. It was then spoken of as a bad weed by farmers, and I presume has been known as such since farming began in Colorado. It is more troublesome some years than others, as only a small proportion of the seed matures." (C. S. Crandall.)

Plains near Greeley, August, 1871. (W. M. Canby.)

Denver, (B. H. Smith.) Canon City, (Brandagee, Porter.) Plains of the Platte, (Coulter.) "Common on the plains." (Porter and Coulter, Synopsis of the Flora of Colorado. Hayden, Geological Survey. Miscellaneous Publication No. 4, p. 104.) Manitou, August, 1881

DAKOTA, NORTH.—Lamoure, Jamestown, Valley City, as a scattering oddity. Fargo, 1894. (Bolley.)

DAKOTA, SOUTH.—"Generally distributed throughout the state; not so abundant in the eastern part. Carried by railroads." (Thomas A. Williams, Brookings.)

Valley Junction, (E. J. McCullock.) Pierre, 1839 (C. A. Geyer.) Pierre, (Eloise Butler.) Vermillion, (Todd.)

GEORGIA.—Macon, Carmilla, (A. W. Chapman.)

ILLINOIS.—Brendel says that the weed comes from the far west, the seeds being dropped probably by freight cars.

Peoria, railroad bridge, 1891; in a vacant lot, 1892; different places in Peoria, 1893. (Brendel.)

Andover, 1894, (J. A. Anderson.) Mero, 1894, (C. Dorsey.) Evanston, 1883, (C. S. Raddin, Cat. of the Phænogamous Plants of Evanston and Vicinity, p. 20.) Evanston, 1895, (C. F. Shipman.) South Chicago, August, 1886, (A. B. Martin.) (Higley & Raddin, Fl. Cook Co., Ill.; and part of Lake Co. Ind.; Bull. No. 6, Chicago Acad. of Sci., Vol. II, p. 85.)

INDIAN TERRITORY.—(Palmer.)

On the line of the M., K. & T, Railroad, at Caddo, Colbert, McAllister, Atoka, Muscogee, Vinita, 1888, (Pammel.) False Washita, 1868, (Dr. E. Palmer.) Limestone Gap, July, 1877, (Geo. D. Butler.)

INDIANA.—"Southern part, some years ago." (Bolley.)

Lafayette, (Arthur.) Toleston, on Ft. Wayne Railroad, near Calumet Bridge (Hill.) Dune Park, 1890, (Higley & Raddin, Fl. Cook Co., Ill., and part of Lake Co., Ind., p. 85.)

IOWA.—Conway, Taylor Co., some years, (Stimson.) Bedford, Taylor Co., (Pammel.) Agency, (Mrs. Richman; Pammel; Report Comm. on State Flora, Iowa Acad. of Science, Vol. I, part II, p. 17. Thirteenth Biennial Rep. Iowa Agrl. College, 1888-1889, p. 45. Bull. No. 13, Iowa Agrl. Experiment Station, p. 74. Halsted, Twelfth Biennial Rep. Iowa Agrl. College. Report Iowa Agrl. Soc., 1893, p. 447, fig. 1.) Mt. Ayr, 1894, (J. W. Sale.) Guthrie Center, 1894. "Plant 5.6 inches in diameter," (W. M. Ashton.) Iowa City, 1888, (T. H. McBride.) Hamburg, July, 1888, (Hitchcock.) Chariton, 1889–1891, (J. A. Brown.) Saylorville, 1890, (Schaffer.) Carroll Co., 1890. Des Moines Fair Grounds, (A. G. Lucas.) Valeria, Jasper Co., (J. E. Bailey.) Ames, (Pammel.) Polk City, 1891. Mt. Pleasant, 1891, (J. H. Mills.) Fremont Co., Council Bluffs, 1883, (J. C. Arthur, Contributions to the Flora of Iowa, No. IV. Proc. Davenport Acad. of Nat. Sciences, Vol. IV, Feb. 8, 1892, p. 66.)

Found in the State in 1894, as follows: Ainsworth, (J. H. Pearson.) Ames, (Tilden.) Boone, (V. O. Holcomb.) Burwick, (Sylvester Snyder.) Castalia, (E. S. Lambert.) Corning, (Salts; W. L. Abbey, 1893; A. R. Ballantyne; A. A. Rawson.) Delmar, (Sunderlin.) Dubuque, (Asa Horr.) Grundy Center, (Anderson). Gus P. O., (E. J. McCulloch.) Hampton, (T. H, Hacker.) Harlan, (Geo. D. Ross.) Hedrick, (Melville). Ida county, (Needham). Imogene, (C. S. Young.) Little Sioux, (McWilliams.) Logan, (F. H. McCabe.) Marion, (A. E. Allen.)

Newell, (E. W. Stetson.) Oldfield, (E. Turner.) Plover, (W. S, McEwen.) Postville, (Ellison Orr.) Red Oak, (W. T. Marshall.) Sanborn, (J. H. Wolf.) Seymour, (L. W. Lewis and S. A. Hibley.) Story county, (Pammel, Ball and Combs.) Valley Junction, (S. V. A.) Whittemore, (L. E. Albion.) Creston, quite a number in the streets, (Pammel.)

KANSAS.—Everywhere. (B. B. Smith, Check List of the Plants of Kansas, 1892, p. 18. Wood and Willis, The New American Botanist and Florist, Revised Ed. of Wood's Botany, p. 63.)

Topeka, July, 1873, (E. A. Popenoe.) Riley, (E. E. Gayle.) Manhattan, June 6, 1886, (C. H. Thompson. Bulkley, April, 1888.) Also, Hamilton, Jackson, Harper, Pottawatamie, Bourbon, Reno, Rawlins, Seward, Sherman, Ford, Barber, Cloud, Green wood, Clay, Saline, Greeley, Kiowa, Miami, Smith, Linn, Decatur, Chase, Osage, Johnson, Douglas, McPherson and Wichita. Miami county, 1883, (J. H. Oyster.)

KENTUCKY.—Fairmount, Jefferson county, (Albert Rust.)

MASSACHUSETTS.—Lowell. "Rather common," (Dr. F. Nickerson.) Watertown and Somerville, (C. E. Perkins.) Malden avenue from the west, (F. S. Collins.) (Collins and L. L. Dame, Flora of Middlesex County, Mass., p, 78.)

MEXICO.—San Luis Potosi—Alt. 6,000–8,000 ft., 22 N. lat.—(Palmer and Parry.) Chihuahua, (Pringle, Potts.) Zimapan, (Coulter.) Valley of Mexico, 1866, (Bourgeau, 114, 542, 982.) North Mexico, (Hemsley, Biologia, Central Americana Bot. II, p. 414.) (Dr. Coulter, Dr. J. Gregg, 1848–9; M. Bourgeau, May 8, 1886.) North of the town of Mexico, 1837, (Bentham, Plantas Hartwegianas, 1839, p. 23, No. 201. Mount Orizaba, August, 1891, (H. E. Seaton.) States of Coahuila and Nuevo Leon, 1882, No. 942, (Palmer.)

MINNESOTA.—Minneapolis, Clay county, near Moorehead. Red River Valley, Minnesota Valley, (Conway McMillan.)

MISSOURI.—Very common in western Missouri, and spreading eastward along railroads. Sometimes erroneously called 'Canada Thistle.'" (S. M. Tracy, Catalogue of the Phænogamous and Vascular Cryptogamous Plants of Missouri, 1886, p. 61.)

Wild in pastures, 1892.

"Is about as abundant as it was when I first came to St. Louis." (Wm. Trelease, 1885–1894.)

St. Louis, August, 1879, (Englemann); September, 1886, (L. H. Pammel); 1887, (Colman's Rural World); Nevada, Sedalia, 1887, (Pammel); Springfield, July 23, 1888, (S. Weller.)

MONTANA.—"Found occasionally," (F. D. Kesley). Forsyth, 1893, (J. N. Rose.)

NEBRASKA.—Lincoln, 1875, (Samuel Aughey, Catalogue of the Flora of the Nebraska—published by the University of Nebraska, 1875—p. 21.

"In 1888 in great quantities for the first time in all parts of Nebraska." "Is becoming a troublesome weed in Nebraska. Came from southwest a few years ago." (C. E. Bessey.)

Kearney, August, 1889, (J. H. Holmes.) Keyapaha county, 1893, (Fred Clements.) Superior, Trenton, 1894, (Amy Robinson.) Waste places, roadsides, etc., in Lincoln, Oxford, Crete, Fairbury, Milford, Omaha, Louisville, Weeping Water, Alliance, Otoe county, (Webber, Catalogue Flora of Nebraska, 1889, p. 136. Extract Report Nebraska State Board of Agrl. for 1889.) Agalolla, (W. A. Henry.) Lincoln, (Webber.) Crete, (C. D. Sweezey.) Duval county, (Rydberg.) Alliance, 1889, (Webber.) Ashland, September, 1890, (Williams.) Hastings, 1886, (Harvey Thompson.)

NEW JERSEY.—New Brunswick. Cultivated grounds, (Report Botanical Department New Jersey Agricultural Experiment Station, 1890, p. 377. Halsted, 1887, Proc. A. A. Sc., Vol. XXIV. Torrey Botanical Club Bulletin, Vol. XIX, p. 46.)

In waste places, Passaic; sparingly about Passaic, (Woolsen.) Atlantic: Introduced with grain at Hammonton, (F. L. Basset.) Cape May: Cape May Point, (Canby.) Fugitive from the west, (Britton, Catalogue of Plants found in New Jersey, Vol. II, p. 181.)

NEW YORK.—Brooklyn Ballast, (Halsted.) (Comm. Torrey Bot. Club, Preliminary Cat. of Anthophyta and Pteridophyta, etc., p. 38.)

NEW MEXICO.—Rock Creek, August, 1847, (Fendler.)

OHIO.—Sellsville, (Wilcox, W. R. Lazenby and W. C. Werner, Suppl. List to the Plants of Ohio, p. 7.)

OKLAHOMA.—Stillwater, July, 1893, (E. W. Olive.)

PENNSYLVANIA.—Susquehanna, October, 1893, (A. Graves).

RHODE ISLAND.—East Providence, (Jas. L. Bennett, Plants of Rhode Island, being an Enumeration of Plants Growing Without Cultivation in the State of Rhode Island. Proceedings of Providence Franklin Soc., 1888, p. 33.)

TENNESSEE.—South Nashville, "I believe it reached here in war times, by movements of troops or by cattle droves. Some years plenty; other years less," (A. Gattinger.) Nashville, "Introduced in Nashville and vicinity, and spreading," (A. Gattinger, The Tennessee Fl., with Special Reference to the Flora of Nashville, Phænogams and Vascular Cryptogams, 1887, p. 67.) Nashville, July, 1877, (A. Gattinger.) Tiptonville, sandy fields near the Mississippi, June 26, 1893,) S. M. Bain.) Lake county, abundant, (S. M. Bain.)

TEXAS.—Lindheimer, 1886, No. 400; Gillespie county, No. 451, (G. Jermy). Plains throughout Texas, (Coulter, Manual of the Phanerogams and Pteridophytes of Western Texas. Contr. U. S. Nat. Herb., Vol. II, No. 2, p 290.) Denison, "I have known it here for eighteen years," (T. V. Munson.) Expedition from Western Texas, to El Paso, Oct., 1849, (Charles Wright.) Guadaloupe, clayey soil, margin of thickets, Sept. 1854. Western Texas, Red River to Rio Grande, (Torrey and Gray, Pacific R. R. Report, Vol. II, 1854, p. 172.) Southwest, 1880, No. 941, (Palmer.) Ennis, "I have known it about twenty years," (Hogan.) Brazos, 1848–9, Brazos county, (Pammel.) Dickinson, (Fred Mally.) Western Texas, (Torrey and Gray, Pacific R. R. Report, Botany, Red River to Rio Grande, Vol. II, p. 172.) On Rio Grande, 1888, (A. C. Lemmon.) Bexar, 1828, Austin, Dallas, Hempstead, Melissa, Calvert, San Marcos, Sherman, McKinney, Paris, Corsicanna, College Station, Clay Station, Brenham, Giddings, Manor. Abundant at all these points in 1887 and 1888. (Pammel.) El Paso, 1888, (G. R. Vasey.)

WISCONSIN.—Watertown, 1887, (Pammel.)

SODOM APPLE, HORSE NETTLE, SAND BRIER, BULL NETTLE.

Solanum Carolinense L.

A deep-rooting perennial, from one to two feet high, propagating freely by its underground rootstocks, which are from one to three feet long; stems hirsute or roughish pubescent with 4-8 rayed hairs, stout subulate yellowish prickles, usually numerous; leaves oblong or sometimes ovate, obtusely sinuate toothed or lobed or sinuate pinnatifid. The few to several flowered racemes simple becoming lateral; lobes of calyx acuminate. Corolla light blue or white, an inch or less in diameter. The yellow globose berries half an inch in diameter.

The record of Sand Brier or Horse Nettle forms an interesting chapter in the migration of perennial plants from one part of the country to another. It is much easier for an annual to became acclimated than a perennial. Throughout the Mississippi valley there are tropical plants which have become thoroughly naturalized, as in *Amarantus retroflexus*, *A albus*, *A. spinosa*, *Abutilon avicennæ* and *Sida spinosa*. Within the memory of the present generation Indian Mallow has been naturalized in western Wisconsin; *Argemone Mexicana* in a comparatively short time has found its way into Kansas, Iowa and Illinois; *Cardiospermum halicacabum* of the southwest is common opposite St. Louis, in Illinois.

With these annuals, it is only essential that they mature their seed; but with perennials they must not only mature their seed, but the plants must be able to survive the winter. Those who hold that perennials cannot be acclimated will find an exception in *Solanum Carolinense*. Darlington, in his "Flora Cestrica," makes the statement that it was introduced by the late Humphrey Marshall into his botanical garden at Marshalltown. Beck, in 1883, gave its distributions as Pennsylvnia to Carolina, west to Mississippi. In the second edition of Gray's Manual, Connecticut is included; it is also included in the fifth edition, and in the "Synoptical Flora" it is said to occur from Connecticut to Illinois and southward. Dr. Eaton, however, writes me that he has not seen it, and there is no record of its occurrence in that state except the specimens found by Dr. Robbins. That the weed is still spreading in West Virginia is indicated by Millspaugh, in Bull. No. 24, Agricultural Experiment Station. In 1852 Brendel found it native in Peoria, Illinois. In Iowa and Nebraska it is mentioned in the catalogues of Arthur (1876) and Aughey (1875), but probably only in this state along the southern border, at Keokuk west to Fremont county. From 1888–1894 it has been reported from central Iowa, Greene and Story, northern Fayette, and in numerous places in southern Iowa. Evidently the weed has migrated northward from fifty to seventy-five miles in twenty years.

Dry waste places, (Pursh Flora Am., Sept. 1, p. 156.) Florida to North Carolina, (Chapman, Flora of the S. U. S., 1860, p. 349.) Connecticut, Illinois and southward, (Gray's Manual of the Botany of Northern U. S., Second Ed., p. 339.) (Halsted, Eastern and Western Weeds, Bull. Torrey, Bot. Club, Vol. XIX, No. 2, Feb. 1892, p. 46. Proc. Am. Assn. Adv. of Science, Vol. XXXIX, p. 308, August, 1890. Check List of Am. Weeds, No. 450.)

ALABAMA.—Dallas county, (Trelease, 1879.)

ARKANSAS.—Bigelow, (Pitcher, Marcy's Exp., June to Sept., 1849, between Neosta and Red Fork.)

Camden, June 15, 1850, (A. Fendler.)

Carolina, North.—Raleigh. "As a troublesome native weed in the state," (Gerald McCarthy, North Carolina Agrl. Exp. Station, Bull. No. 70, p. 11, plate X.)

Swain county, August, 1891, (H. C. Beardslee and A. G. Kofid.)

Wilmington, 1892, (Gerald McCarthy.)

Carolina, South.—Ravenel, (A List of the More Common Native and Naturalized Plants of South Carolina, in South Carolina Researches, etc. Hugh Thompson, Comm., p. 335.)

Aiken, 1869, (Ravenel.) June, 1869, (H. W. Ravenel.)

Connecticut.—Connecticut to Illinois and Southward, sandy soil. (Gray's Manual of Botany of Northern U. S., Fifth Ed., 1867, p. 381.) Connecticut and southern Illinois, Florida and Texas, sandy soil and waste grounds; southward, a troublesome weed in cultivated grounds, (Gray: Synoptical Flora of North Am., Vol. II, part I, p. 230.)

Delaware.—Newcastle county. Fields and roadsides frequent, (E. Tatnall, Calalogue of the Phænogamous and Filicoid Plants of Newcastle County, Delaware, 1860, p. 58.)

District of Columbia.—Washington, (Lester F. Ward, Guide to the Flora of Washington and Vicinity, Bull. No. 22, U. S. Nat. Museum, Washington, 1881, p. 100.) Washington, infrequent in streets, (Pammel.) Washington, 1881, (William J. Canby.) December, 1886, (A. A. Crozier.)

Florida.—(J. T. Powell.) Duval county, northeast Florida, cultivated grounds, (A. H. Curtiss.)

Apalachicola, (A. W. Chapman.)

Georgia.—(Boykin.)

Illinois.—Peoria. "Found plenty when I came to Peoria in 1852, and has been frequent ever since; sandy soils, fields and roadsides," (Brendel, Flora Peoriana, Budapest, 1882, p. 76. Flora Peoriana, 1887, p. 55.)

Port Byron, (Pammel, Orange Judd Farmer, August 25, 1894.)

Oquawka, (Patterson, Check List of the Native and Introduced Plants of Oquawka, Ill.)

Red Bud, 1887, abundant, (Pammel.)

East St. Louis, 1887, abundant in streets, (Pammel.)

Watseka, (Mark Wall.)

South Chicago, (Higley and Raddin); near Union Stockyards, (Babcock); Grand Crossing (Bastin in Higley and Raddin, The Flora of Cook County, Ill., and a part of Lake County. Ind. Bull. Chicago Acad. of Sciences, Vol. II, No. 1, p. 85.)

INDIAN TERRITORY.—Between Forts Cobb and Arbuckle, on the False Washita, 1868, No. 207, (Palmer).

Along the line of the M., K. & T. R. R., 1887, (Pammel).

Colbert, common along railroads eastward; on prairies west, (C. S. Sheldon and Carleton. Holzinger, Contributions U. S. Nat. Herb., Vol. I, No. 6, p. 196).

INDIANA.—C. R. Barnes, (Catalogue of the Phænogamous and Vascular Cryptogamous Plants of Indiana, 1881, p. 20.)

La Porte county, (E. S. Smith.)

Colehour, (Higley & Raddin, Flora of Cook County, Ill., and Lake County, Ind. Bull. Chicago Acad. of Sciences, Vol. II, No. 1, p. 85.)

Noble county, scarce, (W. B. Van Gorder, Catalogue of the Flora of Noble County, Ind., 1885, p. 31.)

Mishawaka, 1889, (E B. Ulin.)

IOWA.—(Arthur, Contributions to the Flora of Iowa: A Catalogue of the Phænogamous Plants, 1876, p. 26. Pammel, Am. Agriculturist, Vol. I, p. 387.)

Wapello, 1894. Evidently has been here sometime, at several places in the city, (Pammel).

Grand Junction, October, 1890, (Smith. Pammel, Iowa Homestead, October 17, 1890.)

Ames, 1889, (Hitchcock, Cat. Anthophyta and Pteriodophyta of Ames. St. Louis Acad. of Sciences, Vol. V. No. 3, p. 510); Halsted, Bull. Dept. of Botany, Iowa Agricultural College, November. 1886, p. 44); Proceedings Am. Assn. Adv. of Sci., Vol. XXXIX, p. 309 (Pammel.) Established for four years on the station grounds.)

Taylor and Green counties, 1892.

Iowa City, 1893, (Fitzpatrick.) Fayette, 1892, (Mrs. M. E. McWilliams.) Ogden, 1894, (John S. Williams.) Plattville, 1894, (J. B. Studley.) Polk county, Beaver township, 1894, (Lucas.) Audubon, (L. Hudler.) Union Mills, (J. A. Castor.) Mt. Pleasant, 1889, (J. H. Mills.) Des Moines, 1894, (Homestead Co.) Woodburn, Clark county, (Erastus Child, George Phillips.) Bedford, (Geo. Phillips.) Muscatine, (Reppert.) Louisa county, (Hitchcock.) Adair county, (H. C. Wallace.) Keokuk, 1891, (P. H. Rolfs.) Mt. Ayr, (Alex. Maxwell, J. C. Faris, A. J. Imus.) Ames, (Pammel, Combs.) Taylor county, (C. O. Pool.) Conrad Grove, (Steelsmith.) Massena, (Morse, Iowa Homestead, Sept. 11, 1891.) Fontanelle, (Winn, Iowa Homestead, Sept. 12, 1892); (Pammel, Some Obnoxious Weeds of Iowa. Rep. Iowa Agrl. Soc., 1893, page 445, plate IV.)

KANSAS.—Topeka, July, 1883, (E. A. Popenoe.)

Fort Riley, (E. E. Gayle.)

Manhattan, (C. H. Thompson.)

Check List of the Plants of Kansas, 1892, p. 81, (B. B. Smith.)

By counties—Sedgwick, Johnson, Greenwood, Saline, Clay, Riley, Wyandotte, Miami, Sumner, Pottawattamie, Crawford, Linn, Cherokee, Bourbon.

By towns—Kansas City, Lawrence, Washington, Topeka, Junction City, Paola, Ottawa, Manhattan, Potwin Place, North Topeka, Waubansee, Douglass, McPherson, Wichita, Harper, Hamilton, Jackson, Reno, Rawlins, Seward, Sherman, Ford, Barber, Cloud, Greeley, Chase, Osage, Decatur, Lawrence, Olathe, Tonganoxie, Louisburg, Osage City, Burlingame, Quenemo, Council Grove, Eckridge, Abilene, Solomon City, Herrington.

KENTUCKY.—Lexington, (Short.)

LOUISIANA.—"Sparse in parishes of southwest Louisiana." (W. R. Dodson.)

"Common along streams of New Orleans." (J. M. Ordway.)

MASSACHUSETTS.—Watertown and Reading, fall, 1888, (C E. Perkins. Collins and Dame, Middlesex Flora, p. 78.)

MARYLAND.—Stockton, Worcester county, (Busby.)

Deer Creek, Hartford county (George Silver.)

MICHIGAN.—Grand Rapids, July, 1886, (Crozier.)

MISSISSIPPI—Determined by Torrey.

MISSOURI.—Common everywhere, (S. M. Tracy, Catalogue of the Phænogamous and Vascular Cryptogamous Plants of Missouri, p. 61.)

St. Louis, 1887, (Colman's Rural World); abundant in streets and fields, 1886, (Pammel); May, 1833, (Geyer); August, 1847, (Engleman); (Riehl).

Louisiana, (Isaac Newton, Catalogue of the U. S. Plants in the Dept. of Agrl., p. 14.)

Jackson county, June, 1892, July, 1893, (Bush.)

Jefferson City, August, 1871, (C. Krause).

NEBRASKA.—1875, (Samuel Aughey, Catalogue of the Flora of Nebraska, published by the University of Nebraska, 1875, p. 21).

On the plains from Nebraska to Texas and westward to the mountains, (J. M. Coulter, Manual of the Botany of the Rocky Mountain Region, p. 269.)

Nehawka, (Sweezey.)

Crete, (J. D. Sweezey.)

Weeping Water, 1889, 1890, (No. 147), (T. A. Williams.)

Mouth of White River, June 17, 1853, (Hayden.)

Lincoln, Peru, Weeping Water, waste places, not common, (Webber, Catalogue Flora of Nebraska, 1889, p. 136.)

Platte River bottoms, (Webber, Appendix to the Catalogue of the Flora of Nebraska. Trans. St. Louis Acad. of Sciences, Vol. VI, No. 1, p. 7. Cont. Shaw School of Botany, No. 9.)

New Jersey.—New Brunswick, cultivated grounds, (Halsted, Rep. Bot. Dept. N. J. Agrl. Exp. Station, 1890, pp. 397, 440 and 441, A. W. Davis.)

Shiloh, Cumberland county, (A Century of Am. Weeds, Bull. Torrey Bot. Club, Vol. XIX reprint, p. 144.)

In dry soil.

Hudson: Weehawken, (Britton); Bergen Point, (Leggett.)

Union: Plainfield, (Tweedy.)

Warren: Banks of the Delaware at Philipsburg, (Porter.)

Hunterdon: Rosemont, rare, (Best); Rush island, Delaware river, (Theo. Breen.)

Mercer: Trenton, frequent, (Miss Isabel Mulford.)

Burlington: Pemberton, (Lighthipe.)

Camden, (Parke.)

Salem, banks of the Delaware, (Commons.)

In waste places.

Passaic: Sparingly about Passaic, (Woolson.)

Atlantic: Introduced in grain at Hammonton, (F. L. Bassett.)

Cape May: Cape May Point, (Canby.) Fugitive from the west.

New York.—Plants reported as growing spontaneously within one hundred miles of New York city, (Comm. Torrey Botanical Club. Preliminary Cat. of Anthophyta and Pteridophyta, etc., 1888, p. 38.)

New York City: Within one hundred miles of New York city, (Preliminary Catalogue of the Anthophyta and Pteridophyta, etc.)

Roadsides New York State, South and West, (Wood and Willis, The New Botanist and Florist, p. 263.)

Roadsides, etc., Rough Weeds New York, Illinois and Georgia, (Alphonso Wood, Class Book of Botany, with a Flora of the U. S. and Canada, p. 578).

Buffalo, (George W. Clinton, Preliminary List of Plants of Buffalo and its Vicinity, 1864, p. 8.)

Day: Rare. Along the Buffalo and Lake Huron Railroad track at Fort Erie, Ont. Along the track of the Lake Shore and Michigan Southern Railroad in Buffalo, (The Plants of Buffalo and its Vicinity. Bulletin Buffalo Soc. Nat. Sciences, Vol. IV, No. 3, April, 1882, p. 125. A Catalogue of the Native and Naturalized Plants of the City of Buffalo and its Vicinity. Buffalo, 1883, p. 61).

OHIO.–Cincinnati: (Joseph F. James, Catalogue of the Flowering Plants, Ferns and Fungi growing in the vicinity of Cincinnati, p. 14, from Journal Soc. of Nat. Hist., April, 1879.)

Central and South: (Newberry, Catalogue of the Flowering Plants and Ferns of Ohio, 1860, p. 28.)

Central and Southern Ohio: (H. C. Beardslee, Catalogue of Plants of Ohio, 1874. Ohio Agrl. Rep. 1877, pp. 336–363.)

Medina: (M. T. Prichard).

Cincinnati: June 25, 1890, near Cincinnati, June, 1879, (C. G. Lloyd).

ONTARIO.—Fort Erie: Day, (see New York).

PENNSYLVANIA.—"Introduced from the south by the late Humphrey Marshall into his botanic garden at Marshalltown—whence it has gradually extended itself round the neighborhood, and strongly illustrates the necessity of caution in admitting mere botanical curiosities into agricultural districts." Pastures, etc., naturalized from the southern states, (Darlington, Flora Cestrica, 3d edition, 1853, p. 229). (Darlington and Thurber, Am. Weeds and Useful Plants, Second Ill. edition., p. 256. Fig. 164.)

Pennsylvania to Carolina west of Mississippi: (Beck—Botany of North and Middle States, 1823, p. 257).

Pennsylvania to Carolina west to Iowa and Illinois. A weed of roadsides. (Alphonse Wood, Class-book of Botany and Flora, edition 1847, p. 448. Sand Beach, Dauphin Co., (Mr. Galloway).

TENNESSEE.—Fields and gardens: (Gattinger, The Tennessee Flora, with special reference to the Flora of Nashville, 1887, p. 67). (F. Lamson-Scribner and C. L. Newman, Weeds of the farm, Tenn. Agrl. Experiment Station, Vol. 1, Oct., 1888, No. 3, p. 40, Plate VIII).

TEXAS.—Drummond: Sandy soil and waste ground extending into Texas from the Atlantic region. (J. M. Coulter Contr., U. S. Nat. Herb., Vol. II, p. 298).

Denison: Is very common and annoying in cultivated sandy lands. (T. V. Munsen).

VIRGINIA.—Virginia to Georgia on roadsides and old fields. (Pursh—Flora Amer. Septentrionalis, London, 1814, I, p. 156).

Marion: (Britton.)

Bedford county: Oct. 4, 1871, (A. H. Curtiss.)

VIRGINIA, WEST.—This exceedingly pernicious weed is rapidly spreading throughout the state, apparently from the west and southwest portions eastward and northward. (Millspaugh, Bulletin Nos. 22 and 23, West Virginia Agr'l Exp. Station, 1892. In Bulletin No. 23 and 22 Agr. Exp. Station included under list of twenty-five worst weeds. Also the Flora of West Virginia, Bull. No. 24. Vol. II.)

Becoming a detestable weed in fields and forests—

Lewis: along Leading Creek. Wood: near Kanawha Station. Wort: near Elizabeth. Randolph: near Crickard P. O. Webster: on Buffalo Bull Mountains. Nicholas: near Beaver Mills. Gilmer: near Glenville, V. M. Fayette: near Nuttallburgh–L. W. N. Monongalia: near Ice's Ferry. Cabel: near Barboursville. Green Brier: near White Sulphur Springs. Monroe: near Alderson. Sumners: near Hinton. Kanawha: near Charleston. Jefferson: near Flowing Springs, and Shepherdstown. Mason: near Point Pleasant. Mercer: near Ingleside.

Reported as a troublesome weed from—

Harrison: near Clarksburgh, Wilsonburgh, Good Hope, Mt. Clare and Wallace. Ohio: near Elm Grove and West Liberty. Wood: near Waverly, Belleville, Deer Walk and Kanawha Station. Hardy: near Moorefield and Wardensville. Grant: near Medley and Petersburg. Jefferson: near Moore's and Kabletown. Summers: near Forest Hill and Talcott. Wetzel: near Endicott, Pine Grove, New Martinsville and Blake. Mineral: near Patterson's Depot and Blaine. Wirt: near Burning Springs, Morris, Evelyn and Weedy Ripple. Jackson: near Grass Lick and Odaville. Cabell: near Union Ridge and Barboursville. Taylor: near Knottsville. Wayne: near Stone Coal and Adkin's Mills. Doodridge: near Smithton and Center Point. Marshall: near Knoxville and Welcome. Braxton: near Bulltown and Tate Creek. Berkley: near Hedgesville. Mercer: near Brammwell and New Hope. Roane: near Looneyville, Clio, Reedy and Pencil. Pocahontas: near Lobelia. Kanawha: near Blundon. Greenbrier: near Trout Creek. McDowell: near Squire Jim. Mason: near Maggie. Brooke: near Wellsburgh. Marion: near Mannington. Taylor: near Grafton. Upshar: near Kanawha Head, Overhill and Hemlock. Hampshire: near Higginsville and Springfield. Tyler: near Long Reach. Webster: near Welsh Glade. Clay: near Valley Fork.

9

STRUCTURE OF THE SEED COATS OF POLYGONACEÆ.

BY EMMA SIRRINE.

Much work has been done on the structure of the seed coats of different orders of plants. The objects of studying the seed coats of plants microscopically are two-fold. First, to help detect adulterated foods, etc., and in this respect the study has been of very great value. Second, to aid in the distinction and separation of species.

From a systematic standpoint the characters afforded by the structure of the seed coats have been found wanting. In some instances in the order *Polygonaceæ* marked differences in structure are present in some species; in all, however, the same general structure occurs.

Among the European investigators who have studied seed coats in general may be mentioned *H. Godfrin, Harz, Lohde, Schleiden and Vogel, U. Dammer and Moeller. But few Americans have taken up this work. Of these, several papers by L. H. Pammel, and one by P. H. Rolfs, on the structure of seed coats of Malvaceæ, may be mentioned.

L. H. Pammel has shown that in the seed coats of the genus *Euphorbia* some marked differences occur. In *Euphorbia polygonifolia* gelatinous spiricles were found when moistened with water; this also occurs in *Euphorbia Geyeri*, but not in *E. Preslli* and *E. maculata*. In the seed coats of leguminous plants the

*H. Godfrin:—Etude histologique sur les teguments seminaux des angiospermes; Adv. Sc., Vol. 39, 1890, page 328. Harz: Landwirthschaftliche Samenkunde, Berlin, 1885. Lohde: Ueber die Entwickelunggeschichte und der bau elniger Samenchalen, Naumberg, 1874, page 34. Schleiden und Vogel; Ueber das Albumen lnsbesondere der Leguminoseen. U. Dammer in Engler and Prantl, Pflanzfamillen III Thiel, pages 6–7. Mœller: Mikroskopie der Nahrugs und Geunssmittel ans dem Pflanzenreiche, pages 119-124. Pammel: On the Structure of the Seed-coats of the genus Euphorbia, Transactions St. Louis Academy of Sclences, Vol. XIII, p. Rolfs: On the Structure of the Seed-coats of Malvaceæ, Botanical Gazette, Vol. XII, p. 33. On the Testa of some Leguminous Plants, Bull. Torrey Bot. Club. Vol. XIII, p. 17. Hanausek: Die Nahrungs und Guensmiotel aus dem Pflanzenreiche. Haberlandt: Sitzungsber. d. k. Akad. d W. zu. Wien. Vol. LXXV., 1877, p. 33 separate.

same general structure occurs throughout the order. The malpighian cells are very characteristic. Haberlandt, Hanausek, Pammel and others have shown that in *Phaseolus vulgaris* twinned or simple crystals occur in the layer immediately following the malpighian cells. In related species and genera these are not found. Harz does not call attention to crystals in this layer in *Phaseolus multiflorus*; and L. H. Pammel, who has studied American species like *P. lunatus* and *Strophosytles paucciflorus* and *S. angulosa* has not found crystals in the second layer. We may reasonably conclude that for diagonostic purposes this is a valuable character.

Very little attention has been given to a study of the seed coats of the order *Polygonaceæ*. Buckwheat, *Fagopyrum esculentum* and *F. tartaricum*, have been studied for economic reasons by Harz, Weisner, Hanausek, Moeller, while Kraus has studied not only *Fagopyrum*, but *Polygonum* and *Rumex*.

In *Coccoloba*, according to Lindau and Dammer, the seed is provided with two integuments. In one the parenchymatous portion of the seeds becomes much expanded during growth, rifts are found, usually two at each corner; into these the outer integument grows; and the parenchyma rapidly develops.

Harz, in his paper, describes the anatomy of several species of the order *Polygonaceæ*, especially the economic species *Fagopyrum esculentum*, *F. tartaricum* and *F. rotundatum*, giving several excellent figures. Harz also speaks of *Rheum* which has been described by Kraus, but I have not seen this paper. Kraus has also studied a specie of *Rumex* and several species of *Polygonum*. According to this author the outer epidermis of the achenium of *P. Persicaria* consists of long star-shaped, thickened cells. The middle portion agrees with *Rumex crispus*. He states that the glistening appearance of these seeds is due to the thickened cuticle. Tannin is very abundant in the undeveloped fruit; a little is found in the outer epidermis, but it is largely developed immediately underneath; farther in this material diminishes. The fruit of *P. Hydropiper*, *P. aviculare*, *P. dumetorum*, and *P. convolvulus* are structurally alike. The fruit of *P. convolvulus* is not shining and is covered with strong, irregular one and two-rowed cuticular projections. Harz describes seeds of *P. tinctorum*, but he does not figure the species. He states that it resembles *Fagopyrum esculentum*.

In the arrangement of the genera and species Gray's Manual has been followed. The different North American genera of this family have been studied, but in some cases not all the species. The representatives of the different sub-genera have been studied except in Bistorta which was omitted for want of good material. The palisade portion constitutes the outer part of the achenium; this is followed, in most cases, by the testa, consisting of several layers of cells, varying in some cases however; they are quite regular in form and in some cases are dark in color. In a mature palisade cell the cell-cavity is present. This varies greatly in the different genera, in some cases occupying nearly the entire cell; in others it is small and irregular. The light line does not occur and hence they differ materially from the malpighian cells found in *Malvaceæ*, *Leguminosæ*, etc. Elongated cells of this character, without the light line have been called palisade, but this term is preoccupied by one used for the elongated cells found in the leaf, *i. e.* the so-called palisade parenchyma. I shall therefore use the term "palisade" in quotation marks. For brevity I shall refer to section of fruit and seed coat as achenmium.

Polygonum virginianum, L.

Figure 1, plate vii.

In the specimens of this species the "palisade" cells are long and narrow, with a cell cavity extending the whole length of the cell. The cell is nearly truncate at the ends, but sends out from its sides minute canals. The whole cell is colored light brown, while the cavities are of a deeper color. The "sub-palisade" portion consists of four layers of nearly square cells arranged systematically. The endosperm is composed of large, irregular cells, containing both simple and compound starch grains. Measurements—achenium 165u, "sub-palisade" cells, 132u, "sub-palisade" 33u.

P. convolvulus, L.

Figure 2, plate viii.

In this species the "palisade" cells are long but not as narrow as in *P. Virginianum*, while the cell cavity is also broader, the cavity has some canals as in that species, but in addition to this occur papillate projections. The whole cell is clear and light, while the cell-cavity is light brown. The "sub-palisade" portion consists of four layers of isodiametric cells. The endosperm is made up of long, regular cells of about the same size as *P. Virginianum*. Measurements—achenium, 132u, "palisade" cells, 99u, "sub-palisade," 33u.

P. dumetorum var. *scandens*, Gray.

Figure 3, plate vii.

In this species the "palisade" cells are long with papillate projections, giving the cells an irregular outline. The cell avity is long and narrow, with quite long, slender canals, extending from sides; at the upper end of the cell the cavity divides into two branches which terminate in the end of the cell; the cell and the cell-cavity is light brown in color, the cavity being somewhat darker than the rest of the cell. In the "sub-palisade" portion but two layers of cells occur. The endosperm is composed of cells much broader than those of *P. Virginianum* and are quite irregular in form. Measurements—achenium 142u; "palisade" cells, 122.1u; "sub-palisade," 13.2u; papillate projection, 9.9u.

P. Hydropiper, L.

Figure 1, plate ix.

In specimens of *P. Hydropiper* the "palisade" cells are long and narrow, very irregular and truncate at ends. The cell-cavity is very narrow and extends the whole length of the cell. The cavity has minute canals which extend out from sides: the cavity also truncate at ends. The cell is colored light brown while the cavity is deeper in color. The "palisade" cells resemble very much those of *P. Virginianum.* The "sub-palisade," however, are much smaller with more numerous indistinct layers, there being at least six layers well defined. The endosperm cells also are small and quite irregular. Measurements—achenium, 132u; "palisade" cells, 92.4u; "sub-palisade," 39.6u.

P. erectum, L.

Figure 5, plate vii.

In this species the "palisade" cells are much broader than in any other Polygonum studied. The cells have irregular papillate projections as in *P. dumetorum* var. *scandens.* The cell-cavity is narrow with long canals extending from it; the cavity branches are forked. In *P. erectum* the whole cell is of a light brown color, while the cavity is colorless. The "sub-palisade" portion consists of two layers of isodiametric cells. The endosperm has long, narrow, regular cells. Measurements—achenium, 82.5u, "palisade," cells, 60u; "sub-palisade," 22.5u; papillate projection, 3.3u.

P. Persicaria, L.

Figure 6, plate viii.

In this species the "palisade" cells are long, narrow and truncate. The cell cavity extends the whole length of the cell; at the upper end, branched. All along sides of the canal are minute projections which sub-divide, forming three or more branching canals. The "sub-palisade" portion consists of four layers of small, round cells, with a small chain-like layer also between "sub-palisade" and endosperm. Endosperm consists of large, irregular cells. Measurements—achenium, 128.6u; "palisade" cells, 108.9u; "sub-palisade," 29.7u.

Eriogonum sp?

Figure 7, plate ix.

In *Eriogonum* the "palisade" cells are narrow and not very long; rectangular in shape, and regularly arranged; the cell-cavity is situated at the lower end of the "palisade" cells, and extends only half its length; the cavity is broad at the base, filling the whole width of the cell, but tapers to a point at the upper end. The cell is light colored, while the cell-cavity is of a deep brown color. The "sub-palisade" consists of two layers of cells, slightly oval in shape, and regularly arranged. The endosperm consists of large cells, nearly as broad as long.

Polygonella gracilis, Meisner.

Figure 8. plate ix.

In this species the "palisade" cells are nearly square, being only a trifle longer than broad. The cell-cavity runs nearly the whole length of "palisade cell", is quite broad and ends in forked canals, which run nearly to the end of cell. The cell walls are light in color, while cavity is somewhat darker. The "sub-palisade" portion consists of round, slightly elongated cells, which are quite small. The endosperm consists of cells a trifle larger than broad and arranged somewhat irregularly. Measurements—achenium, 59.4u; "palisade," 33u; "sub-palisade," 26.4u.

Brunnichia cirrhosa, Banks.

Figure 9, plate viii.

In the specimens of *Brunnichia cirrhosa* very long, broad "palisade" cells occur. The cell-cavity is large and nearly square. A delicate layer of cells occurs between "palisade" and "sub-palisade" layers, beaded in appearance. The "sub-palisade" cells are nearly square and are regularly arranged. The endosperm cells are large rectangular, irregularly placed. Measurements—achenium, 141.9u; "palisade" cells, 99.u; "sub-palisade," 42.9u.

Rumex crispus, L.

Figure 10, plate vii.

In this species the "palisade" cells are broader than in the *Polygonum* but not so long. The cell-cavity is short, only extending a short distance into cell. It is quite regular in form with no branching canals. The cell is light, while the cavity is slightly brownish. The "sub-palisade" cells are irregular in shape, being slightly oval and consisting of three layers. The endosperm is made up of large irregular cells about as broad as long. Measurements—achenium 92.4u, "palisade" cells 36.3u, "sub-palisade" portion 23.1u.

Rumex verticillatus, L.

Figure 11, plate viii.

In this species the "palisade cells" are narrower and longer than in *R. crispus*. The cell-cavity extends the whole length of the cell, differing in this from *R. crispus*, but has no projecting canals. The cell is light colored while the cavity is brown. The "sub-palisade" cells are regular in form and position. The endosperm is made up of irregular cells. Measurements—achenium 92.4u, "palisade" cells 59.4u, "sub-palisade" portion 33u.

Rumex acetosa, L.

Figure 12. plate viii.

This species has very small "palisade cells," rectangular in shape and with a small cell-cavity which occupies only a small portion of the lower end of the "palisade" cell. There are no canals or irregularities of the cell cavity. The cell is light in color while the canal is darker. The "sub-palisade" portion is composed of small round cells variable in number. The endosperm is composed of cells irregularly arranged. Measurements—whole achenium 36.3u, "palisade cells" 23u, "sub-palisade" cells 13.2u.

Oxyria digyna, Hill.

Figure 13, plate ix.

In this species the "palisade" cells are much reduced, consisting of medium sized rectangular cells, with the cavity situated in center of cell and occupying the same for two-thirds of the distance. The cell-cavity is darker than the rest of the cell. The "sub-palisade" portion consists of two layers of rectangular cells, while the endosperm consists of long, regularly arranged cells. Measurements—whole achenium 66u, "palsade" cells 39.6u, "sub-palisade" 26.4u.

Fagopyrum esculentum, Moench.

Figure 14, plate. ix

In this species "palisade" cells appear different in the angles of the seeds than on sides. In the angles the "palisade" cells are much reduced, being nearly round, with a small, round cell-cavity. but in the angles of achenium, the "palisade" cells become longer and the cell-cavity also elongates. The cell is light colored and cavity brown. In the "sub-palisade" portion five layers of cells are present. First—a large square layer occurs; immediately beneath this is a small chain-like layer of cells, and lastly occurs a layer resembling very much the first. The endosperm consists of long regular cells. Measurements—whole achenium 1.65u, "palisade" cells 99u, "sub-palisade" cells 66u.

CONCLUSIONS.

In general the structure of the testa offer few characters that are of sufficient importance to distinguish species, as the related species have similar structures. The genus *Polygonum* is easily distinguished from *Rumex*, by its papillate projections which occur on the surface of the achenium. In *Polygonella gracilis* these papillate projections likewise occur. The small canals radiating from cell-cavity in palisade like cells of the genus *Polygonum* are too variable and not constant enough to be of service in the separation of species. However, studies of this kind are of service and value in botanical work simply as a knowledge of plants as a whole.

DESCRIPTION OF PLATES.

Figure 1.—*Polygonum virginianum; a*, palisade cells; *b*, sub-palisade cells; *c*, endosperm; *b*, embryo. (Plate vii.)

Figure 2.—*P. convolvulus; a*, palisade cells; *b*, sub-palisade; *c*, endosperm. (Plate viii.)

Figure 3.—*Polygonum dumentorum*; *a*, palisade cells; *b*, sub-palisade; *c*, endosperm; *b*, embryo. (Plate vii.)

Figure 4.—*Polygonum Hydropiper; a*, palisade cells; *b*, *c*, sub-palisade layers; *d*, endosperm; *b*, embryo. (Plate ix.)

Figure 5.—*P. erectum; a*, palisade cells; *b*, sub-palisade; *c*, endosperm; *b*, embryo. (Plate vii.)

Figure 6.—*P. Persicana; a*, palisade cells; *b*, sub-palisade layer; *c*, endosperm; *b*, embryo. (Plate viii.)

Figure 7.—*Erigonum; a*, palisade cells; *b*, sub-palisade; *c*, endosperm.

Figure 8.—*Polygonella gracilis; a*, palisade cells; *b*, sub-palisade; *c*, enodsperm; *b*, embryo. (Plate ix.)

Figure 9.—*Brunnichia cirrhosa; a*, palisade cells; *b*, sub-palisade; *c*, endosperm; *b*, embryo. (Plate viii.)

Figure 10.—*Rumex Crispus; a*, palisade cells; *b*, sub-palisade; *c*, endosperm; *b*, embryo. (Plate vii.)

Figure 11.—*Rumex virticillatus; a*, palisade cells; *b*, sub-palisade; *c*, endosperm; *b*, embryo. (Plate viii.)

Figure 12.—*Rumex acetosa; a*, palisade cells; *b*, sub-palisade; *c*, endosperm; *b*, embryo. (Plate viii.)

Figure 13.—*Oxyria digyna; a*, palisade cells; *b*, below this the sub-palisade; *c*, endosperm; *b*, embryo. (Plate ix.)

Figure 14.—*Fogopyum esculentum; a*, cross section of *b*, palisade portion; *c*, sub-palisade above and endosperm below. (Plate ix.)

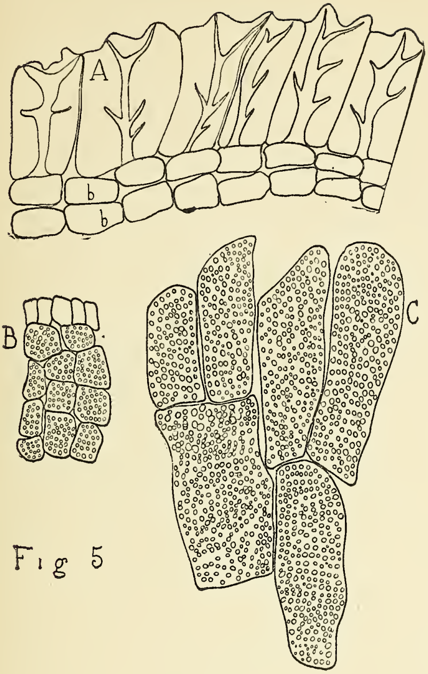


Fig 5

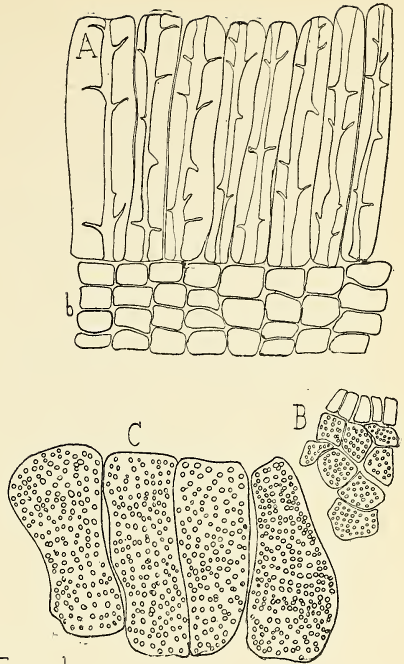


Fig 1

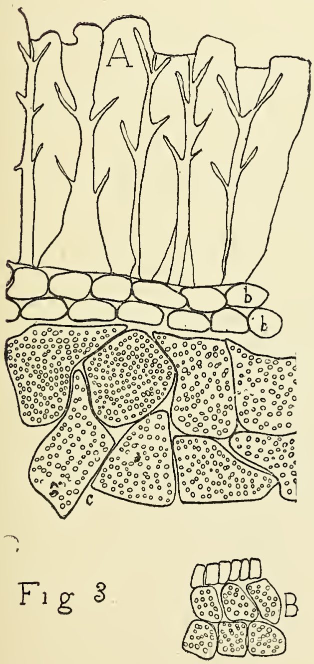
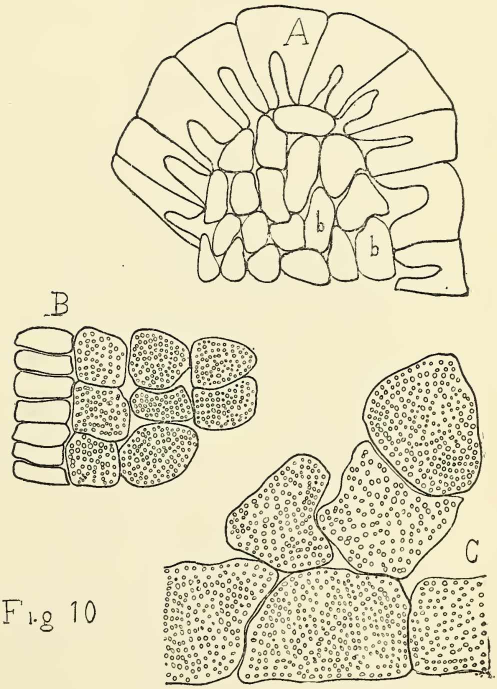


Fig 3



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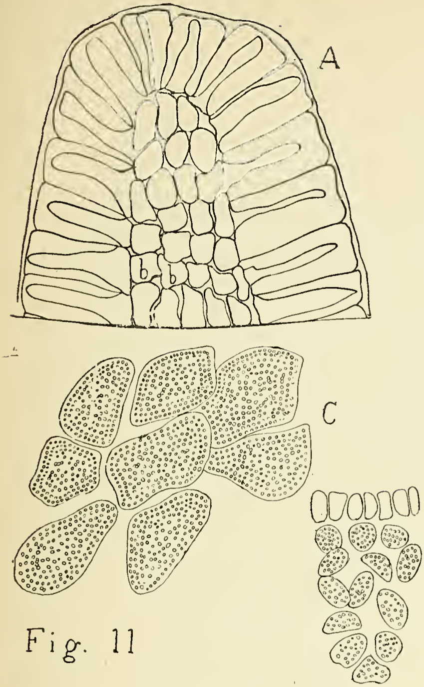
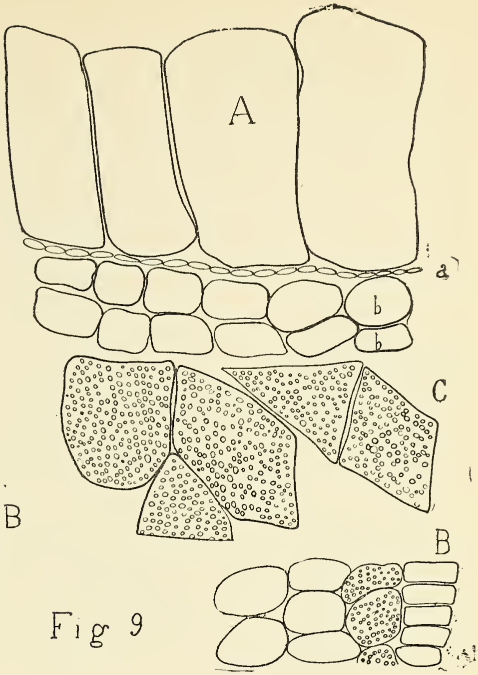


Fig. 11



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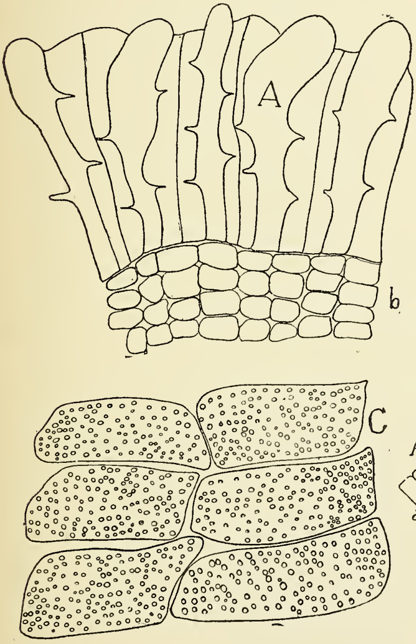
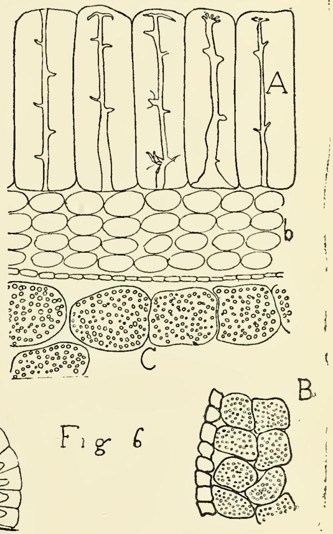


Fig. 2



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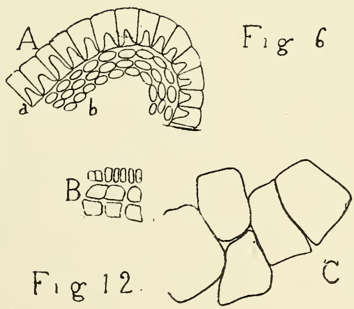


Fig 12.

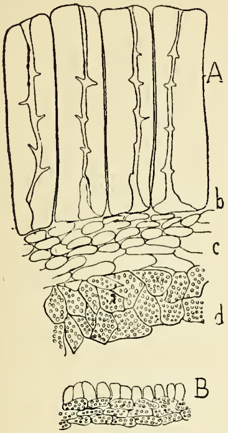
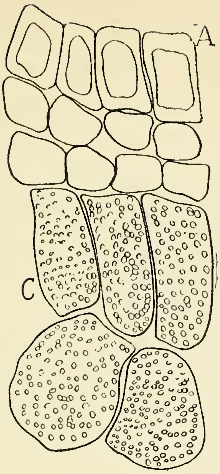


Fig 4



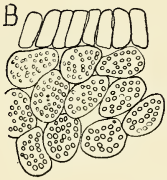
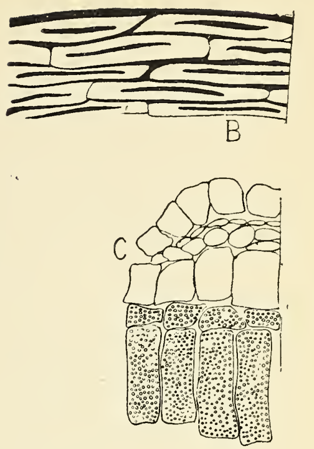


Fig 13



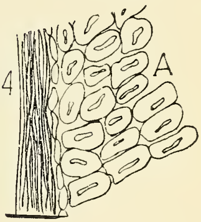
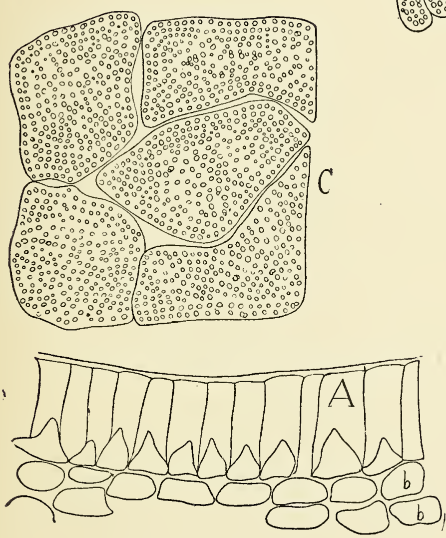


Fig.14



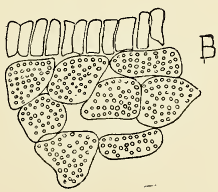


Fig 7

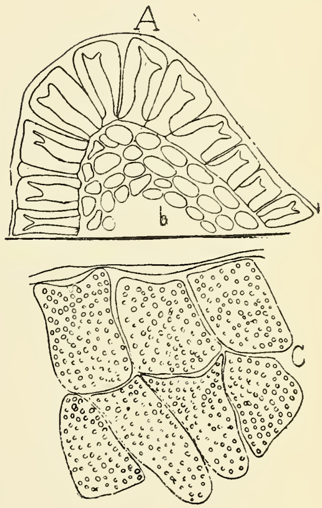


Fig 8

LICHENS COLLECTED BY DR. C. C. PARRY IN WISCONSIN AND MINNESOTA IN 1848.

BY BRUCE FINK.

The lichens of this collection are all conspicuous foliaceous or fruticulose forms. One striking feature is the evident care of the collector to preserve excellent specimens. There are no notes accompanying each packet. However, if all were collected in one of the above named states as is stated on the card accompanying the package sent me, the collection is a very good one, as *Cetraria Islandica*, *Evernia vulpina*, and *Stereocaulon puschale*, are probably new or very rare in either state. The same may probably be said of the two *Umbilicarias* listed. I find the names of the species sent to be as follows:

Ramalina calicaris, (L.) Fr., var. *fastigiata*, Fr.
R. calicaris, (L.) Fr., var. *farinacea*, Schaer.
Cetraria ciliaris, (Ach.)
C. glauca, (L.) Ach.
C. Islandica, (L.) Ach.
Evernia vulpina, (L.) Ach.
Usnea barbata, (L.) Fr., var. *florida*, Fr.
U. angulata, Ach.
Alectoria jubata, (L.).
Parmelia saxatilis, (L.) Fr.
P. physodes, (L.) Fr.
P. conspersa, (Ehrh.) Ach.
Pycine sorediata, Fr.
Peltigera canina, (L.) Hoffm.
Sticta pulmonaria, (L.) Ach.
Umbilicaria pustulata, Hoffm.
U. Dillenii, Tuck.
Stereocaulon paschale, (L.), Fr.
Cladonia cristatella, (L.) Tuck.
C. gracilis, (L.), Ayl.
C. pyxidata, (L.) Fr.
C. squamosa, Hoffm.
C. rangiferina, (L.) Hoffm.

10

STUDY OF GLANDS IN THE HOP-TREE.

BY CASSIE M. BIGELOW.

In studying this plant, the main object has been to bring out the characteristics of the glandular structures in *Ptelea trifoliata* and the differences between the glandular structure of this plant and other used in a like way as the hop.

The hop-tree is grown quite extensively in parts of Russia, as a substitute for true hops. It has the same bitter taste, but is without the aromatic principle which makes the bitterness of true hops so valuable.

It is also used in bread making as a substitute for hops. It does the same thing without giving it exactly the same taste. In bread making it prevents the yeast from souring by checking the fermentation before all the sugar is converted into alcohol and carbon-dioxide.

The members of the order *Rutaceæ* are noted for the conspicuous aromatic properties, as in the prickly ash, Ruta, Dictamnus, orange, lemon, etc. They all have lysigenous passages. Ruta, so commonly cultivated in gardens, is very acrid, sometimes even blistering the skin, and this acrid substance is found in the numerous lysigneous passages produced in the plant.

The glands of Ruta are situated just under the epidermal cells. They are circular in outline, enclosed by layers of thin walled, more or less disorganized cells, followed by a layer of cells with granular contents.

The mode of origin of these glands is quite interesting, especially when compared with resin canals. DeBary and others, who have studied them, find their origin to be as follows.

They can be seen well in sections of young growing leaves of either *Ruta graveolens*, or another nearly related plant, *Dictamnus fraxinella.*

They appear as roundish spaces or cavities filled with their contents (formerly called interior glands), and are produced in such a manner that the cells which occupy the place of the subsequent receptacle becomes filled at an early period with the respective secretion. Afterwards the membrane of these cells containing the secretion disappears.

DeBary states that in Dictamnus, beneath the epidermis, but derived in part from it, there arise cavities containing ethereal oil.

The presence of oil cavities is a general and characteristic phenomenon in members of the order *Rutaceæ*. In the stem of *Dictamnus* and *Correa* these cavities lie directly under the epidermis.

Their origin is in all cases lysigenetic. He refers to a description and drawing by Frank of *Ptelea trifoliata*. The oil glands of Citrus are located in the yellow part of the rind, sometimes extending into the white layer. They are large structures visible to the naked eye, the walls are composed of thin walled rectangular cells so arranged as to give the glands an oval appearance. In the very large oil spaces in the rind of the fruit of Citrus a solution of the cell walls is distinctly perceptible.

This is probably still more the case in trunks of Copaifera, in which the balsam passages attain an enormous development. These trees contain the Copaiva balsam in canals which are as much as an inch in diameter and which often traverses the entire trunks.

Hop-tree differs from most of these in that the cell contains one large oil globule and several smaller ones.

The resin of *Ptelea* is not soluble in cold water, but slightly so in warm water. It seems to dissolve in ether, but there remain small granules,

In alcohol the resin dissolves and the globules break up.

It is not soluble in glycerine. The common hop *(Humulus lupulus)* and hemp *(Cannabis sativa)*, although very different in structure, have similar resinous secretions.

The fruit of the hop as well as the axis and the base of all the leaf-like organs are beset with numerous shining translucent glands to which the aromatic smell and taste are due. Hops found in commerce consist entirely of fully developed cones, more or less compressed.

Each grain is originally attached by a very short stalk. The glands are short stalked, cupped plates of tissue, the cuticle of which is raised up by the bulky secretions, while the cells die. Behrens has recently studied hops. According to him the formation of lupulin glands begin after complete development of the bracts, the ethereal oil is secreted between the cuticle and the cuticularized membrane. He further remarks that the quantity of lupulin grains is dependent upon fertilization. These glands serve as a protection from animals, and also that the only possible way of recognizing ripe hops is to find the lupulin grains filled with this lupulin.

It is gradually soluble by water, and instantly so by alcohol and ether.

The covering of the calyx has on it many glandular hairs which secrete the resin and oil.

Examined under the microscope it appears to be made up of minute transparent grains of brown resin agglutinated with short hairs of the plant.

EXPLANATION OF PLATE.

In Fig. I is shown one of the fruits of the *Ptelea trifoliata.* The glands appear as minute dots over the surface of the fruit, being more numerous directly over the seed.

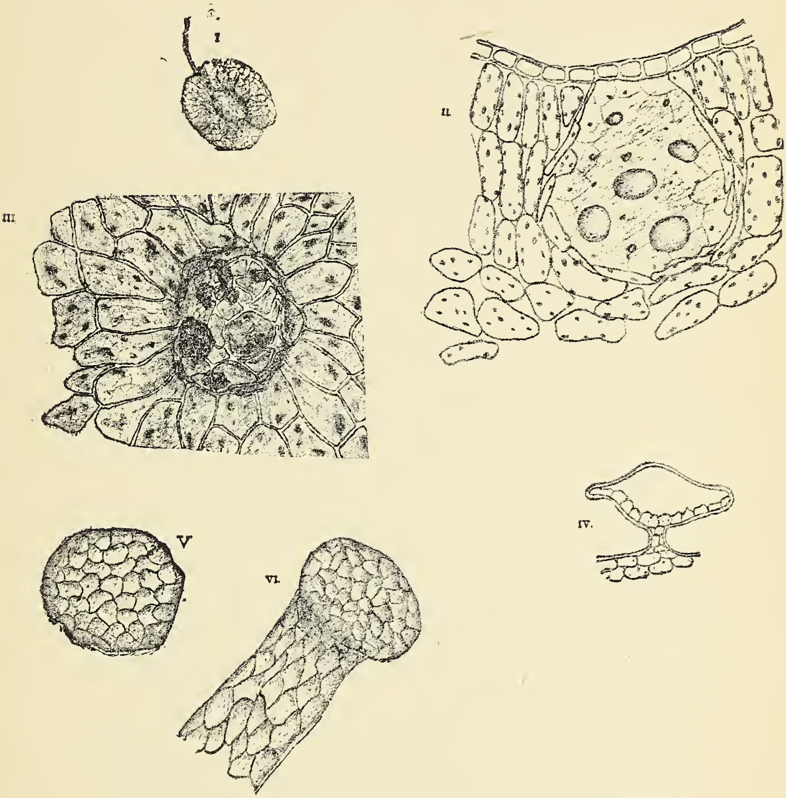
Fig. II is a cross-section of one of the glands of the fruit of *Ptelea trifoliata*, showing the resin and oil globules. The fragments of some of the cells may be seen around the edge of the gland. The gland occurs just beneath the epidermis.

Fig. III is a surface view of one of the glands of the fruit of *Ptelea trifoliata.* The resin and oil globules are shown surrounded by the regular cell structure.

Fig. IV is a cross-section of one of the glandular hairs on the fruit of true hops, *Humulus lupulus.*

Fig. V is a view from the top of one of the glandular hairs which occurs on the hemp, *Cannabis sativa.*

Fig. VI is lateral surface view of one of the glandular hairs which occurs on the hemp, *Cannabis sativa.*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GRAPHIC REPRESENTATION OF THE PROPERTIES OF THE ELEMENTS.

BY T. PROCTOR HALL.

In Mendeleeff's classification the elements are arranged in order on a plane surface, so as to increase along one axis in atomic weight, and along the other axis in valence. The properties of an element can then, to some extent, be inferred from its relation to the others on the diagram. Some of the relations are found to be better expressed when the surface is made cylindrical.

Lothar Meyer shows the same properties in a slightly different way by placing the elements along one axis at distances indicated by their atomic weights, and along the other by their atomic volumes. All the known elements then take their places on a series of wave-like curves, and similar elements have similar positions on the curves. Each curve represents one of Mendeleeff's periods.

It has been suggested that since in the C. G. S. system there are three and only three arbitrary units, namely, mass, length and time; a curve might be drawn with reference to three coördinates corresponding to the three fundamental units, and that the positions of the elements on such a curve ought to be a complete expression of their properties. But if we take only two arbitrary units, say mass and length, all others may, as is well known, be derived from them. In gravitation, force is related directly to mass and inversely to length. Acceleration varies as force, and the unit of time may be easily defined in terms of acceleration and length. But it does not follow that the properties of the elements can be well expressed by a two-fold diagram. Elements and atoms are solids and exist in three-fold space. The constant relation of mass to gravitational force makes it highly probable that all the atoms are composed of the same basal matter, and that their differences arise from differences in atomic structure, and in the quantity of the fundamental matter included in each. The properties of an element are then dependent upon the distribution of matter in three-fold space in its atoms, and are functions of the three space coördinates. The properties cannot, therefore, be completely expressed by a one-fold or a two-fold diagram. A three-fold diagram on such a plan implies a far fuller knowledge of the atoms than we can hope to gain for a long time, and for the present we must be content with approximations.

Mendeleeff's diagram is based on two units—atomic weight, which is proportional to mass; and valence, which is a rough indication of the distribution of the matter of an atom in space. Lothar Meyer takes for the units in his diagram atomic weight and atomic volume. The latter is a different measure of the distribution of the matter of an atom in space. If to either of these diagrams be added a third coördinate indicative in a different manner of some essential feature of the distribution of the matter of an atom in space, the curve in space thus found will be a still closer approximate to the true and complete three-fold diagram. The third coördinate must represent some property which is constant under known conditions for all elements. Valence is too variable. The atomic weight is the only known property of atoms which is strictly constant. Atomic volume, considered as the inverse of the density of the solid element, is slightly variable. If the density could be taken at absolute zero we should have the volume under more uniform conditions. Wherever the coefficient of expansion of an element is known, its volume at absolute zero may be approximately calculated. I have done this in the case of a few elements, and find that its general result is to smooth out the irregularities on Meyer's curve. If, instead of atomic volume, the cube root of the volume is taken, so as to make the coördinate refer to atomic diameter, the curve shows a much more even distribution of atoms than it shows when drawn in the ordinary way.

For a third coördinate the force of attraction between atoms of the same kind seems to be the best property we can find at present. In solids this force is represented by tenacity; in liquids it is proportioned to surface tension, and in gases it is proportional to the heat energy required to move the atoms so far apart that they can no longer cohere, that is to say, to the critical temperature of gas.

The critical temperature can be calculated from measurements of surface tension, leaving only two series of data which may be correlated by the method of comparison, since both the tenacity of the solid and the surface tension in the liquid state can be found for some elements.

Unfortunately I have not been able to collect sufficient data to draw the curve even approximately, but an inspection of the elements on Meyer's curve shows that the curve in space will approximate a spiral, of which Meyer's curve is a projection. For example: The volatile element flourine and the metal magnesium will stand near the top and bottom of the curve respectively, and in general the elements on the rising branch will be high, and those on the falling branch of Meyer's curve low, with respect to the third co-ordinate. Melting points, boiling points, hardness, and other related properties of the elements are likely to be much more clearly represented on this curve than they are by either Meyer's or Mendeleeff's system.

CERTAIN MINERALS OF WEBSTER COUNTY, IOWA.

BY ARTHUR C. SPENCER.

Within the limits of Webster county are found a number of interesting minerals. The following notes are descriptive of a few of them.

Quartz. In the vicinity of Fort Dodge the sandy deposits overlying the gypsum are full of rough calcareous concretions of irregular shape. These formations are never hollow like geodes, but like them consist largely of quartz crystals. Calcite showing little or no crystalline character surrounds and incloses perfect crystals of doubly terminated quartz. These small crystals rarely exceed 3 mm. in length. They show only the simple forms of the unit prism and the unit rhombohedron. Its intimate association with calcite indicates that the quartz was without doubt deposited by circulating carbonate or alkaline waters.

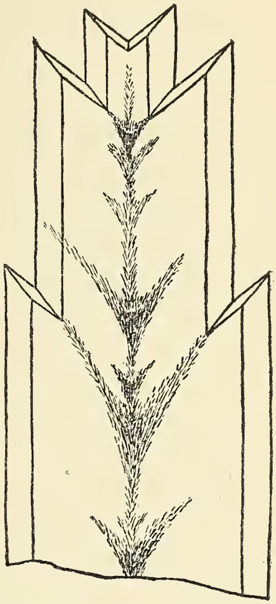
Pyrite. Though of very frequent occurrence throughout the coal measures of Webster county no good crystals have been noted, though careful search would doubtless reveal well crystallized specimens. The mineral occurs in masses disseminated through the coal and shale with slightly projecting crystals, showing the octahedron and cube, the latter often with curved faces. Certain layers of the brick shales are rejected because of its presence. At the clay pit of the Fort Dodge Pressed Brick Company a good sized stigmaria impregnated with pyrite was found. The pyrite is associated with gypsum, crystals of which are often found clustered around masses of it. Pseudomorphs of limonite after pyrite are common in the Saint Louis limestone.

Celestite. Sulphate of strontium has been noted at several places. It is usually in fibrous layers from a quarter to three inches thick in the coal measure sandstones and shales. The seams are variously inclined, one observed having a high angle. A cross-section of the vein showed two or three layers, indicating that the fissures had been widened at different times. White* who had evidently seen only the horizontal seams suggested that the joints were connected with the stratification of the inclosing shales. The same writer stated that the fibers are perpendicular to the plane of the layer, but samples have been obtained where their direction is variously inclined. An inspection of the material collected from the bed of the river a mile or so below Fort Dodge also brings out a variation in the angle between the long direction of the fibres and the basal cleavage. In those seams which are horizontal the cleavage is parallel, or nearly so, to the plane of the layer and the fibers are at right angles to this. In the mineral from those seams which are most nearly vertical the cleavage is inclined both to the sides of the fissure and the direction of the fibers. However the basal plane is always horizontal, suggesting that gravity has played an important part in the orientation of the crystal network. From the imperfect cleavages of the brachypinacoid it is evident that the vertical seam, the fibers, are parallel to a brachy-dome. Some fairly good tabular crystals were obtained from the clay pit of the Fort Dodge Pressed Brick Company, where the mineral is associated with pyrite often filling the interior of sigillaria.

Gypsum. Crystals of gypsum occur in the coal measure shale in considerable perfection of form. So far as observed these crystals are invariably of tabular form parallel to the

*Geol. of Iowa, vol. 11, p. 305. 1870.

clino-pinacoid which with the unit prism and the positive hemi-pyramid are the only forms occurring on crystals found in this vicinity. The twin crystals are united along the ortho-prism. Shadow crystals are common both in simple and twinned forms. In the latter there is also an arrangement of impurities along the common axis of the two individuals from which barbs are thrown out in all directions. These prongs intersect with an approximate angle of 66 degrees which is found to correspond rather closely with the conical angle of the cone-in-cone structure common in the vicinity of Fort Dodge. The resemblance between the structures is very striking. Measurements of simple crystals show them to be commonly a trifle less than twice as long as broad, and their thickness something less than half their breadth. In twin crystals, however, the relative thickness is more than doubled, making each individual nearly as thick as broad. It will be noticed that the growth of these crystals is in one direction, and that they become smaller and smaller by frequent re-entrant angles into which fine clay has filtrated. With the rates of growth in the several directions as expressed above, it is evident that the angle receiving the foreign material is pushed upward approximately twice as fast as outward by reason of which the impurities are left in a cone whose angle is in the neighborhood of 60°. Only occasionally is one of those angles persistant, the majority of them being grown over and buried.



Gypsum crystal from near Fort Dodge.

Peculiar growths are frequently observed where a small crystal protrudes from the prismatic face of a much larger individual. The faces of the prismatic zone of the small crystal are replaced by vicinal planes which come together in a point forming a sharp six-sided pyramid.

Cavities in the gypsum rock sometimes contain crystals of selenite, but the rock consists of fibrous gypsum, crystals being rare.

POLLINATION OF CUCURBITS.

BY L. H. PAMMEL AND ALICE M. BEACH.

During the season of 1892 one of us was engaged in crossing some of the cultivated cucurbits. Incidentally some attention was given to their pollination. As comparatively little has been published concerning the pollination of these plants, these notes may be of interest.

The insects collected in 1892 were identified by Mr. Gossard, who assisted in noting them in the field. We are greatly indebted to Mr. Charles Robertson for determining some of the *Hymenoptera.* Mr. Stewart, who assisted in crossing cucurbits, also frequently noticed the honey bee on various cultivated forms of the Cucurbitaceæ. Most of the drawings were made by Miss Charlotte M. King.

The literature on the pollination of Cucurbitaceæ is very scanty. The European *Bryonia dioica* was studied by Herman Müller.[1] Mr. T. C. Gentry[2] has given a short account of *Cucurbita ovifera* and *C. pepo*, but it is quite inaccurate in some important particulars. G. O. Müller[3] has also given a short account.

The species considered in this paper are pollinated mainly by insects belonging to the order Hymenoptera. The assumption of Thomas C. Gentry that they are pollinated by the agency of the wind is erroneous. G. O. Müller[4] is correct when he states that wind pollination is excluded because of the large size and the small number of pollen grains.

SEX IN CUCURBITACEÆ.

They are usually said to be monœcious or diœcious, although G. O. Müller says occasionally polygamous. It has been known for some time that the same species are polygamous and diœcious.

(1) Fertilization of Flowers, English Translation, p. 268.

(2) American Naturalist, Vol. IX, p. 263.

(3) Die Naturelichen Pflanzenfamilien Engler and Prantl IV, Theil 5 Abth. Bogen 3, p. 8.

(4) L. c., p. 264.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Crozier[5] says in regard to the watermelon: "In making some crosses to-day on the Volga watermelon, a variety from Southern Russia, I discovered that the so-called pistillate flowers possessed stamens." As I had not given the subject much attention, I was surprised to find that some of the flowers of *Citrullus vulgaris* were perfect. The different varieties were noted, and the observations show that Cuban Queen is strictly monœcious; frequently very small rudimentary stamens occur, but they are always sterile. This is also true of Colorado Preserving, which is strictly monœcious. Mountain Sweet and Peerless are monœcious, with rudimentary stamens. In the citron the flowers are monœcious. In New White Gem all of the pistillate flowers had stamens The number of stamens varied from two to three.

Cucumis sativus (Improved Long Green, Early Russian and Early Green Cluster), monœcious.

Bailey[6] has called attention to the fact that some varieties of *Cucumis melo* have perfect flowers. Munson[7] also mentions the fact. "The female blossoms on the variety under consideration, 'Emerald Gem,' were found to bear partially developed stamens." At Ames the large Yellow Cantelope, Improved Green Nutmeg, and Montreal Improved had perfect flowers.

All of the forms of *Cucurbita pepo* (New Golden Bush, Italian Striped, Sweet Sugar, Long Warted, Nest Egg, Gourd, Common Pumpkin and Perfect Gem) are strictly monœcious. *Cucurbita maxima* (Hubbard, American Turban, Mammoth Chili, New Mediterranean, New Prolific Marrow), flowers monœcious.

Lagenaria vulgaris (Dipper Gourd), monœcious.

POLLINATION.

Cucurbita maxima Duch. The flowers are large yellow, and in some forms like the Hubbard have a very pleasant odor. The corolla is five cleft and adherent to the bell-shaped tube of the calyx. The flowers are therefore of easy access to insects. The staminate flowers differ in some important respects from the pistillate. In the former the nectar is contained in the lower part of the staminal tube, and an insect in searching for the same goes over the stamens down along the grooves of the united filaments. The insect thrusts its tongue into the slit at the lower end. Before the flowers have been probed for nectar

(5) Bot. Gazette, Vol. XIII, p. 244.
(6) Third Annual Rep. Cornell University Exp. Station, p. 185.
(7) Annual Rep. Maine State College Agr'l Exp. Station, II, 1892, p. 43.

furrows only can be seen, but when probed several times the filaments separate. The thorax and back of the insect are covered with pollen, as it falls out very easily. An insect frequently probes the other slits of the androecium. When an insect goes to a pistillate flower it passes over the stigmas and down to the nectar which is here found in an open cup. The amount of nectar contained in flowers is large. In some pistillate flowers, which were covered with bags, it was found outside of the nectary. In one or two cases a half teaspoonful of sweet nectar might easily have been obtained. The pollen grains are very large and spiny. The flowers usually last only a day and open early in the morning. In this latitude, however, late in the season, after cold weather begins, they last more than one day. They usually begin to wilt and close before 12:00 M., but the day and the time of the year makes some difference. It is much later in the afternoon in September than in August.

Insect Visitors—

Hymenoptera—Apidæ: (1) *Apis mellifica* Linn.; (2) *Bombus pennsylvanica* DeGeer; Formicidæ: (3) *Formica rufa?* Linn.

Coleoptera—Chrysomelidæ: (1) *Diabrotica punctata* Oliv., *D. vittata* Fab., (3) *D. longicornis* Say.

Of these visitors the honey bee and the bumble bee are the chief pollinators. The striped cucumber and other beetles may also effect pollination as they are often found covered with pollen. The red ants feed on the nectar contained in the flower.

In addition the following insects were observed from the first of August to the first of October, 1894:

Hymenoptera—Apidæ: (1) *Apis mellifica,* Linn., frequent especially during the latter part of the season, when three or four were present in every flower, often the only visitors except the beetles, (2) *Bombus pennsylvanica* DeGeer, ☿; (3) *Xenoglossa pruinosa* Say, ♂; (4) *Melissodes bimaculata* St. Farg., ♀ ♂, almost invariably present in the earlier part of the season, (5) *Melissodes* sp. ♀ ♂., (6) *Calliopsis andreniformis* Sm. ♀; Andrenidæ: (7) *Andrena* sp., ♀; (8) *Agpostemon* sp.; (9) *Angochlora pura* Say, ♀; (10) *Halictus albipennis* Rob., ♀, (11) *H. tegularis* Rob., ♀, (12) *H. fasciatus* Nyl., ♂; (13) *Halictus Zephyrus* sm.; (14) *Xenoglossa* sp., ☿ ♂.

Cucurbita pepo, Linn.

The different forms of this species have the general arrangement and structure as are found in *C. maxima.* The odor of the large yellow flowers is not so pleasant as in that species, but


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rather disagreeable. Nectar is abundant, and the insect reaches it in essentially the same way. The flowers open early in the morning, and when mature the pollen falls out, frequently filling the bottom of the flower. The grains are very large, round and spiny. When placed in water the spines in several places are thrown off, and in a short time the contents pass into the water. *Insect Visitors:*—

Hymenoptera—Apidæ: (1) *Apis mellifica* Linn.; (2) *Bombus. pennsylvanica* DeGeer; Formicedæ. (3) *Formica rufa* ? Linn.

Coleoptera—Chrysomelidæ: (1) *Diabrotica 12-punctata* Oliv; (2) *D. vittata* Fab.

The Coleoptera in this species bear the same relation to the flowers as in the squash.

Additional visitors taken on pumpkin in 1894:—Hymenoptera —Apidæ: Melissodes *sp ? aurigenia* Cr., ♂. *Xenoglossa pruinosa* Say ♂. Patton also records the latter species. He remarks*, "The loose scopa seems particularly adapted to retain the large spinyg lobes which form the pollen of the pumpkin. In the blossoms of these plants the bees delight to revel."

The following were noted on the summer squash;

Hymenoptera—Apidæ: (1) *Bombus fervidus* Fab. ♀; (2) *X. pruinosa*, Say, ♀ ♂; (3) *Melissodes* sp.; Andrenidæ: (4) *Halictus coriaceous* Sm., ♀; (5) *H. tegularis* Rob., ♀; (6) *H. zephyrus* Sm.. ♀; (7) *Halictus* sp.; (8) *Augochlora similis*, ♂; (9) *Andrena* sp.

Citrullus vulgaris Schrad.

The pale yellow corollas are widely spreading. The honey is secreted at the base of the flower. It is easy to observe how the honey bee obtains its nectar. It uses the petals as a resting place, and obtains the nectar through the opening. It first probes one side, and then passes over the stamens to the opposite side of the flower from which the nectar is taken. When its work is finished it flies to another flower. Its visits are confined chiefly to one variety, but occasionally other varieties are visited. It was noticeable that when flies collect pollen, honey bees flit about the flower a moment, and then go to another. The flowers are open all day.

Insect Visitors—

Hymenoptera—Apidæ: *Apis mellifica* Linn., chiefly.

Diptera—Several species of Syrphus flies. These active insects find a resting place on the petals, where they collect

*Bull U. S. Geol. and Geog. Survey, Vol. V, No 3, p. 473.

pollen. In no case did they seem to collect nectar in staminate flowers.

Coleoptera—Chrysomelidæ: (1) *12-punctata* Oliv.; (2) *D. vittata* Fab.

Hemiptera—Capsidæ: *Clocorusa* sp.

Cucumis melo.

Few observations were made. The yellow flowers open early in the morning and remain open the greater part of the day. *Insect Visitors*—

Hymenoptera—Apidæ: *Apis mellifica* Linn.

Coleoptera—Chrysomelidæ: *Diabrotica vittata* Fab.

In addition, the following visitors were observed on July 20th, 27th and 30th, 1894:

Hymenoptera—Apidæ: (1) *Ceratina dupla* Say; (2) *Calliopsis andrenifomis* Sm., ♀, frequent; Andrenidæ: (3) *Augochlora pura* Say, ♀, frequent; (4) *Halictus fasciatus* Nyl., ♀ ♂, abundant.

Diptera—Bombylidæ: (5) *Sistœchus vulgaris* Loew.

Cucumis sativus.

The light yellow flowers are ready to receive the pollen early in the morning, but the corolla remains firm much longer than in *Cucurbita pepo.* Honey bees were observed.

In 1894 observations were continued from July 18th to September 28th, and the following insects observed:

Hymenoptera—Apidæ: (1) *Apis mellifica* Linn,, very abundant; (2) *Melissodes bimaculata* St. Farg.,, ♀, frequent; (3) *Ceratina dupla* Say; (4) *Calliopsis andreniformis* Sm,, ♀ ♂, frequent; Andrenidæ: (5) *Agapostemon* sp., ♀, abundant; (6) *Aradialus* Say; ♂, abundant; (7) *Agapostemon texanus* Cr., ♀, abundant; (8) *Halictus coriaceous* Sm., ♀; (9) *H. fasciatus* Nyl., ♀ ♂, frequent.

Diptera—Dolichopidæ: (10) *Psilopus sipo* Say; Bombylidæ: (11) *Systœchus alopex?* O. S., abundant.

Lepidoptera—Papilionidæ: (12) *Pieris protodice* Bd.—Lec.

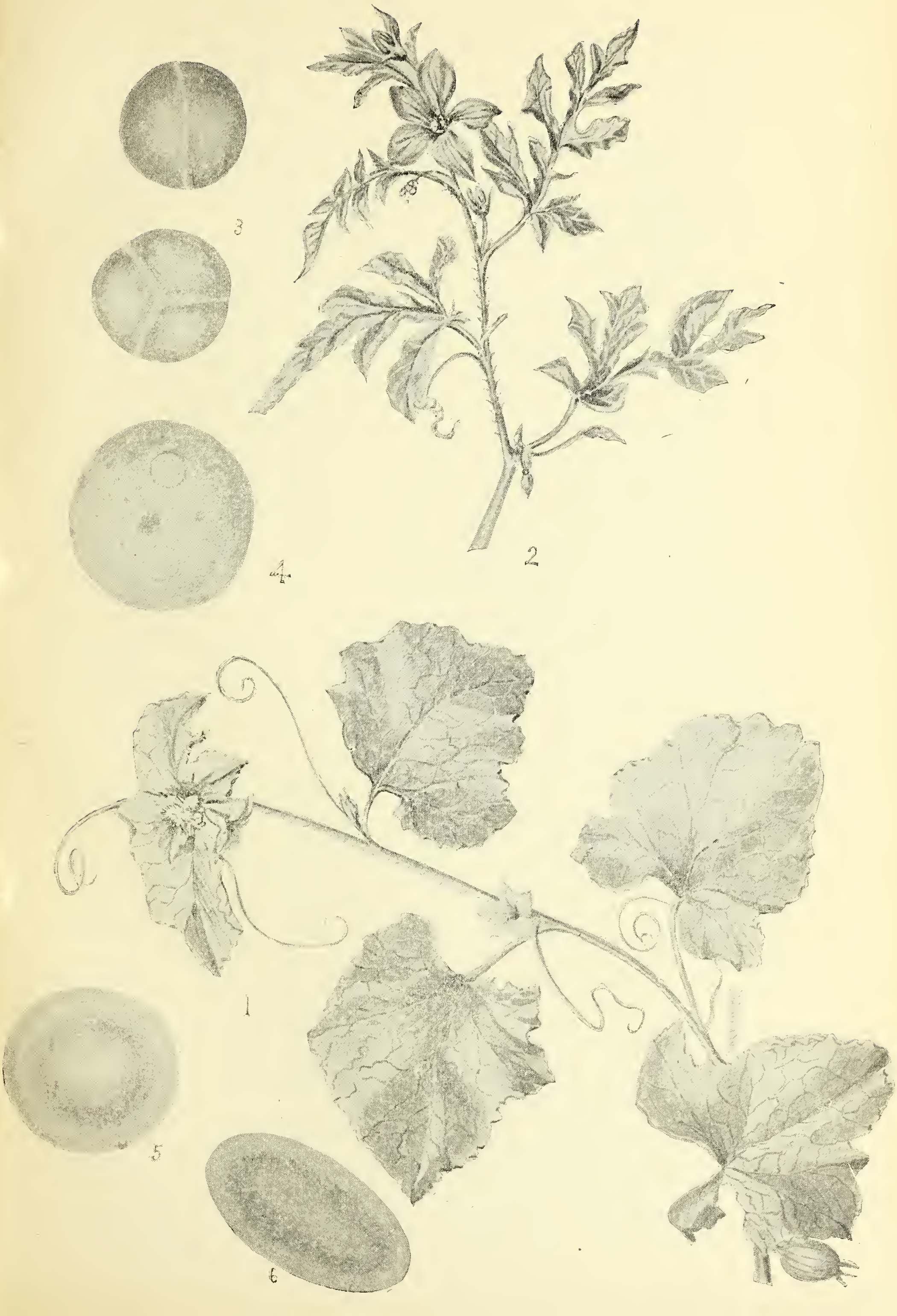
Coleoptera—Chrysomelidæ: (13) *Diabrotica vittata* Fab.

Hemiptera—Capsidæ: (14) *Calicoris rapidus* Say.

Numbers 10 and 14 are accidental pollinators.

Lagenaria vulgaris Ser.

The musk-scented flowers of the dipper gourd have a funnel or bell-shaped calyx with a long tube. The white petals are persistent a much longer time than in *Cucurbita pepo*, and the nectar is not so easily accessible and exposed as in *Citrullus* and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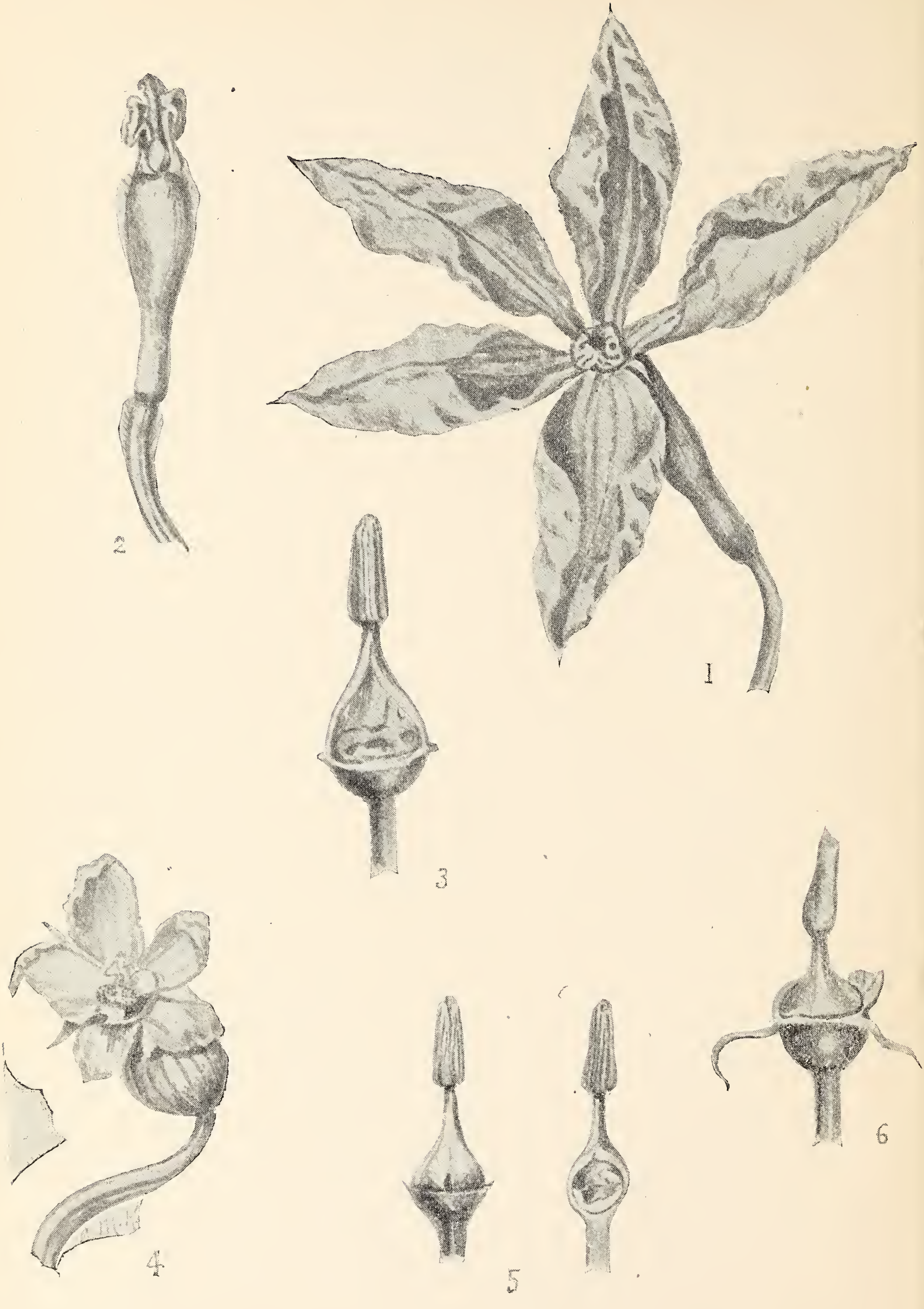
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Cucurbita. The three stamens effectively block the way for the larger insects. The flower is adapted to hummingbirds, which can easily get the nectar with their long tongues. The color and odor would seem to indicate that it is adapted to Sphingidæ, but as the plants were so far away observations were not made at night. In addition to the hummingbird, *Bombus pennsylvanica* was observed collecting pollen. *Diabrotica vittata* was also found covered with pollen.

PLATE XI.

Hubbard Squash, *Cucurbita Maxima.* Fig. 1. Pistillate flowers showing shallow nectary with membrane. Fig. 2. Staminate flowers. Fig. 3 and 4. Pollen grains; 3, before the addition of water; 4, pollen grains after the addition of water. Large nectar on one side, and drops of oil over the surface. On addition of water several of the spines come off in the form of caps. Camera sketches from Zeiss B. B., obt. and compensating ocular, reduced one-half. Figs. 1 and 2 one-half natural size. Drawn by Charlotte M. King, except Figures 3 and 3.

PLATE XII.

Cucurbita pepo. Figs. 1 and 2. Perfect Gem Squash. Fig, 3. Pistillate flower showing stigma, style and saucer like nectary. Fig. 4. Bush Scalloped Squash, pistillate flower with open nectary. Figs. 3 and 5. Long warted staminate flowers. Fig. 3 Cut lengthwise to show slits near base of filaments, used by insects to get the nectar. One-half natural size. All drawn by Charlotte M. King.

PLATE XIII.

Fig. 1. Musk Melon, *Cucumis melo.* Fig. 2. Perfect Gem Water Melon. *Citullus vulgaris.* Figs 3 and 4. Pollen grains of *Lagenaris vulagris*; fig. 3, previous to the addition of water; fig. 4, on the addition of water, nucleus shown at one side. Figs. 5 and 6. Pollen grains of *Echinocystis echinata.* fig. 5, before the addition of water; fig. 6, after the addition of water. Drawn to same scales as pollen grains in plate XI. Figs. 1 and 3 drawn by Charlotte M. King.

PLATE XIV.

Figs. 1 and 2. *Largenaria vulgaris.* Fig. 1. Staminate flower showing corolla. Fig. 2. Pistillate flower with petals removed. Fig. 3. Staminate flower of Perfect Gem Squash

(*C. .pepo*) cut lengthwise to show nectary. Fig. 4. New White Gem Water Welon with perfect flowers. Figs. 5 and 6. Long warted; fig. 5, one flower cut lengthwise to show nectary, the other shows an opening near base. All natural size. Drawn by Charlotte M. King, and pollen grains drawn by L. H. P.

PSYLLIDÆ FOUND AT AMES.

BY C. W. MALLY.

While studying Hackberry Psyllidæ last year, several other interesting species were found. This led to a general study of the family as represented in this locality. It was the original intention to give a general account of the anatomy and life history, with descriptions of new species. However, only the latter part is given at this time.

One important fact has been brought out again during this study, and that is that in order to generalize in regard to any group of insects, we should have a good representation of the species. Many statements that would be true for a small representation may need to be considerably changed in order to include other nearly related forms, which may not only show valuable structural characters, but in their life history present phases of development having an important bearing on other facts at hand.

Another thing of importance is to know, so far as possible, what has been done. To show this in the present instance, the best way will be to give a list of the American species already described. Dr. C. V. Riley, in Proc. Biol. Soc. Wash., v. 2, p. 67, gave a list and the synonòmy up to that time. Since then quite a number of new species have been described and so many new facts brought to light that it seems best to present them altogether, showing clearly the synonomy, the species since recorded, and for the benefit of those interested in the Iowa fauna, indicate the species found here.*

*NOTE.—The following list was prepared in connection with a bibliography of the family. The most important paper in this connection is the one by Dr. C. V. Riley just mentioned, and the synonomy is the same as there recorded. The names of the species recorded since that list was published were taken, as far as possible, from the articles in which they were first mentioned. Inaccuracies were avoided as much as possible. If it proves to be of value to other investigators and induces them to publish their observations on this family, it will have served its purpose.

Beginning with genus *Livia*, we find the described species to be as follows:

FAMILY PSYLLIDÆ.

I. SUB-FAMILY LIVIINÆ.

1. Livia vernalis, Fitch. (Ames, Ia.)
   Diraphia femoralis, Fitch.
   Diraphia calamorum, Fitch.
2. Livia maculipennis, Fitch. (Ames, Ia.)
   Diraphia maculipennis, Fitch.

II. SUB-FAMILY APHALARINÆ.

3. Aphalara ilicis, Ashm.
   Psylla ilicis, Ashm.
4. Aphalara calthea, Linn.[1] (Ames, Ia.)

III. SUB-FAMILY PSYLLINÆ.

5. Calophya rhois, Glover.[2]
6. Calophya vitripennis, Riley.
7. Calophya nigripennis, Riley.
8. Calophya flavida, Riley.
9. Psylla arctica, Walker.
   Aphalara arctica, Walker.
10. Psylla quadrilineata, Fitch.* (Ames, Ia.)
11. Psylla carpini, Fitch. (Ames, Ia.)
12. Psylla annulata, Fitch. (Ames, Ia.)
13. Psylla pyricola, Forster.[3]
    Psylla pyri, Harris, Fitch, Glover, etc.
    Psylla pyrisuga, Bernard.
14. Psylla buxi.
15. Pachypsylla venusta, O. S.
    Psylla venusta, O. S.
    Pachypsylla celtidis-grandis, Riley.

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*The specimens in collections marked *Psylla quadrilineata*, Fitch, agree perfectly with the specimens of *Aphalara polygoni* found here. So it must be the same as the European species mentioned, or else we have not seen a specimen of the real *Psylla quadrilineata*, Fitch.

[1]Mentioned in bulletin 102 of Mich. Ag. Exp Sta. as being injurious to celery.

[2]In a foot note of Dr. Riley's article, Proc. Biol. Soc. Wash., v. 2, p. 67, he substitutes the name of *nigripennis* for *rhois*. In his next paper, "Psyllidæ of the United States," Proc. A. A. A. S., v. 32, p. 319, *Calophya nigripennis* is included as a new species. I conclude that the old name, *Calophya rhois* Glover, is retained and another species, *Calophya nigripennis* Riley, added as shown above.

[3]*Psylla pyricola* Forster has been carefully studied by Mr. M. V. Slingerland, of Ithaca, N. Y., and the results given in bulletin 44 of the Cornell Exp. Sta. He found it to be dimorphic, and designated the summer form as *Psylla pyricola pyricola*, and the winter form as *Psylla pyricola simulans*.

16. Pachypsylla celtidis-mamma, Riley. (Ames, Ia.)
    Psylla celtidis-mamma, Riley.
17. Pachypsylla (Blastophysa). celtidis-gemma, Riley, (Ames, Ia.).
18. Pachypsylla celtidis-cucurbita, Riley.
19. Pachypsylla celtidis-pubescens, Riley.
20. Pachypsylla celtidis-asteriscus, Riley. (Ames, Ia.).
21. Pachypsylla celtidis-umbilicus, Riley.
22. Pachypsylla celtidis-vesiculum, Riley. (Ames, Ia.).
23. Pachypsylla celtidis-inteneris, Mally. (Ames, Ia.).[4]

IV. SUB-FAMILY TRIOZINÆ.

24. Trioza tripunctata, Fitch.
    Psylla tripunctata, Fitch[5].
    Pyslla rubi, Walsh and Riley.
25. Trioza diospyri, Ashm.
    Psylla diospyri, Ashm.
26. Trioza magnoliæ, Ashm.
    Psylla magnoliœ, Ashm.
27. Trioza sanguinosa, Riley.
28. Trioza sonchi, Riley.
29. Trioza pyrifoliæ, Forbes[6].
30. Ceropsylla sideroxyli, Riley.
31. Rhinopsylla schwarzeii, Riley.

Thus we see that we have now thirty-one species on record.

While studying the group last season, a number of species were found that heretofore had not been mentioned or described. One found very numerous on Polyganum agrees very well with the European species *Aphalara polygoni.* Another species found on Ash at Jamaica, Long Island, is apparently identical with the European species *Psylla unicolor*, also found on Ash[7].

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[4]This species was first mentioned by the author in Proc. Ia. Acad. Sci., (1893), vol. 1, part IV, p. 138.

[5]In an abstract of Dr. C. V. Riley's paper on "The Psyllidæ of the United States," *Phylloplecta tripunctata* is mentioned as occurring on the blackberry. This apparently is the same as *Trioza tripunctata* as mentioned in the list, except that a new genus has been designated. Not having seen the complete paper, however, I cannot say whether it is the same species or a new one which also infests the blackberry.

[6]This species was first mentioned and described by Prof. S. A. Forbes in the 14th Ill. Rept., (1884), p. 98.

[7]The specimens were sent to me by Mr. F. A. Sirrine, Entomologist in the N. Y. State Exp. Sta.

Other new species found are as follows:

PSYLLA NEGUNDINIS, sp. nov.

Found on box elder.

Description of the adult.—General color light green, sometimes tinged with yellow. Head, including the eyes, much wider than length of vertex; median line distinct; posterior margin concave, the part on either side of median line almost straight, meeting at an obtuse angle; lobes of vertex distinct, roundish, tips quite widely separated and between them is placed the anterior, bright yellow ocellus. Discoidal impressions large, deep, varying in shape, not distinctly limited. Near posterior end of median line there is usually a sharp constriction joining the impressions. Posterior ocelli are bright yellow, very prominent, located on roundish tubercles between discoidal impressions and inner angle of the eyes, and present a rather striking bead like appearance. Eyes very prominent, large, almost semiglobose, brownish, moderately granulated, inner angle distinct, roundish. Portion of head bearing the eyes very prominent, marked off from the rest of the head by a distinct constriction, thus bringing the eyes into greater prominence. Frontal cones large, color bluish-green (sometimes light green), visible from above, strongly diverging, equal in length to the vertex, furnished with numerous bristle-like hairs, slight constriction at middle, tips rounded. Antennæ light yellow, located centrally on either side between the anterior margin of the vertex, the eyes and the base of the frontal cones. First joint roundish, placed in a cup-like cavity with a sharply defined edge. Second joint about half as large as the first. The succeeding joints filiform, the last one slightly enlarged, black, terminal bristles nearly equal. Third joint the longest, the five succeeding ones nearly equal, the ninth and tenth shorter, being very little longer than the second. Tip of ninth slightly enlarged and sometimes darkened.

Pronotum small, of equal width througout, two distinct lateral impressions on either side with a small ridge-like portion between them. In a fresh specimen we can usually distinguish four whitish spots as follows: Two comparatively large, roundish, dorsal ones separated by a faint median line of yellow, and a smaller one on either side about half way down to the lateral impressions.

Dorsulum well developed, usually tinged with yellow and has whitish markings.

Mesonotum of medium size, has two broad, yellow longitudinal bands on either side of median white line, which is broken in the middle, the ends somewhat triangular in shape and the points turned toward each other. Between the two bands on each side is a fine, curved, whitish line ending at the slight posterior angles of the dorsulum, and posteriorly at the whitish scutellum. Between the base of the anterior wings and the yellow bands, the mesonotum is more light colored.

The wings are transparent, characteristic for this genus, but present no special specific characters.

Ventrally the thorax is light green, sometimes tinged with bluish, sometimes tinged with yellowish, The legs are light colored, the tibiæ and tarsi usually bluish green, distal end of posterior tibia and first tarsal joint with prominent black spines. Terminal claws and adhesive pads of second joint well developed.

Mouthparts inconspicuous, tip of terminal segments black.

Genital organs about same length as abdomen of female soon after transforming to adult, but as the developing ovaries gradually distend the abdomen, the ovipositor appears relatively shorter. The dorsal plate is longer than the ventral, although when closed their tips come near together. Anal opening large and prominent. From there on the dorsal plate descends rapidly, is almost straight, except the tip which is short, wedge-shaped, the angles rounded and slightly turned upward. Its margins are curved upward at tip, and at about one-third their length curve downward and meet the ventral plate which is large at base, of equal width to about its middle where it turns distinctly upward and tapers rapidly and evenly to a point. Some show a distinct concavity just beyond the turn. The basal portion of the upper margin distinctly curved upward.

The inner division of the egg sheath can be seen when the plates are slightly spread. The tip is chitinous, brownish, strongly curved upward and narrowing rapidly. The outer more transparent division is visible, flat, the apical angles broadly rounded.

The ventral plate is about two-thirds as long as dorsal one. Their tips coming so closely together is due to the fact that the base of the upper plate is farther forward than the base of the lower. The ovipositor is furnished with numerous, long, conspicuous hairs.

In the male the lower plate is smaller than usual, little longer than the preceding ventral segment, tapers slightly to base of claspers, roundish ventrally, posteriorly deeply concave for reception of base of claspers, dorsal margins short, nearly straight. Claspers long, inclined forward when at rest, furnished with numerous short bristly hairs, curved laterally so as to include an egg-shaped space with the point downward, tips sharply pointed, brownish black, apparently chitinous, and touching each other. Dorsal plate same height as claspers, wide at base, has no horizontal, backwardly projecting prolongations as in the genus aphalara, tapers gradually to the tip, has a distinct curve in the middle, causing the tip to bend toward the claspers. Viewed posteriorly it is oval in outline, the curves corresponding to the curves in the claspers, whose closed tips fit neatly into the dorsal plate.

Penis usually distinctly visible between the claspers, its height to the geniculation a little more than one-half the height of the claspers.

Pupa.—Anterior margin of head broadly convex and bearing six or more bristles. Compound eyes dark, prominent. Paired ocelli distinct; anterior one hidden from above. Antennæ long, reach to middle of wing-pads, and have the usual ten segments as follows: Two enlarged basal joints and five succeeding ones distinctly separated, the eighth, ninth and tenth not so distinct, only being indicated by constrictions. The tip is black, terminal bristles distinct, of equal length. The first joint is short, thick and very roundish. The second is shorter, more cylindrical and much smaller in diameter than the first. Joints about three to seven, about equal in length and width, the fifth, however, being slightly shorter than the others; all have one or two visible bristles at their distal end.

Prothorax distinct and as broad as head with the eyes. Femur of first pair of legs projects about half its length beyond prothorax; tibia shorter than femur; first tarsal joint not clearly separated from tibia, only indicated by a slight constriction.

Mesothorax strong and robust, wider than head or prothorax. Wing-pads robust, outer margin convex, furnished with numerous hairs, tip broadly rounded and reaching back to second abdominal segment. Posterior wing-pads smaller, front part overlapped by anterior pads; tip and posterior margin projecting beyond the anterior pads, broadly rounded; anterior margin more nearly straight, being shaped like costal of wing in the adult.

Abdomen widest at segments three and four, narrowing anteriorly to the first. Posteriorly it is broadly rounded. Segments one to five present short, sparse, marginal wax hairs or bristles, while the three terminal joints have numerous long wax hairs which become more numerous toward tip of abdomen. Anus reniform, with the notch turned backward.

The ventral surface usually a little lighter colored than the dorsal. Clypeus is prominent and of a more yellowish color. Mouth-parts distinct, first joint received by sternal lobes; the second short, quadrangular; the third or distal one longer, conical, tip black, and sometimes turned forward. Hind legs as yet not specially developed. All the coxæ are quite well defined, trochanters usually distinct.

Brief History.—This species was first noticed at Ames by Mr. F. A. Sirrine during the spring of 1893. The larvæ were found feeding in the opening buds and at the base of quite young leaves. Since then the life history has been traced in detail and some of the more important facts will be given.

The eggs are deposited in autumn just as soon as the leaves begin to fall. They are inserted closely around the edge of the buds, but are attached to the twig, so in case the bud is broken off the eggs still remain in place. They hatch in early spring, enter the opening buds and feed by sucking the juices from the young tissue. When the leaves are large and have a long petiole, the young larva may be found anywhere on the under side of the leaf, on the petiole, or more preferably at the axil of the leaf, with head downward, *i. e.* toward the stem, and crowded as far down as possible for protection. In this position they may be observed for hours, sitting very quietly, only moving the abdomen laterally or vertically occasionally so as to remove the white mass of excreta and the cottony wax secretion. They pass through five stages[8] and emerge as adults about the middle of May or the first of June. The adults live on the trees during the summer months, feeding on the plant juices, pairing, and maturing the eggs till autumn. When the leaves begin to fall and expose the buds the female begins

[8]European authors record only four larval stages. With specimens of this species, and also of *Aphatara polygoni*, five stages were recorded. The stage that was most difficult to observe was the one from the hatching of the larva up to the first moult. After that the stages were more easily watched.

depositing the little white glistening eggs around the edges of the buds, and their life cycle is complete.

The egg when first deposited, during October, is of a glistening white color, largest at posterior end, *i. e.* the end having the stem or handle, which is roundish, and blends by a gentle curve with the side opposite the stem. This side is strongly convex in the posterior half, but the curve becomes more gradual as we approach the apex or cephalic end, which lies just across an ideal line extending longitudinally through the center of the egg. At the origin of the stem the egg is slightly bulged. Following the stem the egg is slightly concave, bending toward the opposite convex side of the egg. Then toward the anterior end it again becomes convex and blends with the opposite side to form the tip, which is acutely rounded and has a slight transparent appendage which, in some cases, is indistinct.

After the egg has been deposited for some time it turns yellow, probably due to the gradual development of the larva. As a whole it is not as transparent as with certain other species, but still the segmentation can be seen to some extent. Although they are deposited in the fall they do not hatch till in the spring when the buds begin to open.

The young larvæ present the usual appearance, but are marked with black while the older ones are light green.

PSYLLA AMORPHÆ. sp. nov.

Found on Amorpha fruticosa.

Description.—General color light green, marked with yellowish bands, especially on the mesothorax. On the dorsulum we find two bands usually united in front but diverging posteriorly; on the mesonotum are four long yellow bands separated by smaller bluish-green ones. Head, including the eyes, much broader than long; posterior margin concave; dorsal cavities large, round, comparatively deep, well defined. Sometimes slightly tinged with yellowish, and surrounding surface of a lighter green color. Lobes of vertex distinct, rounded, slightly diverging. Frontal cones very short, broadly rounded, distant, and furnished with a large bristle and numerous small ones. Antennæ reach to base of first pair of wings; first joint larger than second, third the longest of all, succeeding ones of equal length; the tenth somewhat enlarged; first three light colored, the tips of the rest darker, being most intense on the fourth, sixth and eighth; ninth and tenth black, and end with two equal terminal bristles. Eyes prominent, brownish, the margins somewhat lighter colored; ocelli reddish, placed as usual. Mouth-parts not clearly visible, the last joint black. Legs light green or yellowish, first and second tarsi brown or black, the third tarsi lighter; anterior tibia with a brown tinge, which is less distinct on the second, and usually hardly visible on the third. Posterior tibia and first tarsal joint have distinct black spines on the distal end; on first and second pair these spines are of same color as the legs, and therefore quite invisible. Terminal claws and adhesive disk well developed. Pronotum short, with three distinct lateral impressions, and a fourth sometimes indicated. Mesothorax moderately developed, marked as stated above. Wings transparent, project to one-third their length beyond tip of abdomen, veins whitish, petiolus cubitii half as long as discoidal portion of subcosta; radius straight, except a slight curve near distal end, almost parallel with stigmal portion of the costa. First cubitus straight, or but slightly curved toward clavus; second cubitus distinctly curved toward radius, and about three times as long as preceding. First furcal curved toward second, about one-third as long, and meets anal margin at only a slight angle. Second furcal strongly curved toward the third, and meets anal margin quite obliquely. Third furcal shorter than the second, almost straight, but in some cases showing a slight double curve. Fourth furcal slightly curved toward radius. First marginal cell wider than the second, but not so long as measured by first and third furcals. Cubital cell long and narrow; discoidal cell still longer and sides nearly parallel, being widest at furcation of second cubitus; radial cell narrow. Pterostigma distinct. Claval suture joins anal margin at union of first furcal. Anal cell distinct. Metasternal processes distinct, diverging, blue-green. First visible ventral abdominal segment longer and more strongly developed than usual, blue-green in the center; remaining abdominal segments smaller, light green. Ovipositor of female of medium size, furnished with numerous long hairs; dorsal and ventral plates pointed as usual; points of inner division of egg-sheath project beyond tips of the outer plates, are chitinous, slightly enlarged, arrow shaped, sharp at tips. Outer division of egg-sheath prominent, the tips standing out horizontally as lateral projections.

In the male the ventral plate is rounded, deeply lobed posteriorly. Dorsal plate longer than the claspers whose rounded bases are received in the lobed portion of the ventral plate, then constricted above this and again enlarged, roundish, having a distinct inward curve posteriorly and a similar one dorsally, thus making the upper posterior corners quite prominent and roundish. The upper anterior corners extend forward as roundish lobes which reach over half way to the dorsal plate and have numerous strong, slightly curved, spine-like projections. Their dorsal edges are sharp, turned inward, black, and apparently chitinous.

This species was first noticed June 17, 1894, on *Amorpha fruticosas.* At this time it was in the adult stage and depositing eggs very abundantly on the under side of the leaves, especially near the ends of the branches where the leaflets were as yet quite closely clustered together. Although many eggs were deposited, for some reason only a few larvæ could be found. It was thought probable that some predaceous insect devoured the eggs; but careful observations failed to disclose any such insects. Egg parasites were also suspected, but could obtain no definite proof. This fact of sudden disappearance was also very noticeable in the *Hackberry Psyllidæ.* In the season of 1892 the latter were very abundant and numerous parasites were found. In 1893 they were very abundant, and the parasites somewhat more numerous. In 1894 the Psyllidæ were very scarce, many eggs having been deposited early in the spring, but very few galls formed. In this case the chalcids (probably *Encyrtus Pachypsyllæ*) were prominent factors. The history of the case as just stated is more in accord with the general record of parasitism. One fact that makes it easier to trace the parasites in galls is that they are enclosed by the gall, thus preventing their dropping from the leaves, as is probably the case with the non gall-forming species.

TRIOZA SALICIS, sp. nov.

Found on Willow, (*Salix sp.*)

Description.—General color orange yellow, somewhat lighter underneath, the abdomen in some cases is of a light green color ventrally.

Ground color of head yellow, somewhat lighter than the rest. Vertex, including the lobes and posterior part of head, which is only narrowly visible from above, black, shining. Eyes prominent, black, shining, finely granulated. Ocelli close to inner angle of eye, of deep orange color, and imbedded in the somewhat lighter colored part of head. Just outside the ocelli there is a fine constriction, beyond which the yellow part of the head simply forms a light band between the black posterior part of the head and the eyes. In some cases this constriction is more distinct, giving the impression that the eye is placed dorsally on a lateral tubercle. Antennæ filiform, reaching about to base of second pair of wings; four basal segments light colored, except top of fourth which, with the remaining segments, is black. In some cases the fifth and sixth segments are also light colored, except the tip. The two basal joints enlarged as usual, third the longest of all, fourth, fifth, sixth and seventh joints about equal, eighth somewhat longer, ninth and tenth short, equal in length, and, including the tip of the eighth, somewhat enlarged. Terminal bristles small, nearly equal. Frontal cones prominent, moderately diverging, acutely pointed, furnished with hairs, black, tips sometimes whitish. Clypeus dark colored.

Mouth-parts not prominent, terminal segment and tip of second black. Thorax prominent, convex. Pronotum short, comparatively small, orange yellow; dorsulum same color as prothorax, but in some cases the posterior part tinged with black; widens posteriorly till it almost equals width of head and eyes; mesonotum orange yellow with central portion black. Sides of the thorax sometimes with black markings, the most prominent of which is a curved one opposite the metasternal spines, and another one in front of this. Dorsally the posterior part of the metathorax* is marked with four longitudinal black lines.

Legs light colored, tibiæ and torsi of first and second somewhat darker, smoky; posterior tibiæ and tarsi nearly the same color as the femora, slightly darkened in some cases. Posterior tibiæ with strong black spines. The tibial spines in the others light colored.

Wings comparatively long, extending over half their length beyond the tip of the abdomen. Pterostigma wanting, *i. e.*, no enlargement at union of subcosta and costa. Discoidal portion of subcosta more than one-third as long as basal portion. Basal part of radius straight, the distal part curved slightly toward

*NOTE.—This part of the metathorax probably corresponds to the dorsal part of the first abdominal segment, which, according to Witlaczil, has coalesced with the metathorax.

costa, which it joins about two-thirds the distance from pterostigma to tip of wing. First cubitus only slightly curved toward costal margin, the second strongly curved. First furcal short, almost straight, and meets the anal margin at a slight angle about one-fourth the distance from tip of clavus to tip of wing. Second furcal a little over three times as long as the first, strongly curved towards costal margin, and meets anal margin very obliquely. Third and fourth furcals straight, third almost parallel to the first, fourth about one-half longer than the third, and meets the marginal vein just at tip or a very short distance in front of it. Usually, however, the tip is acutely rounded and may be said to be between third and fourth furcals. The costal margin is in the form of a gentle curve from base to tip, only the curve becoming slightly stronger in the distal half. Anal margin almost straight from base of anal cell to first furcal. Tip of clavus distinct. On anal margin near center of first marginal, cubital, and second marginal cells is a darker, somewhat triangular spot as in *Trioza tripunctota*, only not so distinct. Greatest width of wing at union of first furcal with the anal margin. Wings, as a whole, very transparent, all the nerves very distinct, light colored, slightly tinged with yellow. Posterior wings very delicate, costal margin shaped as usual; deeply curved at tip of clavus, broadly rounded at end of second furcal, strongly ascending from them to tip, which is comparatively rounded and between the two longitudinal veins; nerves all quite indistinct. The hind wings are more whitish than the first pair. (This appearance is probably due to a fine whitish pubescens.)

Abdomen a little shorter than the thorax, dorsal portion of the segments dark, sides and ventral portion usually light green. Ovipositor very short, hardly as long as preceding ventral segment, roundish, furnished with numerous hairs. Dorsal plate the largest, its tip black.

In the male the genital organs small and difficult to examine. The claspers exceed the ventral plate in length, curve toward each other, are slender, acute at tip, and furnished with numerous hairs.

Some important variations in color, not previously given, must be noticed, especially the markings of the head. We can arrange a gradual series of specimens so that the head will be darker and darker until almost jet black. The same is true of the antennæ, all being black except the basal joints and part of the fourth, but in some cases the fifth and sixth are also light colored except the distal part. The dark colors of the thorax and legs are also liable to vary, On the abdomen, in some cases, the black markings could be traced slightly below the pleurum, being most noticeable in the males, which are usually a little smaller and darker than the females.

The intensity of these markings may be due largely to the length of time from their issuing as adult and their being killed. The older the more intense are their color markings. Still this cannot be taken as an invariable rule. Some specimens seem to have their colors more intense than others, although they are of the same age. This same fact of color variation is also noticed in the larvæ. Some are more intense than others, and the marks somewhat differently arranged. The life history has not been traced carefully enough, as yet, to say whether the darkest larvæ produce the darkest adults, or whether this larval variation has any effect on the markings of the adult.

The first specimens were taken by Mr. E. D. Ball in August, 1894. The adults and the larvæ could be collected from that time on till the leaves fell in November. They are quite inconspicuous, because their coloration blends very nicely with that of the leaves and twigs, thus bringing out very nicely the subject of protective resemblance. This is very noticeable throughout the family.

Larva.—The young larvæ are thin, flat, scale-like, very closely applied to the surface of the leaf; wing-pads blend with general form of body, making a quite regular oval outline. Head broad; front margin gently rounded, distinctly lobed, terminates in gently rounded angles in front of the eyes, and furnished with a conspicuous fringe of wax-hairs. Antennæ comparatively small, in first or second stages reaching only about half way to anterior margin. Eyes of usual shape, deep orange yellow. The wing-pads usually extend forward to the eyes, but sometimes reach the slightly indicated lateral angles of anterior margin of head. They gradually diverge posteriorly, and the first pair extends slightly beyond the posterior coxæ, but do not reach the posterior margin of the metathorax. The second pair are much smaller, extend over half their width back of first pair, and reach to the second or third abdominal segment. Abdomen broadly oval in outline, segments distinctly indicated. Anal opening larger than usual, conspicuous. The pseudovitellus is not as regular as in other species, especially *Aphalora polygoni*, often being broken up into a number of parts, and these parts on each side more unequal than usual. Legs well developed, quite distinct from above, but ordinarily only the tarsi projecting beyond the wing-pads.

There is a distinct longitudinal dorsal black band extending the full length of the body. Its width is about equal to half the width of the head between the eyes. On the abdomen it expands somewhat, becoming rather oval in outline, contracting again a short distance before the tip of the abdomen, which is slightly tipped with black. In the middle of this band there is a distinct, clear, longitudinal line extending from the anterior lobe of the head to the first or second abdominal segment. In the full grown larva this line extends still farther back, reaching the fourth segment.

As the larvæ grow older, all the parts become more distinct. The antennæ project beyond the head, the longitudinal black band becomes somewhat irregular, but more intense in places; the head, thorax and wing-pads dark-colored, varying from smoky to brownish.

In the full grown larva the head and prothorax are closely united, about equal in length, half as long as broad, and together are subquadrate in outline. The mouth-parts are distinct, strongly held by the prosternal lobes, tip of last segment black. The antennæ project about half their length beyond anterior margin, but do not show the joints very plainly, as those in the club are simply indicated by constrictions as in the other species. Mesothorax and metathorax distinct, dark color quite intense and shows several light colored portions. (See plate xv, figure 8.)

The abdomen presents five large, usually roundish, light-colored spots on either side, the anterior the smallest and not so distinct. Between each one of these spots is a dark band extending inward and slightly forward toward median dorsal band. In some cases these little bands are rectangular, in others triangular with the points turned inward. When the bands between the marginal abdominal spots are rectangular, their inner ends are usually blended, thus forming a crescent-shaped band on either side of the median longitudinal band, leaving a light-colored space between them.

The color markings are somewhat variable, depending on the age of the larva and the length of time after moulting.

Closer study of their life-history will undoubtedly furnish accurate characters and markings for separating the different stages of development.

APHALARA EXILIS Web. and Mohr., var. RUMICIS, var. nov.

Description.—General color brown. Head uniformly light brown, the posterior margin obtusely angled. Eyes distinct, very dark brown or almost black; the part of the head on which they are placed is lighter colored and separated by a distinct suture. Front dark brown or blackish, clypeus somewhat lighter. The antennæ reach to the base of the upper wings or a little beyond; the two basal segments light brown, the six succeeding joints somewhat lighter colored or even light yellow, and the two terminal joints dark brown or black, forming a small compact club, the last being sometimes almost truncate; terminal bristles of equal length. The third joint is the longest, but comparatively not as long as in Aphalara polygoni. Pronotum of almost equal width throughout, being slightly wider and convex in the middle, slightly inclined, and has two distinct cavities on either side. Anterior half dark brown or almost black, being darker than the adjoining parts of the head or mesothorax; the posterior half lighter. In some cases there are only light spots on the posterior half and from some points of view look like a white line between it and the mesothorax. Dorsulum uniformly light brown, surrounding sutures black. Mesonotum prominent, light brown, in some cases white. In others it has two large dark bands on either side of median dark line, all separated by longitudinal bands of lighter color which sometimes extend forward to the dorsulum. Sometimes the whitish bands predominate, giving the mesonotum a more whitish appearance, and extending forward in the dorsulum almost obscure the brown color. In some the two central whitish bands of the mesonotum extend back into the scutellum and give it a whitish appearance, only the fine brown central part being maintained, the two lateral ones only slightly indicated. The scutellum is usually brown, sometimes light brown or grayish.

The central portion of the metathorax is usually light brown; the lateral portions dark brown or black, bordered with a whitish line. Prosternum dark colored, mesosternum dark with a light border; metasternum brown; metasternal tubercles brown except the tips and a light spot near the base. The legs are light colored; sometimes the second tarsal joint and the claws brownish; the femora slightly tinged with brownish, the posterior ones sometimes having a faint brownish band near the base.

The wings have the typical venation for Aphalara. The brownish markings are as follows: A black spot at the anal angle of the clavus; a slight one at the origin of the cubitus; three darker ones almost in a straight line across the wing, the anterior one near the middle of the descoidal portion of subcosta, the middle one a little beyond the center of the petiolus cubitii, and the third near the top of the clavus; a black spot on the pterostigma and the union of the radius and each of the four furcals with the marginal vein; a clouded spot surrounding the first furcal; an oblique somewhat irregular band extending from the end of the first marginal cell to near the end of the radial cell, being most dense in these two cells, and quite thin and scattered in the cubital and descoidal cells; at the end of third and fourth furcals is a clouded portion which is more or less dense across the second marginal cell. The oblique apical band varies as to continuity. In some cases it is broken up into three or four separate parts and more scattered. The abdomen is uniformly dark colored dorsally; the ovipositor light brown and the tip furnished with numerous radiating hairs. The lateral margins are light colored, being the same color as the pleurum in the distended abdomen. The anus usually shows a fine cottony substance which may or may not collect in the form of a little mass as in *Aphalara polygoni*, depending on when the specimen was taken, how mounted, and its condition before mounting. On the posterior margin of the first visible ventral segment is a distinct white band, widest in the middle where it is arched and nearly reaches the middle of the segment. The two succeeding ones are more uniformly colored, only being slightly lighter in the middle. The fourth is light colored, only having a dark portion between the light colored margin and the central portion, and extends backward under the ventral plate, thus giving the ovipositor the appearance of being retracted, only the distal half being visible from below. Usually there are fine white lines separating the abdominal segments. These represent the more distinct light colored tissue between the segments which in life are distended, giving the abdomen a plump appearance and showing the three divisions, tergite, pleurite and sternite. In the female, in life, the white parts predominate, the brown parts appearing as distinct transverse bands, the last four of which are arranged in pairs, while the first is separate.

The male differs from the female in that the brown spots are usually somewhat darker and the brownish tinge of the legs is more distinct. The lower genital plate is brownish at base, while the tip and upper margins are whitish. The claspers dark-colored, furnished with numerous hairs, somewhat enlarged toward the tip but narrowing acutely and the points slightly overreaching. They are equal in height to the dorsal plate, which is dark-colored. The horizontal, backwardly projecting portions of the dorsal plate are light-colored, hairy, and not reaching beyond the forceps as in *A. polygoni.*

The pupa is smaller than in *A. polygoni*, and can be easily distinguished by being much more elongated, the wing-pads narrower and their anterior angles more acute. The abdomen is comparatively more elongated and does not give so much the appearance of being drawn cephalad. The color-markings are virtually the same as in *A. polygoni* and are as follows:

On the head, between the eyes, two brown spots separated by the whitish longitudinal band which extends to the fifth abdominal segment. Their inner and posterior borders are nearly straight, but the anterior and lateral ones roundish. Just back of these there are usually two small brown spots indicated. On each division of the thorax there are two squarish brown spots, and just back of each of these two smaller ones indicated. On each of the first four abdominal segments there is a short, transverse brown band on either side of the longitudinal line. Just back of those on the first segment two small ones are indicated. On the fifth the transverse brown band extends the entire breadth.

The last three segments are distinctly indicated, but not especially marked, being uniformly dark colored. The wing-pads are of a light brown color. The legs are light colored, the tarsæ more distinctly tinged with brownish. The antennæ are mainly light colored, a little darker at tip. Ventrally the general color of the pupa is more whitish, thus giving the legs a darker appearance than when compared with the darker dorsal surface. The clypeus is yellowish, the suture between it and the head indicated by a fine dark line. The prosternal lobes which receive the first joint of the rostrum are indicated by two very fine black lines. The second joint of the beak is short, squarish, light colored, margined with black. The terminal joint is cone-shaped, tip and sides black, but central basal portion light colored. The ventral color of the abdomen is whitish, and the posterior margin of each segment indicated by two fine, short, black lines.

This species was first noticed about the latter part of August in the summer of 1894. It lives on the common dock, *Rumex altissimus.* It is most commonly found on the tips of the branches in autumn and causes them and their leaves to curl up into a rather compact ball. In a short time these take on a brown color and some of them soon die, only the stems remaining alive. These gnarled bunches are very characteristic and can be recognized as far as visible. They very much resemble the work of plant lice and very likely have been considered by some as such.

One important fact in its life history is the production of honey dew in connection with the white waxy secretion.

It was first studied as a new species and a description written for it under the name *Aphalara rumicis.* But since then careful comparison with the description of *Aphalara exilis* given by Flor in "Rhynchoten Livlands," Vol. II, p. 532, shows that the two forms are very nearly related, possibly the same species, the variations due probably to locality and host-plant. Yet the fact of such a difference in host-plant, when considered in connection with observations on other species in regard to this point, indicates that there is an essential difference. The difference in color-markings could be easily reconciled because they have been found quite variable in some species. The first tarsal joint in *Aphalara exilis* is stated to be as long as the second, and they together about half as long as their tibia. In the form at hand the first tarsal joint is about half as long as the second, and they together about one-third as long as their tibia. The ovipositor of the female of the present form is very similar to that of *A. polygoni*, but in the male genital organs the claspers and the horizontal backwardly projecting portions of the dorsal plate seem to be quite different, while in *A. exilis* they are given as almost identical, there being only a slight variation in the claspers. The form on *Rumex acetosella* has not been found here as yet, and until a careful comparative study of the life history of the two forms is recorded it is difficult to say just how the form on *Rumex altissimus* should be designated. At present it is thought best to consider it as a variety of *Aphalara exilis.*

EXPLANATION OF PLATES*.

PLATE XV.

Figures 1, 2, 3.—Different stages of the larva of *Aphalara polygoni*, 3 representing the pupa.

Figures 4, 5, 6.—Different stages of the larva of *Aphalara exilis var. rumicis*, 6 representing the pupa; *a*, anterior lobes of head showing the wax-hairs; *b*, second tarsal joint showing claws and adhesive disk; *c*, part of the tip of the abdomen showing the wax-hairs.

Figure 7.—Young larva of *Trioza salicis*.

Figure 8.—Pupa of *Trioza salicis; d*, edge of wing-pad showing wax-hairs; *e*, tip of abdomen showing wax-hairs.

Figure 9.—Central nervous system of larva of *Psylla amorphæ* (third or fourth stage); *c. b.*, central body; *m.*, mushroom-shaped body; *m. l.*, middle lobe; *o. m.*, outer medulary layer; *e. s.*, eye swelling; *c. e.*, compound eye; *at. l.*, antennal lobes; *f. l.*, frontal lobes; *œ.*, œsophagus; *s. g.*, sub-œsophageal ganglion; *s. s.* indicates the location of what Dr. E. Witlaczil designates as the sack containing the setæ; *th. g.*, thoracic ganglion showing four distinct parts, of which 1, 2 and 3 represent the ganglia for the three divisions of the thorax respectively, and 4 the ganglion from which arise the abdominal nerves.

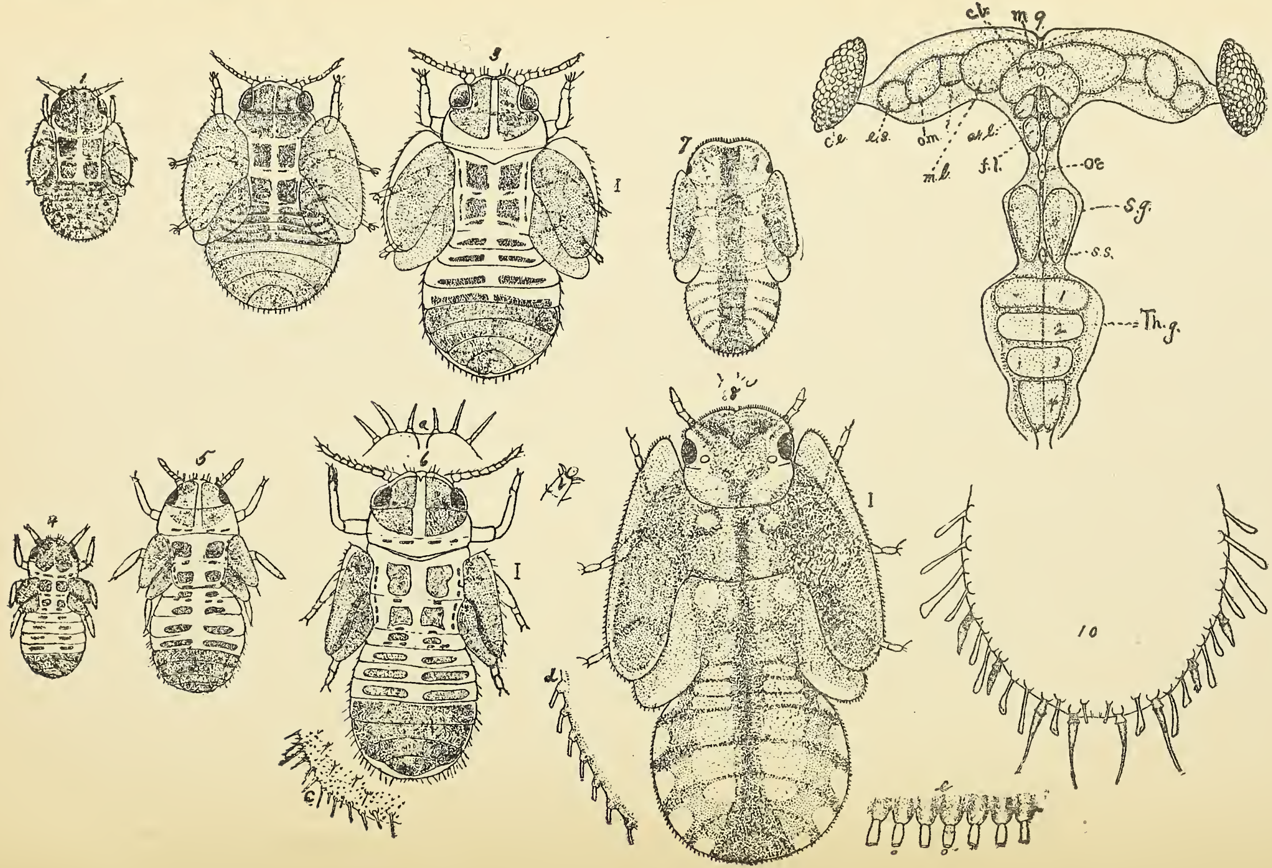
The drawing was made from a dorsal view of the larva named above. The parts named were determined by comparison with figures in Dr. E. Witlaczil's paper on "Die Anatomie der Psylliden," and the brief review of the same paper by Prof. G. Macloskie in Amer. Nat., Vol. XX, p. 283. Some of the parts were quite puzzling, especially the lobe between the middle lobe and the outer medulary layer. It is indicated in Dr. Witlaczil's paper, plate XXI, figs. 39 and 40, but apparently not named. Also the parts designated as antennal lobes and frontal lobes. It seems as though they would be more on the front part of the brain and not visible from above. But as the larva is so flat and all the parts of the head not so distinctly developed as in the adult, it is likely that these lobes are located backward and upward from what they are in the adult, thus bringing them more nearly into the same plane with the other lobes indicated, and making them visible from above. They may, however, indicate entirely different parts. Further research during the larval stages is necessary to determine that point.

Figure 10.—Edge of abdomen of *Psylla amorphæ*, showing the peculiar development of the marginal wax-hairs.

PLATE XVI.

Figure 1.—Wings of *Psylla carpini*, Fitch. The veins of the front wings are usually designated as follows: *a*, basal portion of costa, which continues clear around the wing as a marginal vein; *b*, stigmal portion of costa; *c*, basal portion of the subcosta; *d*, discoidal portion of subcosta; *e*, radial portion of subcosta; *pt*, pterostigma; *r*, radius; *p. c.*, petiolus cubiti; c_1, stem of

*Miss Charlotte M. King did the pen work on the drawings. All the figures are much enlarged; the natural size of some of them being indicated by the lines at the side of the figure. Those in plate xv drawn from measurements, 7 and 8 being drawn on a little larger scale than the preceding, and 9 and 10 much more enlarged. Those on plates xvi and xvii are camera drawings.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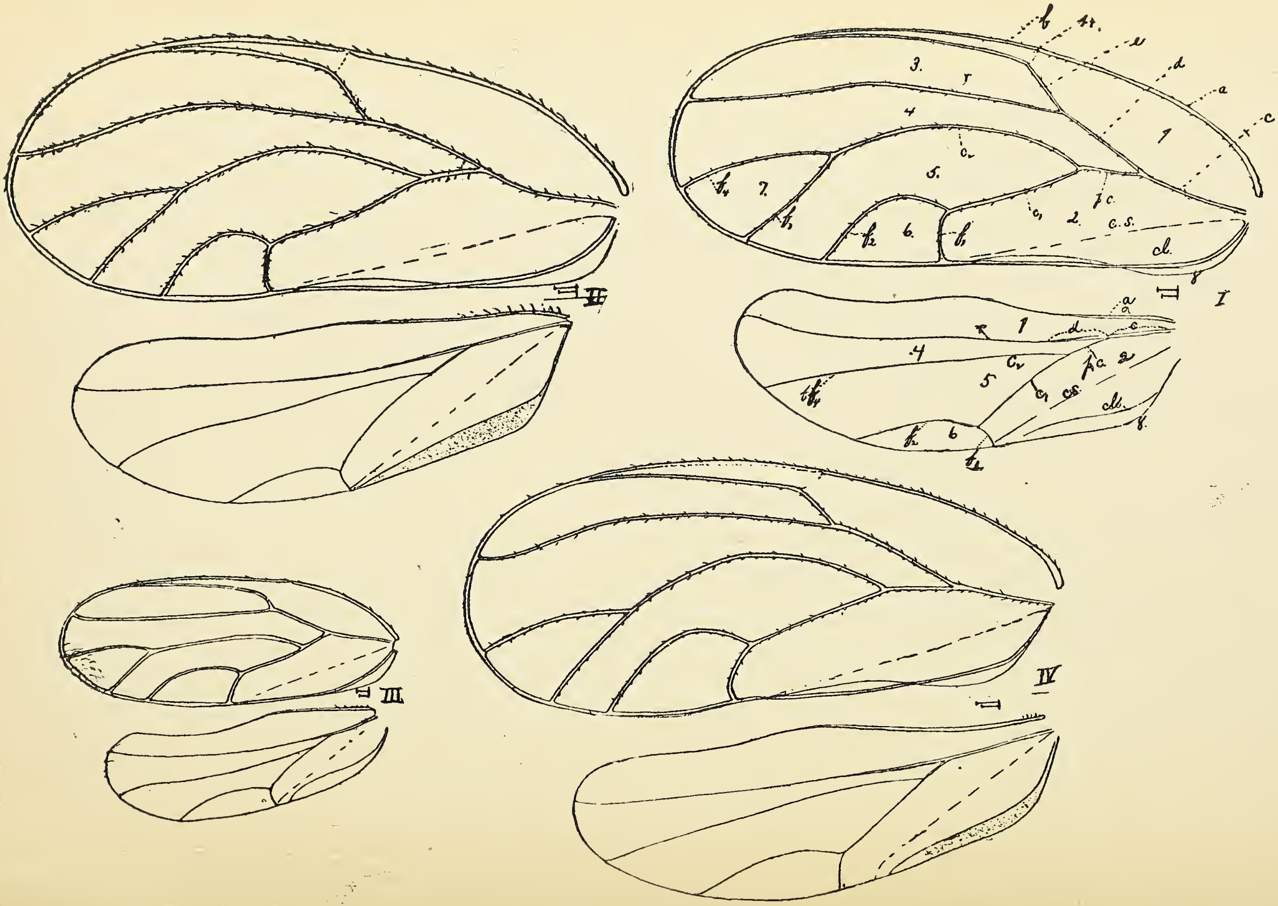
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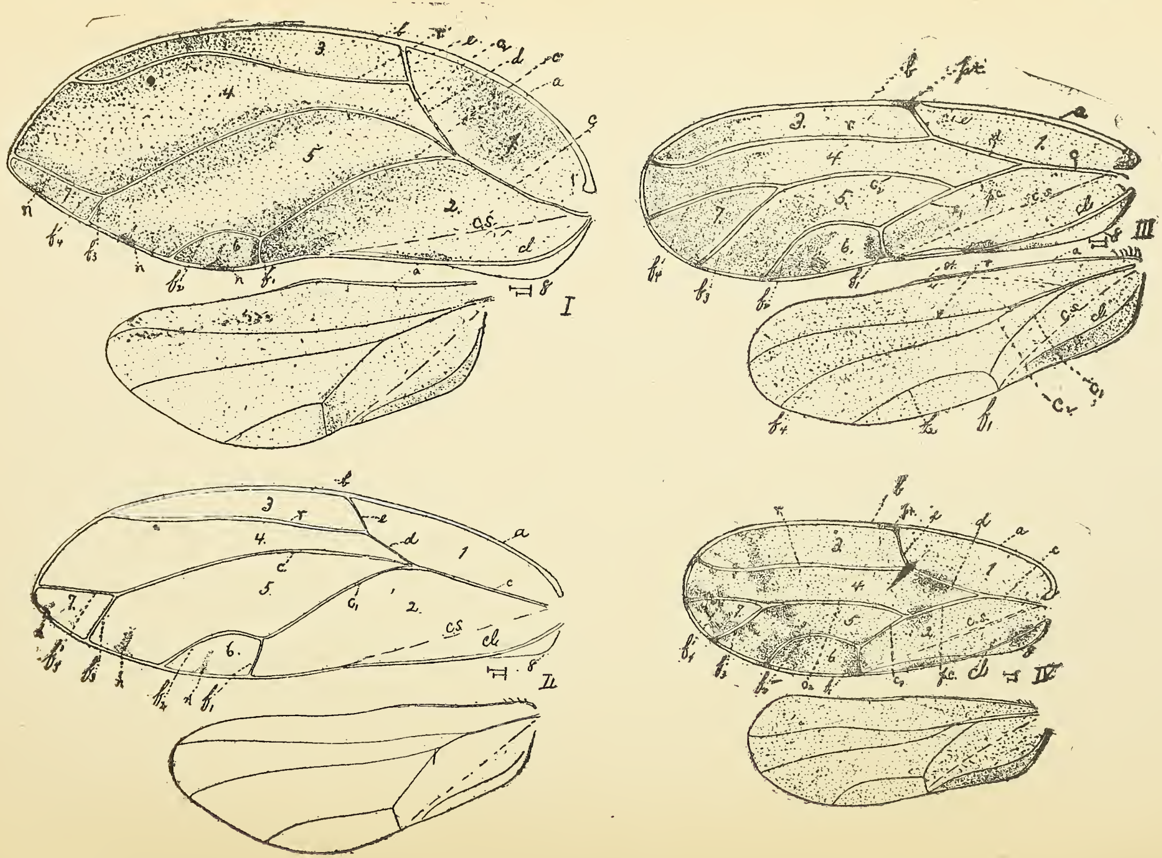
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first fork, or first cubitus; c_2, stem of second fork, or second cubitus; f_1, f_2, f_3, f_4, first, second, third and fourth furcal veins respectively; *c. s.*, claval suture; *cl.*, clavus.

The cells are designated as follows: 1, outer basal cell; 2, inner basal cell; 3, radial cell; 4, discoidal cell; 5, cubital cell; 6, first marginal cell; 7, second marginal cell; 8, anal angle.

The same letters that are applied to the front wings are also used for the corresponding parts of the hind wings.

In the venation of the hind wings notice: (1) That the radial portion of the subcosta is obsolete, thus leaving the outer basal cell and the radial cell unseparated and in the form of one long costal cell. (2) The basal portion of subcosta, discoidal portion of subcosta, and the radius form a continuous vein extending the full length of the wing. (3) The third furcal is obsolete, leaving the stem of second fork (second cubitus) and the fourth furcal as one continuous vein, and the second marginal cell in common with the cubital cell. Otherwise the venation seems to be virtually the same as in the front wings, except that the marginal vein becomes indistinct from the stigmal part on to the clavus.

The fine hair lines indicate the natural size of the wings.

Figure 2.—Wings of *Psylla negundinis*, n. sp. The venation is the same as usually found in the genus Psylla, and all the veins and cells correspond very closely to those of figure 1.

Figure 3.—Wings of *Psylla amorphæ* n sp. Veins and cells named the same as in figure 1.

Figure 4.—Wings of Psylla *annulata*, Fitch. Veins and cells named as in figure 1.

PLATE XVII.

Figure 1.—Wings of *Trioza tripunctata* Fitch. Lettering the same as in figure 1, plate II. The same veins are represented except the petiolus cubiti which is wanting, thus causing the stem of the first fork (first cubitus) and the stem of the second fork (second cubitus) to arise from the same point. In the hind wings the part that would correspond to the petiolus cubiti is represented.

Figure 2.—Wings of *Trioza salicis* n. sp. Lettering same as preceding.

Figure 3.—Wings of *Aphalara polygoni.* Lettering the same as before. The petiolus cubiti is a little shorter than the discoidal portion of the subcosta, but the other structural characters unmistakably place it in the subfamily Aphalarinæ. The hind wings show an important difference in the fact that the veins marked c_1 and c_2 arise from different parts of the subcosta, and the part that in the other genera corresponds to the petiolus cubiti is wanting.

A very faint vein arising about half way between the two forks and extending to what corresponds to the pterostigma, is sometimes indicated and might be taken to represent the radial portion of the subcosta.

Figure 4.—Wings of *Aphalara exilis*, var. *rumicis*. Lettering same as before.

CEMENT MATERIALS IN IOWA.

BY E. H. LONSDALE.

[Abstract.]

Some time after the discovery of massive deposits of the Cretaceous chalk in the northwestern portion of the state the question arose as to the adaptability thereof -- whether this calcareous material might be considered of any practical value and if so what means should be taken to reduce it preparatory to its application. Certain initiatory steps were undertaken towards determining these points but as yet but little has been done. Chemical analyses have been made of the rock and test shafts put down in order to ascertain the thickness of the beds, but further development has never been attempted.

Vicat and Pasley were among the investigators who sought to determine some means through which the manufacture of artificial cement might be made possible and they soon proved that a mixture of chalk with clay or river mud produced the desired results. Since that time the growth of the industry has been rapid in this as well as foreign countries.

The well known Portland cement now so extensively produced and generally utilized is made by the calcination of a mixture of chalk with argillaceous material. It sets more readily and its adhesive powers are claimed to be stronger than in the case of the natural cement. The relative amounts of the two components vary at different plants. In the United States and in France and England what is known as the wet process is used, while in Germany the dry method is adhered to. The affinity which caustic lime has for silica and alumnia and the affinity of the combination for water gives rise to the hardening of the materials. The degree to which the calcining should be carried on depends upon the percentage of the alkaline silicates in the calcareous body, and since these are shown by analyses to be practically absent from the Iowa chalk, a high calcination

is desirable. The relative amounts of the chalk and clay in the same locality vary greatly, owing to the differences in the chemical composition of the material making up the several strata. The common ratio of chalk to clay is about three to one. A test of certain clays about Sioux City shows that a proper proportion could only be obtained through the mixing of five parts of one kind of clay or two parts of another with but a single part of the chalk.

These chalks, which have been fully described by Calvin in various articles recently issued, are available in the northwestern portion of Woodbury county and in the southwestern part of Plymouth along the bluffs of the Big Sioux river. The maximum thickness of the chalk is about fifty feet and the areal extent is so great as to make it wholly inexhaustible. In speaking of these chalks and clays Calvin* makes a brief reference to the adaptability of the materials for Portland cement and there certainly seems no reason why the Iowa material might not be used with success equal to that attained at other points. The most natural combination would be the chalk with the clay immediately under it.

Away from the Sioux City region there are no other chalk beds east of the river until a point in the extreme southeastern township of Sac county, nearly east of Grant City, is reached. An exposure several feet thick of very clean, yellow to white chalk has been discovered here. It is not very unlike that to the west. The associated clays are neither so readily available nor so adaptable to use in cement making. It may be that further search will reveal splendid grades of argillaceous materials at this point, and if so the manufacture of cement may be carried on here fully as successfully as at the localities already mentioned. On account of its softness the chalk is far preferable to the hydraulic limestone and the resulting cement is equally strong.

Selenitic or gypseous cement is secured by substituting gypsum for the chalk in combinations much the same as those referred to; and, although no attempt has been made to utilize the massive mineral at Fort Dodge in the manufacture of cement, it would seem that it could be readily done. The available clays in this vicinity are not like those associated with the chalks, but the superior grades, such as are now being used for common pottery, are found near by. The hardening of the

* Iowa Geol. Sur. Vol. I, First Ann. Rep., pp. 158 and 160, 1893.

gypseous cements takes place principally through a combination with water rather than in the manner of ordinary hydraulic cement, where the hardening is brought about by re-crystallization of the calcium, alumnia and silica present.

MISSISSIPPIAN ROCKS OF CENTRAL IOWA*.

BY H. FOSTER BAIN.

The Mississippian series includes all the rocks lying between the base of the coal measures and the top of the Devonian. They have been principally studied in southeastern Iowa and adjacent portions of neighboring states. More recently the study of the exposures of that portion of central Iowa which includes Marion, Mahaska, Keokuk and Washington counties has allowed the construction of a central Iowa section.

As shown in this region the rocks include the following divisions:

Saint Louis	Pella beds. Verdi beds. Springvale beds.
Augusta.	
Kinderhook	Wassonville limestone. English river gritstone. Maple mill shale.

These beds are separated on lithologic and stratigraphic grounds. Faunal studies have not yet been carried to any degree of completion, but seem so far to confirm the divisions.

The divisions of this section are readily correlated with those of the southeast. The minor divisions of the Augusta found in the latter region are not traceable farther north.

The Maple mill shale contains certain fossils with Devonian affinities and may be ultimately placed in that series.

*Abstract of a paper published in full in American Geologist, vol. xv, under the title Central Iowa Section of the Mississippian Series.

TOPAZ CRYSTALS OF THOMAS MOUNTAIN, UTAH.

BY ARTHUR J. JONES.

In the summer of 1891 it was the privilege of the writer to visit what is known as Topaz Mountain in southern Utah. It is about thirty-five miles south of the northern end of the Dugway Mountains, called by Simpson the Thomas Range, twenty-five miles northwest of Deseret, forty miles north of Sevier Lake, and about the same distance west of Eureka, Utah.

This locality was discovered by Henry Englemann, geologist of Capt. Simpson's expedition across Utah in 1859. Owing to inaccuracies in the description of the place it was lost sight of for nearly ten years but was at last re-discovered and has since been visited constantly by tourists. Very few accounts of the locality have, however, appeared in print.

Englemann* describes the crystals found here as follows:

"Perfectly colorless and transparent and of great beauty and luster. Degree of hardness=8. Before the blowpipe they proved infusible and when strongly heated they were covered with small blisters, but did not show any change of color. They exhibit reactions of fluorine, alumina and silex."

Prof. J. E. Clayton of Salt Lake City, visited this place in 1884 and collected many very beautiful crystals, some of which he sent to Whitman Cross for examination. These were soon afterward described by the latter† in connection with similar crystals from Colorado.

Other accounts of the same occurrence have been given from the information furnished by Prof. Clayton, by Mr. G. F. Kunz.‡

In the book first mentioned Mr. Kunz describes the topaz as "the most beautiful and brilliant crystals known to occur in

* Exploration across the Great Basin of Utah, Simpson, 1859. p. 325.

† Am. Jour. Sci., (3), XXXI, 432. 1886.

‡ Gems and Precious Stones, p. 67. New York, 1892. U. S. Geol. Surv., Mineral Resources, 1883-1884, p. 738. 1885. U. S. Geol. Surv., Mineral Resources, 1892, p. 764. 1893.

the United States." A short account of the same topaz is also given by Mr. A. N. Alling.* Dana also mentions this locality.†

The crystals occur in cavities formed in lava. This rock is white or grayish in color and has a peculiarly banded structure resembling sandstone. It seems to be made up of loose, intensely sharp crystals laid down in layers, as though it might have been the settlings of volcanic ejectamenta. It carries finely disseminated gold and lead and is a typical rhyolite of Pliocene-Tertiary age or of the immediately preceding period. The lava overlies all the stratified rock and caps the Dugway range. It is in a bed nearly 1,000 feet thick, fifteen miles long and from two to five miles wide. The natural occurrence of the crystals is in cavities in the rock, but the great majority of those seen had been separated from the lava and were scattered over the surface. The whole mountain was apparently covered with them and presented a magnificent appearance in the bright sunlight, the crystals gleaming like drops of dew in the morning sun. Turn where you would the glitter of the bright gems met your eyes. In some places they were so thick that one could almost scoop them up. But by far the greater number were broken and imperfect, the most perfect ones generally being the tips broken off along the basal cleavage planes from larger crystals. In the course of four or five hours nearly a pint of quite perfect specimens was collected with a much larger number of imperfect ones. These crystals varied in size from tiny ones no larger than a pin-head to those as large as one's thumb. For the most part they are, as Englemann described them, "entirely colorless and transparent," but some wine-colored ones were also discovered. These were always and only found in cavities in the rock where they were not exposed to the light, it being thus conclusively proven that the wine-colored ones fade to white under the influence of bright sunlight. This change of color has also been noticed in the topaz found at Nathrop, Colorado.

With the topaz of the latter place crystals of garnet, quartz and sanidine are associated in varying quantities.

It has been suggested that these crystals are of secondary formation resulting from the action of acid waters on the rock since its deposition. But Cross, in the article above mentioned,

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*Am. Jour. Sci., (3), XXXIII, 146. 1888.

†A System of Mineralogy, p. 495. 1893.

says of the Nathrop crystals: "They are evidently not secondary like zeolites, but primary and produced by sublimation or crystallization from presumably heated solutions contemporaneous or nearly so with the final consolidation of the rock." It is very likely that the Utah topaz was formed in the same way.

FORMATION OF THE FLINT BEDS OF THE BURLINGTON LIMESTONES.

BY FRANCIS M. FULTZ.

[Abstract.]

For convenience the flint beds of the Burlington limestones are usually separated into two divisions, known as the "lower" and "upper" flint beds. The lower series is probably from fifteen to twenty feet thick and the upper a little more. They have always been classed as the latest deposits of the Lower Burlington and Upper Burlington limestones, respectively. The lower beds are not so continuously chert as the Upper; in fact much of the deposit is siliceous shale mixed with clay and containing thin bands of limestone. There are also certain strata which look like heavy-bedded limestone, but which contain so much siliceous and argillaceous matter as to be utterly worthless. As already stated the upper series is somewhat the thicker. There is also a much greater proportion of chert and much less siliceous shale, while the amount of limestone remains about the same.

As yet no very satisfactory theory as to the origin of these flint beds has been advanced. Certainly none satisfactory enough to be generally accepted. The investigation to which attention is here called has been mainly as to whether the origin of the material has been chemical or organic. So far the preponderance of evidence is in favor of the former.

SYNOPSIS OF AMERICAN PALEOZOIC ECHINOIDS.

BY CHARLES ROLLIN KEYES.

For the more minute correlations in stratigraphy no group of fossils is of more practical service than the echinoderms. Where the remains of these organisms are abundant, as in many of the Paleozoic rocks, the entire history of events may be inferred from them alone. Composed of hard parts or plates which are more or less regularly shaped and which are arranged according to a definite plan the evolution of the various forms may be readily traced and the slightest changes in physical conditions at the time of sedimentation quickly detected. In the Mississippi basin the crinoids are widely distributed both geographically and geologically in the later Paleozoic strata. Their structure has been made out in great detail and hence their value for geological classificatory purposes is second to no other criteria. The same is also true of a closely related class of stemmed echinoderms—the blastoids.

There is another group of echinoderms which begins to appear rather frequently in the latter part of the Paleozoic and which continues to become more and more abundant through the Mesozoic to the present time. These are the echinoids, popularly known along the present seacoast as sea eggs or sea urchins. The recent species have been lately exhaustively monographed by Prof. Alexander Agassiz. The Mesozoic forms have, within the past year, received scholarly treatment at the hands of Prof. W. B. Clark; and the Tertiary varieties are now being thoroughly studied by the same author.

With the American Paleozoic echinoids practically nothing has as yet been done to place this group on a working basis. To be sure, a considerable number of species have been named, but with very few exceptions the descriptions have been very meager and have been founded upon exceedingly fragmentary material—isolated plates or primary spines.

During a recent study of the fossils of Missouri most of the species hitherto described were obtained and much new material was examined, some of it being in an unusually fine state of preservation. In a number of cases the structure of the organisms was made out much better than ever before, enabling critical comparisons to be instituted between most of the known genera. The minute structure of the ambulacral plates and ornamentation of Melonites, Oligoporus, and Archæocidaris were especially well exhibited. The more salient points of difference are shown in the accompanying plates.

It is the purpose of the present paper to bring together the material which has been described and to present briefly some of the more salient characteristics of the group. It is preparatory to a more complete and critical study of all the material now known, and a careful comparison of the genera with typical European forms as well as with those most nearly related among the Mesozoic and later groups. So much American material has accumulated of recent years and is now within easy reach that much of interest is promised as the result of its examination.

The American Paleozoic echinoids with a single exception are from the Carboniferous. Although during the period there was a remarkable and important expansion of echinodermal life, and a wonderful culmination of certain groups, echinoids were scarce. The genera were few, and species were meagerly represented and widely scattered, though they showed a constant yet slow increase from the time of their first appearance. The distribution of the different genera and species is indicated in the following table:

GEOLOGICAL DISTRIBUTION OF AMERICAN PALEOZOIC ECHINOIDS.

GENERA.	Devonian (Chemung).	Kinderhook.	Augusta.	St. Louis.	Kaskaskia.	Lower Coal Measures.	Upper Coal Measures.
Pholidocidaris	......	......	1				
Palæchinus	......	......	2				
Melonites	......	......	......	2			
Oligoporus	......	......	4	1			
Lepidesthes	......	......	3	......	1		
Archæcidaris	1	2	4	2	3	4	8
Lepidechinus	1	1	4				

It is to be noted that the echinoids occur most abundantly in the Augusta limestone, the rocks in which another group of echinoderms, the crinoids, exist in myriads, so that the former would be expected to be more plentiful in those strata.

PHOLIDOCIDARIS IRREGULARIS Meek & Worthen.

Pholidocidaris irregularis Meek & Worthen, 1869; Proc. Acad. Nat. Sci., Phila., vol. XX, p. 78.

Pholidocidaris irregularis Meek & Worthen, 1873; Geol. Sur. Illinois, vol. V, p. 512, pl. xv, fig. 9.

Known material very imperfect; all plates irregular, imbricating; interambulacral rows six or more; plates with central tubercles.

Horizon and localities. Carboniferous, Keokuk limestone: Hamilton and Nauvoo, Illinois.

PALÆCHINUS BURLINGTONESIS Meek & Worthen.

Palæchinus burlingtonesis Meek & Worthen, 1860; Proc. Acad. Nat. Sci., Phila., vol. XI, p. 396.

Palæchinus burlingtonensis Meek & Worthen, 1860; Geol. Sur. Illinois, vol. II, p. 230, pl. xvi, figs. 3*a-c*.

Test spherical, perhaps somewhat depressed at the poles. Ambulacra narrow, with a double row of alternately small and large plates in each series; poral ossicles about thrice as wide as high, five to seven, equaling the height of an adjoining interambulacral plate; pores in pairs in a zigzag line. Interambulacral pieces in four series in each field. Surface marked by numerous small tubercles for the attachment of the spines, rather regularly arranged in rows of which thirty to forty occupy an interambulacral plate.

Horizon and localities. Lower Carboniferous, Burlington limestone: Burlington, Iowa.

PALÆCHINUS GRACILIS Meek & Worthen.

Palæchinus gracilis Meek & Worthen, 1869; Proc. Acad. Nat. Sci., Phila., vol. XX, p. 82.

Palæchinus gracilis Meek & Worthen, 1873; Geol. Sur. Illinois, vol. V, p. 473, pl. x, fig. 2.

Similar to *P. burlingtonensis* but smaller, ambulacra proportionately much wider and height of poral pieces greater. Interambulacral plates much smaller and arranged in seven or more ranges instead of only four.

Horizon and localities. Lower Carboniferous, Upper Burlington limestone: Burlington, Iowa.

MELONITES MULTIPORA Norwood & Owen.

Melonites multipora Norwood & Owen, 1846; Am. Jour. Sci., (2), vol. II, p. 222, figs. 1–2.

Melonites multipora Roemer, 1855; Arch. für Naturgeschichte, 21 Jahrgang, I Band, pp. 312–320, xii Taf.

Melonites multipora Meek & Worthen, 1866; Geol. Sur. Illinois, vol. II, p. 228.

Melonites multipora Safford, 1869; Geology Tennessee, p. 346.

Melonites stewartii Safford, 1869; Geology Tennessee, p. 346, plate vi, figs. 1*a–d*.

Melonites irregularis Hambach, 1884; Trans. St. Louis Acad. Sci., vol. III, p. 549, pl. C, fig. 2.

Melonites multipora Keyes, 1894; Missouri Geol. Sur., vol. IV, pl. xvi, figs. 1*a–b*.

Test large, spherical, with ten meridional folds, of which the ambulacral are the narrower. Ambulacral areas about two-thirds the width of the interambulacra, each composed of about ten rather poorly defined rows of very irregular pore-plates, the ossicles of the central two ranges being about three times as large as the others. The interambulacral areas have eight rows of hexagonal ossicles, the marginal ones being only about one-half the width of the others; toward the poles, however, the plates are somewhat irregular and the ranges are not distinctly defined. The apical disk is rather small in size; the oculars are very small, only about one-fifth the size of the genitals, quadrangular in outline, and so far as is known, not perforated. The genitals are quite large, sub-pentagonal in shape, one being slightly larger than the other four. The madreporic plate is perforated by numerous very minute openings, and apparently by a single large one. The two genitals nearest the madreporite have each four large perforations and the two opposite each three. The number of holes in the genital plates appears to differ somewhat in different specimens. The oral aperture is rather small, subcircular in outline. Five strong triangular jaws have been observed within the peristome of some specimens. The surface of the test is covered by numerous small granules, which support the spines, about thirty occupying each interambulacral plate.

Horizon and localities. Lower Carboniferous, St. Louis limestone: St. Louis, Missouri; Clarkesville and Charlotte, Tennessee.

Melonites crassus Hambach.

Melonites crassus Hambach, 1884; Trans. St. Louis Acad. Sci., vol. IV, p. 548, pl. C, fig. 1.

Melonites crassus Keyes, 1894; Missouri Geol. Sur., vol. IV, p. 126.

Closely resembles *M. multipora*, but with only five rows of interambulacral plates, the latter being also larger and covered with larger spines.

Horizon and localities. Lower Carboniferous, St. Louis limestone: St. Louis, Missouri.

Oligoporus nobilis Meek & Worthen.

Oligoporus nobilis Meek & Worthen, 1868; Proc. Acad. Nat. Sci., Phila., vol. XIX, p. 358.

Oligoporus nobilis Meek & Worthen, 1873; Geol. Sur. Illinois, vol. V, p. 476, pl. xi, fig. 3.

Somewhat larger and heavier than *O. multipora*, but with fewer ranges of interambulacral plates, which are also much larger; apical portions very similar.

Horizon and localities, Lower Carboniferous, Burlington limestone: Calhoun county, Illinois.

Oligoporus danæ Meek & Worthen.

Melonites danæ Meek & Worthen, 1860; Proc. Acad. Nat. Sci., Phila., vol. XI, p. 397.

Oligoporus danæ Meek & Worthen, 1866; Geol. Sur. Illinois, vol. II, p. 249, pl. xvii, fig. 8.

Oligoporus danæ Keyes, 1894; Missouri Geol. Sur., vol. IV, p. 126, pl. xvii, figs. *2a-b*.

Test large, spherical. Interambulacral areas lanceolate in outline, moderately convex, occupied below the middle by nine vertical ranges of plates. Ambulacral areas about half as wide as the others, and nearly as convex, the broad, rounded furrow on each side of the middle rather shallow. Pore plates in four rows, much wider than high, and somewhat irregular. Surface covered with small tubercles at the spine bases.

Horizon and localities. Lower Carboniferous, Keokuk limestone: Felton (St. Louis county) and Curryville (Pike county) in Missouri; Keokuk, Iowa; Warsaw, and in Jersey county, in Illinois.

OLIGOPORUS MUTATUS Keyes.

Oligoporus mutatus Keyes, 1894; Missouri Geol. Sur., vol. IV, p. 126, pl. xv, figs. *4a-b*.

Test rather large, spherical, lobed. Interambulacral areas rather broad, moderately convex, composed of five vertical ranges of large hexagonal plates. Ambulacral areas less than one-half the width of the interambulacral, very convex or sharply angular; pore plates small, very low, but wide, in four rows, the median pair being about twice as wide as the outer ones. Surface covered by small spine tubercles.

Horizon and localities. Lower Carboniferous, Keokuk limestone: Keokuk, Iowa.

As distinguished from *O. danæ*, this form is somewhat smaller in size, with the ambulacral areas much more elevated centrally and the bordering furrows much more shallow. In the interambulacral areas there are only five instead of nine vertical rows of plates.

OLIGOPORUS COREYI Meek & Worthen.

Oligoporus coreyi Meek & Worthen, 1870; Proc. Acad. Nat. Sci., Phila., vol, XXII, p. 34.

Like *O. danæ* but smaller, more depressed; ambulacra more deeply furrowed; only six rows of interambulacral plates instead of eight, and larger in proportion to the size of the test.

Horizon and localities. Lower Carboniferous, Keokuk shales: Crawfordsville, Indiana.

Nothing is known of this species beyond the original diagnosis, the salient points characterizing it being given above. This description was a preliminary one and the revised account never appeared in the Illinois reports, as was customary with the species described by the authors.

OLIGOPORUS PARVUS Hambach.

Oligoporus parvus Hambach, 1884; Trans. St. Louis Acad. Sci., vol. IV, p. 550, pl. C, fig. 3.

Oligoporus parvus Keyes, 1894; Missouri Geol. Sur., vol. IV, p. 127.

Like *O. danæ* but somewhat smaller.

Horizon and localities. Lower Carboniferous, St. Louis limestone: St. Louis, Missouri.

Lepidesthes coreyi Meek & Worthen.

Lepidesthes coreyi Meek & Worthen, 1868; Geol. Sur. Illinois, vol. III, p. 525, fig. A.

Ambulacra broad lanceolate, one and one-half times as wide as interambulacral fields; poral plates rather large, broadly hexagonal, in ten ranges. Interambulacral areas narrow with six to seven rows of plates. Surface granulose.

Horizon and localities. Lower Carboniferous, Keokuk shales: Crawfordsville, Indiana.

As remarked by Meek & Worthen, Lepidesthes with its imbricating ossicles bears the same relation to Melonites as Lepidechinus does to Archæocidaris.

Lepidesthes colletti White.

Lepidesthes colletti White, 1878; Proc. Nat. Acad. Sci., Phila., p. 33.

Lepidesthes colletti White, 1883; U. S. Geol. Sur. Terr., 12th Ann. Rep., p. 163, pl. xl, figs. *2a–b*.

Like *L. coreyi*, but with very much narrower interambulacral areas.

Horizon and localities. Carboniferous, Keokuk shales: Salem, Washington county, Indiana.

Lepidesthes formosus Miller.

Lepidesthes formosus Miller, 1879; Jour. Cincinnati Soc. Nat. Hist., vol. II, p. 41.

Horizon and localities. Carboniferous, Keokuk shales: Crawfordsville, Indiana.

Lepidesthes spectabilis Worthen & Miller.

Hybochinus spectabilis Worthen & Miller, 1883; Geol. Sur. Illinois, vol. VII, p. 332, pl. xxxi, figs. *3a–d*.

Similar to *L. coreyi* but smaller.

Horizon and localities. Carboniferous, Kaskaskia limestone: Prairie du Long creek, Monroe county, Illinois.

Archæocidaris drydenensis (Vanuxem).

Echinus drydenensis Vanuxem, 1842; Geol. Rep. Third Dist., New York, p. 184.

Archæocidaris drydenensis Shumard, 1865; Trans. St. Louis Acad. Sci., vol. I.

Eocidaris drydenensis Hall, 1867; New York State Cab. Nat. Hist., 20th Ann. Rep., p. 298.

Test spherical, with poles deeply impressed, ambulacra wide, narrowing above, composed of very short broad plates, about five in the space of one-tenth of an inch, each perforated by two small pores, four rows of pieces to each ambulacral area, and depressed in the median part of the field as to form a well defined meridional groove. Interambulacra in widest part composed of seven ranges of plates; each plate with a central tubercle. Spines slender, from one-half to three-fourths of an inch in length, with annulation at base.

Horizon and locality. Devonian, Chemung sandstone: Dryden, New York.

Vanuxem's description is so meager as to hardly deserve mention. The above is essentially the same as that given by Hall. It is, however, far too imperfect, in the absence of figures, to allow with exactness very much to be known concerning the genetic relationships of the species. Ordinarily the form might be ignored entirely; but the importance of the type and its being the oldest echinoid yet known from American ranks makes it desirable to recognize the form. Little is known of the species beyond the published notes of Hall, who states that "One specimen, as it occurs flattened upon the stone, is nearly two and three-fourths inches in diameter." The specimen described by Mr. Vanuxem is upon a thin shaly sandstone of about ten by eleven inches; one of the angles, being nearly one fourth of the area, having been broken off. Upon this slab is one specimen better preserved than the others, from which the characters have been mainly derived. There are three other individuals possessing the form and showing the ambulacral fields; while there are parts of four others with multitudes of slender spines scattered over the surface.

ARCHÆOCODARIS LEGRANDENSIS Miller & Gurley.

Archæocidaris legrandensis Miller & Gurley, 1890; Desc. New Sp. Fossils, p. 59.

Horizon and localities. Carboniferous, Kinderhook limestone: LeGrand, Marshall county, Iowa.

ARCHÆOCIDARIS AGASSIZI Hall.

Archæocidaris agassizi Hall, 1858; Geology Iowa, vol. I, p. 698, pl. xxvi, figs. 1*a-d*.

Archæocidaris agassizi Keyes, 1894; Missouri Geol. Sur., vol. IV, p. 127, pl. xv, fig. 5.

Known only from loose plates and spines. Interambulacral plates are of medium size, hexagonal, except the marginal ones, which are subpentagonal. Central tubercle large, occupying two-thirds of the superficial area of plate, rather high; base small, perforated. Surface of plates smooth, except along the margins, which are deeply crenulated, or marked by a marginal series of elongated confluent nodes. Spines long, stout, somewhat compressed, contracted below, bluntly pointed above; socket deep; annulation rather coarsely striated. Surface of the spine below smooth; above marked by numerous small spinous tubercles, arranged in oblique rows, or in quincunx order.

Horizon and localities. Lower Carboniferous, Burlington limestone: Hannibal, Missouri, Burlington, Iowa.

ARCHÆOCIDARIS SHUMARDIANA Hall.

Archæocidaris shumardina Hall, 1858; Geology Iowa, vol. I, p. 669, pl. xxvi, figs. 3*a-d*.

Archæocidaris shumardina Keyes, 1894; Missouri Geol. Sur., vol. IV, p. 128.

Spines and plates as in *A. agassizi*, but only about one-third as large.

Horizon and localities. Lower Carboniferous, Keokuk limestone: LaGrange, Lewis county, Missouri; Warsaw, Illinois.

ARCHÆOCIDARIS KEOKUK Hall.

Archæocidaris keokuk Hall, 1858; Geology Iowa, vol. I, p. 699, pl. xxvi, figs. 2*a-b*.

Eocidaris blairi Miller, 1892; Geol. and Nat. Hist. Indiana, 17th Ann. Rep., p. 683, pl. xii, figs. 1–2.

Archæocidaris keokuk Keyes, 1894; Missouri Geol. Sur., vol. IV, p. 128.

Known only from fragments. Plates with the marginal nodes more prominent and further apart than in *A. agassizi*, and the central tubercles also smaller. Spines less than two-thirds the size of those of the species just mentioned.

Horizon and localities. Lower Carboniferous, Keokuk limestone: Clark county and Booneville, Missouri, and Warsaw, Illinois.

The form described as *Eocidaris blairi* is too imperfect to deserve recognition and the figures show clearly that only the general characters were capable of being made out. From other remains found at Booneville of what appears to be the same form it may be inferred that it is identical with *A. keokuk*, and until more satisfactory evidence is forthcoming Miller's name may be ignored altogether or regarded as a synonym of Hall's.

ARCHÆOCIDARIS WORTHENI Hall.

Archæocidaris wortheni Hall, 1858; Geology Iowa, vol. I, p. 700, pl. xxvi, figs. 4*a–g*.

Archæocidaris wortheni Keyes, 1894; Missouri Geol. Sur., vol. IV, p. 128, pl. xvi, figs. 3*a–b*.

Test subglobose. Interambulacral areas made up of four rows of large hexagonal plates; central tubercle about one-half as broad as the plate, with the boss moderately elevated; surface of the plates glabrate, except at the borders where the marginal row of nodes is quite narrow. Ambulacral area narrow, about one-half as wide as the large hexagonal ossicles, composed of rectangular plates, which are about twice as wide as high, about ten occupying the height of an interambulacral piece, each having a pair of large oval pores. Spines rather small, slender, slightly curved, with an apparently smooth or finely granular surface, below expanding rapidly into the broad crenulated annulation.

Horizon and localities. Lower Carboniferous, St. Louis limestone: St. Louis, Missouri.

ARCHÆOCIDARIS NEWBERRYI Hambach.

Archæocidaris newberryi Hambach, 1884; Trans. St. Louis Acad. Sci., vol. IV, p. 551, pl. D, fig. 1.

Archæocidaris newberryi Keyes, 1894; Missouri Geol. Sur., vol. IV, p. 129.

Very closely related, and perhaps identical with, *A. shumardiana.*

Horizon and localities. Lower Carboniferous, St. Louis limestone: St. Louis, Missouri.

ARCHÆOCIDARIS ILLINOISENSIS Worthen & Miller.

Archæocidaris illinoisensis Worthen & Miller, 1883; Geol. Sur. Illinois, vol. VII, p. 338, pl. xxxi, figs. 1*a–b*.

Spines like *A. agassizi* but somewhat stouter and granulations less numerous.

Horizon and localities. Carboniferous, St. Louis limestone: Hardin county, Illinois.

ARCHÆOCIDARIS NORWOODI Hall.

Archæocidaris norwoodi Hall, 1858; Geology Iowa, vol. I, p. 701, pl. xxvi, figs. 5*a-e*.

Archæocidaris norwoodi Keyes, 1894; Missouri Geol. Sur., vol. IV, p. 129.

Interambulacral plates with smaller tubercles than in *A. agassizi.* Spines small, slender, with sharp, scattered spinous processes on the upper half.

Horizon and localities. Lower Carboniferous, Kaskaskia limestone: Chester, Illinois.

ARCHÆOCIDARIS MUCRONATA Meek & Worthen.

Archæocidaris mucronata Meek & Worthen, 1860; Proc. Acad. Nat. Sci., Phila., vol. XI, p. 395.

Archæocidaris mucronata Meek & Worthen, 1866; Geol. Sur. Illinois, vol. II, p. 295, pl. xxiii, figs. 3*a-c*.

Known only from detached interambulacral plates and the primary spines. The ossicles are hexagonal, slightly wider than high, nearly smooth, with a marginal row of small granules and a prominent central tubercle. Spines long, gradually tapering, giving off numerous sharp spinous processes from a short distance above the proximal end to the pointed top. Articulating end rather large and provided with a well pronounced annulation.

Horizon and localities. Lower Carboniferous, Kaskaskia limestone: Liberty (Randolph county) and Chester, Illinois.

ARCHÆOCIDARIS CRATIS White.

Archæocidaris cratis White, 1876; Geology Uinta Mts., p. 109.

Archæocidaris cratis White 1883; U. S. Geol. & Geog. Sur. Terr., 12th Ann. Rep., p. 130, pl. xxxiii, fig. 2*a*.

Primary spines only known, similar to *A. mucronatus*, but more slender, annulation more prominent, spinous processes less numerous.

Horizon and localities. Carboniferous, Coal Measures (Lower Aubrey): Utah.

ARCHÆOCIDARIS ACULEATA Shumard.

Archæocidaris aculeata Shumard, 1858; Trans. St. Louis Acad. Sci., vol. I, p. 223.

Archæocidaris verneuiliana Swallow, 1858; Trans. St. Louis Acad. Sci., vol. I, p. 180. (Not King: Per. Foss., pl. vi, figs. 22–24.)

Archæocidaris gracilis Newberry, 1861; Rept. Colorado Riv. West, Ives' Exp., p. 117, pl. i, figs. 4–4*a*.

Archæocidaris edgarensis Worthen & Miller, 1883; Geol. Sur. Illinois, vol. VII, p. 337, pl. xxx, figs. 15*a–c*.

Archæocidaris aculeata Keyes, 1894; Missouri Geol. Sur., vol .IV, p. 130, pl. xv, fig. 3.

Known only from spines, which are long, with numerous short spinous processes, lower part contracted somewhat.

Horizon and localities. Upper Carboniferous, Upper Coal Measures: New Point (Jackson county), Missouri.

ARCHÆOCIDARIS BIANGULATA Shumard.

Archæocidaris biangulata Shumard, 1858; Trans. St. Louis Acad. Sci., vol. I, p. 224.

Archæocidaris biangulata Keyes, 1894; Missouri Geol. Sur., vol. IV, p. 130, pl. xv, figs. 1*a–c*.

Interambulacral plates as in *A. agassizi*, but somewhat wider than high, and with the boss much larger. Spines moderately stout, with a broad alate extension running longitudinally on opposite sides from near the crenulated annulation to the end. Both the central thickened portion of the spine and its expansions are covered by small scattered spinous tubercles.

Horizon and localities. Upper Carboniferous, Upper Coal Measures: Lexington and Kansas City, Missouri.

ARCHÆOCIDARIS MEGASTYLUS Shumard.

Archæocidaris megastylus Shumard, 1858; Trans. St. Louis Acad. Sci., vol. I, p. 225.

Archæocidaris megastylus Keyes, 1894; Missouri Geol. Sur., vol. IV, p. 129, pl. xv, figs. 2*a–b*.

Known only from loose spines and plates. Interambulacral plates very large and heavy, hexagonal, margins slightly turned upward; central tubercle large, considerably elevated; marginal nodes rather small, distant. Surface smooth. Spines large, attaining a length of eight or nine centimeters; very heavy, and nearly of a uniform size throughout the entire length. A few long spinous projections stud the surface at irregular distances.

Horizon and localities. Upper Carboniferous, Upper Coal Measures: Independence (Jackson county), Missouri.

ARCHÆOCIDARIS HALLIANUS (Geinitz).

Eocidaris hallianus Geinitz, 1866; Carb. und Dyas in Nebraska, p. 61, tab. v, figs. 1*a–b*.

Eocidaris hallianus Meek, 1872; U. S. Geol. Sur. Nebraska, p. 152, pl. vii, figs. 9*a-d*.

Archæocidaris hallianus, Keyes, 1894; Missouri Geol. Sur., vol. IV, p. 129.

A very small form, with spines about a centimeter in length.

Horizon and localities. Upper Carboniferous, Upper Coal Measures: Kansas City, Missouri; Nebraska City, Nebraska.

If the identification of the Kansas City specimen is correct, it seems probable that this form should more properly come under Archæocidaris than Eocidaris.

ARCHÆOCIDARIS SPINOCLAVATUS Worthen & Miller.

Archæocidaris sp. und., Meek & Worthen, 1873; Geol. Sur. Illinois, vol. V, pl. xxiv, figs. 13*a-e*.

Archæocidaris spinoclavatus Worthen & Miller, 1883; Geol. Sur. Illinois, vol. VII, p. 337, pl. xxx, figs. 14*a-c*.

Spines stout, enlarging and becoming triangular above the middle, spinules numerous, large. Interambulacral plates of moderate size.

Horizon and localities. Carboniferous, Upper Coal Measures: St. Clair and Marshall counties, Illinois.

ARCHÆOCIDARIS DININNII White.

Archæocidaris dininnii White, 1880; Proc. U. S. National Museum, vol. II, p. 260, pl. i, figs. 13–14.

Archæocidaris dininnii White, 1883; U. S. Geog. & Geol. Sur. Terr., 12th Ann. Rep., p. 131, pl. xxxv, figs. 6*a-b*.

Archæocidaris dininnii Keyes, 1894; Missouri Geol. Sur., vol. IV, p. 130.

Primary spines long, subfusiform, covered by long, scattered spinous processes.

Horizon and localities. Upper Carboniferous, Upper Coal Measures: Kansas City, Missouri; Tecumseh, Nebraska; Red Oak, Iowa.

ARCHÆOCIDARIS TRISERATA Meek.

Archæocidaris triserata Meek, 1872; U. S. Geol. Sur. Nebraska, p. 151.

Horizon and localities. Carboniferous, Upper Coal Measures: Nebraska City, Nebraska; Kansas City, Missouri.

ARCHÆOCIDARIS TRIPLEX White.

Archæocidaris triplex White, 1882; Rep. Carb. Invert. New Mexico, p. 22.

Horizon and localities. Carboniferous, Upper Coal Measures: New Mexico.

ARCHÆOCIDARIS ORNATUS Newberry.

Archæocidaris ornatus Newberry, 1861; Ives' Expl. Colorado River, p. 116.

Arch ocidaris ornatus White, 1877; U. S. Geog. Sur. w. 100 Merid., vol. IV, p. 104, pl. vi, fig. 7.

Only spines and an imperfect interambulacral plate known. The former are much stouter and spinous projection much larger than in *A. longispinus.*

Horizon and localities. Carboniferous: Ojo del Oso, New Mexico.

ARCHÆOCIDARIS TRUDIFER White.

Archæocidaris trudifer White, 1874; Expl. and Sur. w. 100 Merid., Prelim. Rep. Invest. Fossils, p. 17.

Archæocidaris trudifer White, 1877; U. S. Geog. Sur. w. 100 Merid., vol. IV, p. 104, pl. vi, figs. 8*a–b*.

Similar to *A. megastylus*, but with spines more slender, and spinous processes smaller; interambulacral plates much smaller.

Horizon and localities. Lower Carboniferous: "Camp Apache," Arizona.

ARCHÆOCIDARIS LONGISPINUS Newberry.

Archæocidaris longispinus Newberry, 1861; Rep. Colorado River of West, Ives' Exp., p. 116, pl. i, figs. 1–1*a*.

Spines only known, long, straight, with small granulations as spinous processes.

Horizon and localities. Carboniferous: Juncture of the two Colorado rivers, Arizona.

PERISCHODOMUS?? ILLINOISENSIS Worthen & Miller.

Perischodomus illinoisensis Worthen & Miller, 1883. Geol. Sur. Illinois, vol. VII, p. 333, pl. xxxi, fig. 8.

Test small. Interambulacral plates in five to seven rows.

Horizons and localities. Carboniferous, Kaskaskia limestone: Bay City, Pope county, Illinois.

The species is too poorly defined to enable the characters to be made out with certainty and the figure of the type shows practically nothing except the general outlines. The fact that the plates appear to be somewhat beveled for over-lapping seems to be the chief reason for referring the form to McCoy's genus Perischodomus, but this feature is also known among some of the species Archæocidaris.

LEPIDECHINUS RARISPINUS Hall.

Lepidechinus rarispinus Hall, 1867; N. Y. State Cab. Nat. Hist., 20th Ann. Rep., p. 295, pl. ix. fig. 10.

Test spherical or depressed spheroidal. Interambulacra with seven to nine ranges of plates, which are imbricated from below upward and from the middle of the areas outward; each plate with large central boss. Ambulacra narrow, with a double range of small low plates, each of which is pierced by two pores near the distal extremity; three to four plates in the space of one-tenth of an inch.

Horizon and localities. Devonian, Chemung sandstone: Meadville, Pa.; Carboniferous, Waverly sandstone: Licking county, Ohio. (Hall.)

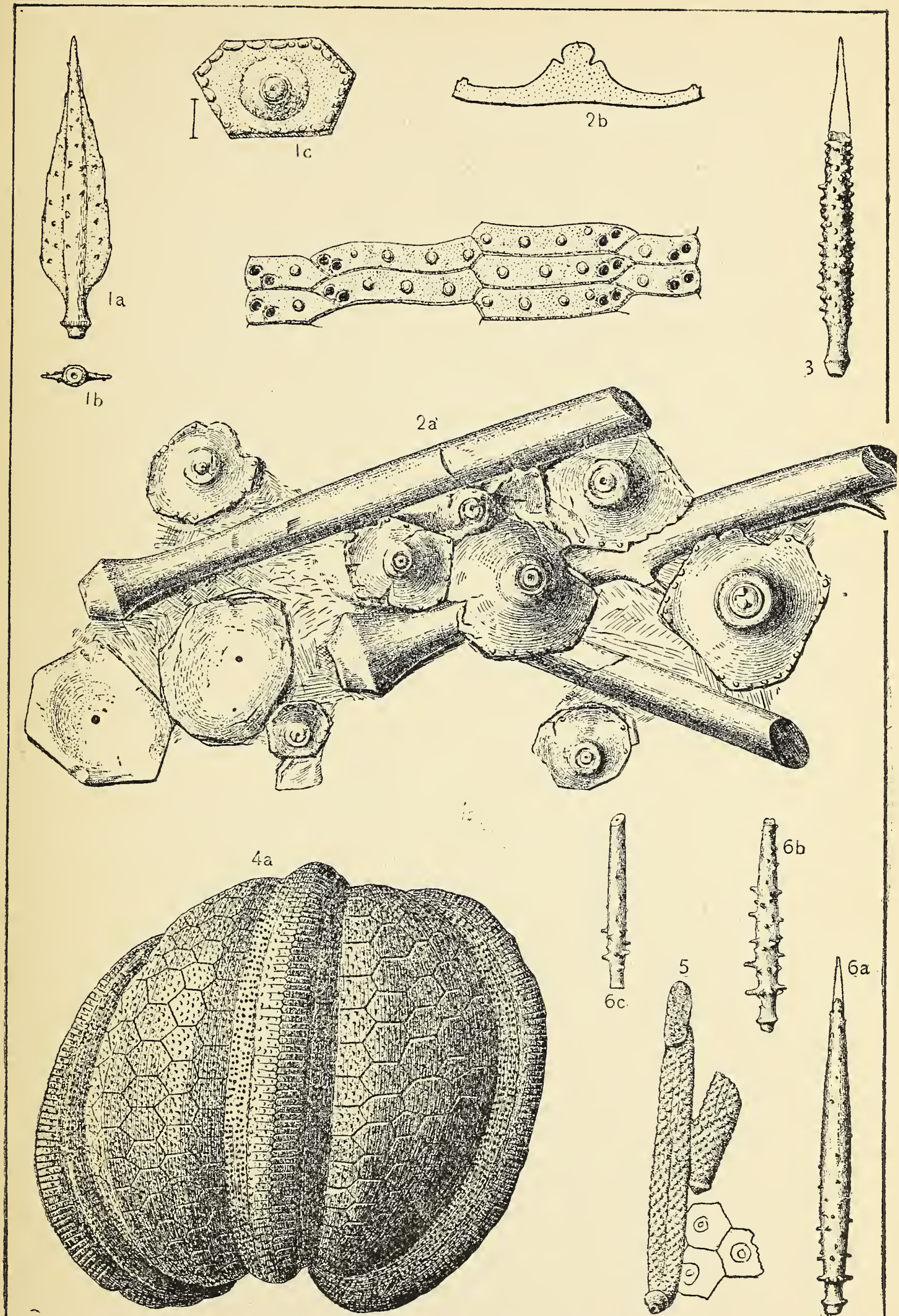
LEPIDECHINUS IMBRICATUS Hall.

Lepidechinus imbricatus Hall, 1861; Desc. New Species Crinoidea, Prelim. Notice, p. 18.

Horizon and localities. Lower Carboniferous, Burlington limestone: Burlington, Iowa.

The original description of this form is too defective to merit recognition and it is difficult to determine exactly what its distinctive characters are. From the location and the collection in which it was probably seen the type was presumably very nearly related to that figured by Meek and Worthen as *Lepidocidaris squamosus.* The fact that Hall subsequently described and figured another species which he referred to Lepidechinus (*L. rarispinus*) gives grounds for considering the genus which would otherwise have to be ignored entirely, for the illustration shows clearly what type he had in mind when he first proposed the name. Taking this view of the data presented Hall's genus should be regarded as valid.

Meek & Worthen's name, Lepidocidaris, which was proposed several years ago, after Hall's genus, does not appear to be sufficiently distinct to deserve separation; and it is not improbable that the type of the two genera proposed are one and the same species. Doubtless the last mentioned authors were somewhat misled by the brief diagnosis of the former author.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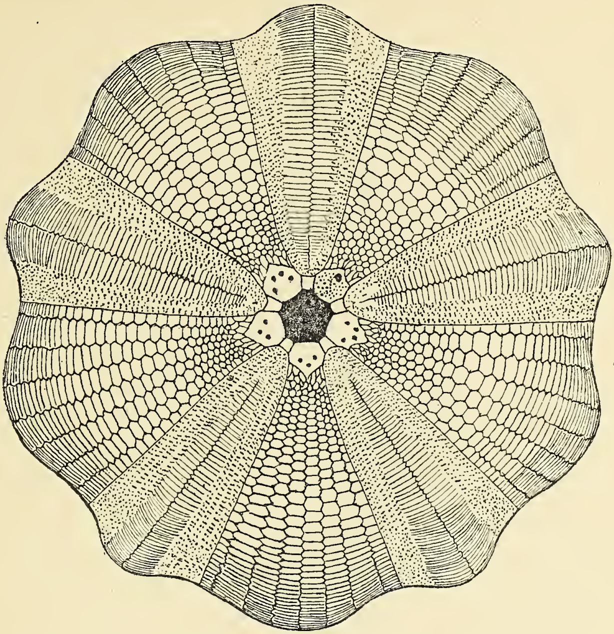

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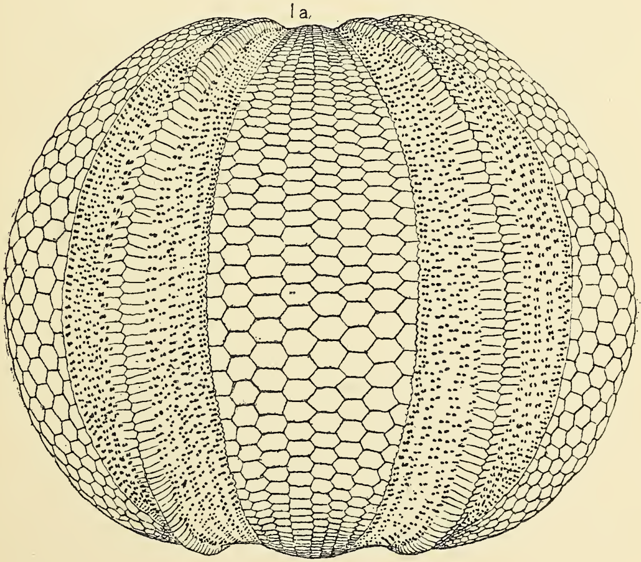

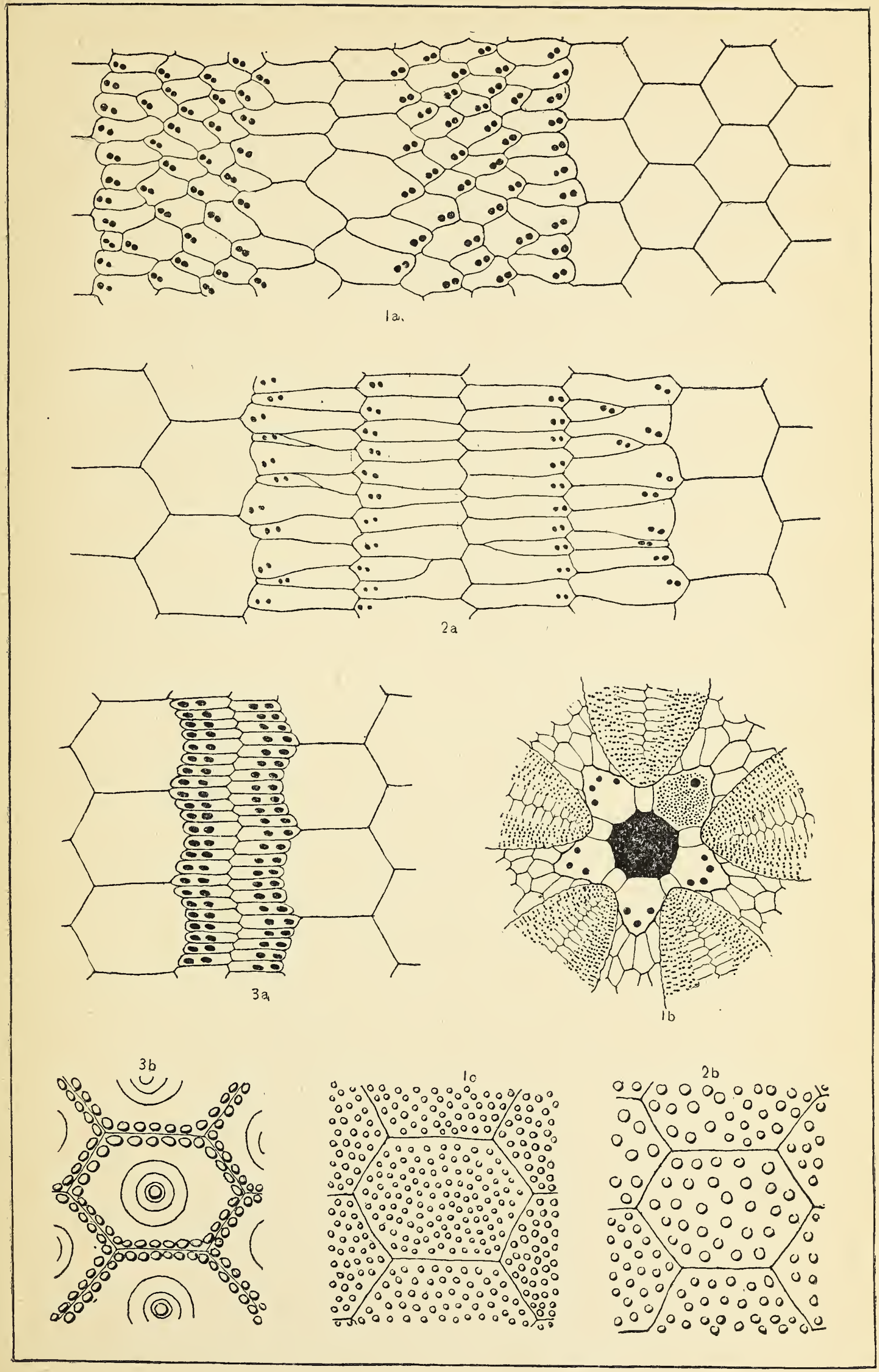
1a
2a
3a
1b
3b
1c
2b

Lepidechinus is manifestly closely related to Archæocidaris and the generic separation of the two appears to rest chiefly on the imbricated character of the plates on the former genus. To what extent this feature may be relied upon as a generic character cannot at this time be stated. Certain forms of Archæocidaris appear to have beveled interambulacral ossicles and this may prove to be one of the distinctive features of the genus. Meek has also noted this fact in connection with several species belonging to the latter group.

LEPIDECHINUS SQUAMOSUS (Meek & Worthen).

Eocidaris squamosus Meek & Worthen, 1869; Proc. Acad. Nat. Sci. Phila., vol. XXI, p. 79.

Eocidaris squamosus Meek & Worthen, 1873; Geol. Sur. Illinois, vol. V, p. 478, pl. ix, figs. 15*a-g*.

Lepidocidaris squamosus Meek & Worthen, 1873; Geol. Sur. Illinis, vol. V, p. 482.

Similar to *A. shumardi*, but with interambulacral plates beveled so as to allow marked imbrication; and ambulacral ossicles much more irregular.

Horizon and localities. Lower Carboniferous, Burlington limestone: Burlington, Iowa.

EXPLANATION OF PLATES.

PLATE XVIII.

Figure 1.		*Archæocidaris biangulata.*
	1*a*.	Side view of spine.
	1*b*.	View of same from below.
	1*c*.	Interambulacral plate.
Figure 2.		*Archæocidaris megastylus.*
	2*a*.	Spines and plates.
	2*b*.	Cross-section of Interambulacral plate.
Figure 3.		*Archæocidaris aculeata.*
Figure 4.		*Oligoporus mutatus.*
	4*a*.	Type specimen.
	4*b*.	Ambulacral plates (enlarged).
Figure 5.		*Archæocidaris agassizi.*
		Spines and plates.
Figure 6.		*Archæocidaris dininnii.*

PLATE XIX.

Figure 1.		*Melonites multipora.*
	1*a*.	Side view of nearly perfect specimen.
	1*b*.	Same from above.

PLATE XX.

Figure 1. *Melonites multipora.*
1*a*. Ambulacrum (enlarged).
1*b*. Apical disk (enlarged).
1*c*. Interambulacral plate (enlarged).
Figure 2. *Oligoporus danæ.*
2*a*. Ambulacral plates (enlarged).
2*b*. Interambulacral plates (enlarged).
Figure 3. *Archæocidaris wortheni.*
3*a*. Ambulacral plates (enlarged).
3*b*. Interambulacral plates (enlarged).

GEOLOGICAL SECTION OF THE Y. M. C. A. ARTESIAN WELL AT CEDAR RAPIDS, IOWA.

BY WILLIAM HARMON NORTON.

The record of this well is of special importance because it supplements and corrects the published records of the earlier city wells. It is based almost wholly upon drillings taken at frequent intervals directly from the sand pump. Unfortunately samples of the first ninety feet were not saved, within which space the drill must have passed through the beds lying between the lowest recognized Devonian and the Le Claire beds of the Upper Silurian. The interval, in part at least, can be supplied from outcrops in the immediate vicinity. The geological section at Cedar Rapids is as follows:

	FEET.
Fayette breccia including the Gyroceras beds of Calvin	11
Independence shales (Kenwood beds)	30
Otis limestone (*Spirifer subumbonus* beds)	30

Within a block of the well there outcrops, three feet above low water in the Cedar river, a locally persistent layer of the Otis; a brown, non-magnesian limestone macrocrystalline heavily and irregularly bedded and with large calcite nests. This is underlain at water level by a buff thin-bedded limestone. The brown limestone makes a locally persistent horizon not over twelve feet from the base of the Otis, where at numerous exposures along the Cedar below town, noticeably at Otis, it passes into a heavily-bedded, soft, buff magnesian limestone. Between the outcrop of this buff limstone, which we may designate as the Lower Otis, and the western boundary of the Le Claire and Mount Vernon beds, there extends along Big creek for ten miles an outcrop of an unfossiliferous, hard, heavily-bedded, drab limestone fifty feet in thickness, termed the Bertram beds in the author's report on the Geology of Linn county.*

Supplying, therefore, the upper ninety feet of the well section from the vicinal strata, we have the following succession:

Number.		Thickness in feet.	Depth of low'r limit.
	Otis limestone	29?	29?
	Lower Otis limestone	20?	49?
	Bertram limestone	41?	90?
17	a Chips of dark, slate colored, non-magnesian limestone; argillaceous, hard, compact sub-conchoidal fracture, pyritiferous: showing junction surfaces with green clay. b Smaller chips of light buff magnesian limestone, not porous; lustre earthy. c Green clay	5?	95
16	Magnesian limestone, or dolomite, light buff, slightly vesicular, lustre earthy; samples at 95, 105 and 115 feet	25	120
15	Dolomites, buff, pinkish and grey in color; mostly vesicular, sub-crystalline and sub-translucent. Seventeen samples	324	444
14	Dolomite, hard, grey, argillaceous, with argillaceous powder	6	450
13	Bluish shale with intercalated limestones at 525, 565 and 595 feet, in all seven samples	270	720
12	Dolomites; rough, hard. Six samples	65	785
11	Limestones, magnesian, some cherty. Eight samples	135	920
10	Limestones, briskly effervescent, earthy; in flaky chips, bluish grey in color	15	935
9	Shale and limestone, brown, petroliferous	15	950
8	Shale, blue	40	990
7	Limestone, bluish-grey, in flaky chips; briskly effervescent. Samples at 990 and 1,000 feet	35	1025
6	Sandstone, of clean white quartz sand; grains rounded and ground	20	1045
5	Dolomite, grey, cherty; samples at 1,045, 1,080, 1,100 and 1,115 feet	85	1130
4	Dolomite, arenaceous; in fine buff dolomitic powder with some quartzose grains	40	1170
3	Sandstone, in fine, light yellow quartz sand of angular grains, with some dolomite; samples at 1,170, 1,185 and 1,200 feet	55	1225
2	Dolomite, grey; samples at 1,225, 1,240, 1,260, 1,265, 1,280, 1,290, 1,310, 1,330, 1,350, 1,360, 1,380 and 1,390 feet; at 1,240 and 1,380 feet arenaceous	175	1400
1	Sandstone, of clean white quartz sand similar to No. 6 but coarser. samples at 1,400, 1,420, 1,435 and 1,445 feet; at 1,435 feet slightly calciferous	62	1462

* Iowa Geol. Surv., vol. IV., p. 135. 1895.

Taking No. 17 to represent the base of the Bertram beds the succeeding numbers are referred to the following formations:

		THICKNESS IN FEET.
Nos. 16-15.	Niagara and Le Claire	349
Nos. 14-13.	Maquoketa	276
No. 12.	Galena	65
No. 11-7.	Trenton	240
No. 6+.	St. Peter	25
Nos. 5-4.	Upper Oneota	125
No. 3.	New Richmond	55
No. 2.	Lower Oneota	175
No. 1.	Upper Saint Croix to bottom of well, 1,462 feet	62

The first artesian well at Cedar Rapids, which reached the Algonkian floor, disclosed the base of the sandstone referred to the Upper Saint Croix at 1,690 feet and the following strata succeeding:

FORMATION.	THICKNESS IN FEET.
Shales. Lower St. Croix	100
Sandstones. Potsdam	360
Quartzite. Sioux, to base of well at 2,225 feet	75

Points of special interest in the above section are:

(1). The thickness of the Niagara-Le Claire. Being but about ten miles distant from the thickest known outcrop of the Le Claire, where it aggregates ninety feet, it is believed that we have here a reliable measure of the probably maximum thickness of the formation; verifying White's estimate of 350 feet.

(2). The thickness of the Maquoketa, previous estimates not having exceeded 100 feet.

(3). The clear distinction between the Galena and Trenton, not marked in the record of the first artesian well*. In the driller's record of this well as published by R. E. Call†, the entire Galena-Trenton limestones are termed "sandstones."

(4). The presence near the base of the Trenton of a petroliferous shale, in other states the source of natural gas and oil.

(5). The reduction in the thickness of the Saint Peter given in the records of the first well at 116 feet.

(6). The division of the Oneota by a well defined sandstone. The equivalent of the New Richmond sandstone of Minnesota. The Upper and the Lower Oneota dolomites, whose joint thickness is 300 feet, were published as "sandstones" in the record of the first artesian well‡.

* Iowa Geol. Surv., vol. III, p. 195. 1895.

† Proc. Iowa Acad. Sci., vol. I, pt. ii, p. 58. 1892.

‡ Loc. cit., 58.

UPPER CARBONIFEROUS OF SOUTHWESTERN IOWA.

BY E. H. LONSDALE.

The district at hand is one somewhat remote from any known field of productive Coal Measures, but being Upper Carboniferous in age is a region to which considerable geological and economical interest has been attached. There has always been an anticipation of finding heavy fuel veins, but as yet these looked-for strata have not been positively located. Reports, often manufactured, and the meeting of thinner veins of coal, have led to the increased expectations now prevalent in the district.

Since the publication of the results of the reconnoissance by Meek and White in 1867 and the more extended report by the latter a few years afterwards all prospecting and hopes have been based upon the conclusions of these authors. Certain of these estimates have proven to be misleading. In the preliminary reports* it was predicted that the Upper and the then-called Middle Coal Measures would be passed through at a level not exceeding 500 feet lower than the water of the Missouri river at Nebraska City, almost the extreme southwestern point in Iowa. Here the elevation above sea level is 907 feet and the drainage level of the greater portion of the southwestern district is from 50 to 200 feet lower. Consequently the depth in the valley to the Lower Coal Measures would in no case be more than 700 feet. This is upon the supposition that the Carboniferous strata in this region lie approximately level. But, considering the dip as southwestward and at the rate of ten feet per mile, as is usually accepted, then at the southwest corner of Adams county, about fifty miles from Nebraska City, the base of the "Middle" Coal Measures would rise to within about 200 feet of the surface.

* U. S. Geol. Surv. of Ter., First Ann. Rep., p. 7. 1873.

There are many other facts which point to the inaccuracy of these early conclusions. Within the last fifteen years especially, deep boring has been prosecuted at various points in the field at hand. Other holes have been drilled and, although there are not many carefully kept records of any of these, each served to indicate the existence of very different conditions from those which had hitherto been believed to prevail. At Council Bluffs, Glenwood, Red Oak, Villisca, Riverton, Shenandoah, Clarinda, Atlantic, and other cities east of the river and at Plattsmouth and Omaha, across the Missouri, holes from 300 to 2,000 feet deep have been bored, in the attempt to find workable coal veins or artesian water. At the first named point on the grounds of the School for the Deaf, a well was put down 1,080 feet, and an examination of the drillings shows that strong clay shales, doubtless Coal Measure, prevailed to the bottom, and no bituminous vein whatever was penetrated.

Call* has reviewed the sequence at the Glenwood deep well and put the base of the Upper Coal Measures at 517 feet from the surface, thus allowing a thickness of only 154 feet to this geological division. A recent careful examination of the drillings reveals the fact that the measures for a great distance below this level are evidently in no manner different from those above, and such beds, mainly argillaceous shales, extend to more than 1,400 feet below the surface. It would certainly be more consistent to consider as belonging to the Upper division all above that point and to concede the remainder of the section to be "Middle" and Lower, or Des Moines series. The last 500 feet, as shown by the samples, is made up of very fine sands, white to yellow in color, with an occasional layer of clay shale.

The Des Moines terrane or Lower Coal Measures has been assigned a thickness of about 400 feet by Keyes†, hence if the division maintains its thickness throughout the southwest, as declared by White‡, and its thickness be added to that of the Upper Coal Measures at Glenwood, then the evidence would tend to show that the Lower Carboniferous beds were nearly reached in the 2,001-foot well. Yet at the same time it would seem more natural for the fine-grained shales to be prevalent in this southwestern area and not the fine sandstones, since the field lies within the central portion of the great Carboniferous

*Proc. Iowa Acad. Sci., vol. I, pt. ii, pp. 60-63. 1892.

†Iowa Geol. Surv., vol. II, pt. iii, p. 118. 1894.

‡Geol. Iowa, vol. I, p. 243. 1870.

basin. For this reason there is considerable difficulty in explaining this unusual occurrence, unless it can be accounted for by replacements or by conceding the portion just above the sandstones to be barren Lower Coal Measures.

At Red Oak only shales and limestones are recorded in a 650 foot well section—all certainly Upper Coal Measures; while thirty miles northeast, at Atlantic, a well was bored 1,300 feet deep and down to the last 250 feet the strata passed through consisted for the greater part of similar materials, and from 1,100 to the bottom the same sandstones which were met at Glenwood were discovered. Allowing for the dip and respective elevations of the two points the discrepancy in the depths to sandstone would just about be explained, the total dip being from about 300 feet between the two points.

At Clarinda, about fifty miles south of Atlantic, a prospect hole 1,020 feet deep was put down, and from the record it would seem conclusive that the Upper Coal Measures were not fully penetrated. The same may be said of the holes at Shenandoah and Riverton to the westward. The records of shallower borings in southwestern Iowa might be gone over, and likewise the drillings at Plattsmouth, Omaha and Council Bluffs, but these data simply corroborate the statements already made and nothing at variance is found.

Considering, therefore, the data at hand as at least in a manner reliable, the following conclusions pertaining to the Upper Paleozoic rocks of southwestern Iowa might be given: 1. The combined thickness of the divisions of the Upper Carboniferous approximates 2,000 feet. 2. The Upper Coal Measures, or Missouri series of Keyes, has a thickness of from 1,400 to 1,500 feet.

In support of this it may be stated that Broadhead* found the Upper Coal Measures in Atchison, the most northwestern county in Missouri, to be more than 1,100 feet thick, and the Upper Carboniferous as 1,900 feet. Later information has led this author to place the thickness of the latter in Missouri as 1,979, and the old Middle and Lower as 664 feet. These figures relating to the superior division have been more recently vouched for by Winslow†.

After a brief reconnoissance of the Iowa-Missouri coal field, and a review of the work of Meek, White and Broadhead,

* Iron Ores and Coal Fields, Geol. Surv. Mo., pt. ii, pp. 6 and 98. 1873.

† Mo. Geol. Sur., Prelim. Rep. on Coal. p. 23. 1891.

Aughey* argues that the Lower Coal Measure beds might be reached at any locality between Omaha and Plattsmouth at from 800 to 900 feet from the surface. This is exceeded somewhat by the figures here given; and is at the same time considerably more than the theoretical estimates of the earlier writers.

As to the general lithological character of the Upper Carboniferous beds in the area under discussion it may be said that there is a difference in the several sections so far as the association is concerned, but similar beds may be traced over the entire region.

It is a noticeable feature that while the upper or exposed strata are prevailingly limestones, in the case of under layers as shown by borings, the reverse is true, they being made up of argillaceous shales interlaid sparingly with ledges of limestone, bituminous shales, coals and sandstones. The total depth, however, of the exposed strata is by no means comparable with that of the concealed beds. These upper limestones may have occupied at the close of the Carboniferous epoch the highest position of that formation, or may have been overlain by softer strata such as clay shales or even arenaceous deposits, which being comparatively friable easily gave way to the later erosive agencies. The limestones as well as many of the shales are highly fossiliferous. The bituminous veins, whether coal or shale, are rather uncommon in occurrence and the individual layers rarely exceed two feet, The coal seam mined in Adams, Taylor, Page, Montgomery and Adair has an average thickness of perhaps twenty-one inches with an extreme of thirty inches. As yet the existence of heavier veins has not been definitely proven; the certain detection of coal beds of the Lower Coal Measures has not been possible and no satisfactory evidence indicating the presence of such seams as are mined in central and southeastern Iowa and in Missouri has been produced.

The Nodaway coal underlies a large territory, perhaps a greater one than that of any other vein in the state; it has been safely traced from the southern edge of Cass county as far south as the state boundary and northward from this line for somemiles. It is even possible that the Adair county coal as well as the vein found in western Mills county and running across into Missouri may be connected with the Nodaway seam.

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* Phys. Geog. and Geol. of Neb., p. 66. 1880.

DISEASES OF PLANTS AT AMES, 1894.

BY L. H. PAMMEL.

To fully discuss the fungus diseases of plants we should consider all matters that have a bearing on the question. One of the most essential conditions is the character of the weather. The relative humidity and precipitation are very important factors in the development of fungi. The germination of spores depends largely on the humidity of the atmosphere.

Dr. Erwin F. Smith has shown how important climatic conditions are in production and spread of *Exoascus deformans* (Berk.) Fuckel* and Dr. Byron D. Halsted has shown how important a factor moisture plays in the distribution of the Downy Mildews†. Professors B. T. Galloway, H. L. Bolley, the writer and numerous others have called attention to the prevalence of wheat rust during certain seasons; and it is a well known fact that climatic and meteorological conditions are very important factors in the production of these diseases‡.

The writer has published several papers giving the occurrence of fungi for certain seasons. Dr. Halsted has done a similar piece of work for New Jersey and several European writers have likewise given lists of fungi for certain years.§

BACTERIACEAE.

Bacillus amylovorus (Burrill) Trev. Blight has been unusually severe this year, occurring on Oldenburg, which seldom

* Journal Mycology, vol. VI, p. 107.

† Iowa Peronosporeæ and a Dry Season, Botanical Gazette, vol. XIII, pp. 52-59. Peronosporeæ and Rainfall, Journal of Mycology, vol. V, p. 6. Notes upon the Peronosporeæ for 1886. Bulletin Department of Botany Iowa Agricultural College, 1886, p. 53.

‡ Journal of Mycology, vol. VII, p. 195. Indiana Agricultural Experiment Station, Bulletin No. 26.

§ L. H. Pammel, Journal of Mycology, vol. VII, p. 95. Agricultural Science, vol. VII, p. 20. Botanical Gazette, vol. XVIII, p. 26. Iowa Agricultural Experiment Station, Bulletin No. 18, p. 188. Byron D. Halsted, Notes upon Peronospereæ for 1892 Report Botanical Department of New Jersey Experiment Station for 1892, p. 276. P. Magnus, Verzeichniss der vom 11 August bis September in Bayern gesammelten meist parasitischen Pilze Separat. Berichte d. Bayrischen Bot. Gesellsch. zur Erforschung der heimischen Flora.

blights, and many other varieties growing in this vicinity. I am inclined to think that the dry season during the flowering period this year has had much to do with the spread of the disease. Blight has also been general this year in many parts of the state. My observations made here for several years show that blight usually occurs on the young twigs, affecting not only *Pyrus communis* but *P. coronaris*, *P. malus* and *P. prunifolia*. This year it affected more especially *P. malus*, especially blossom blight. M. B. Waite* has shown that insects are important in carrying the disease from one flower to another. The disease entirely disappeared during July and August and trees have been unusually free during the latter part of the season.

Bacillus sorghi Burrill. This organism, so abundant every year, has not been so common the past season as during previous ones.

Bacillus cleaceae Jordan. Has not been observed by me the past season on the College grounds, although some years it is extremely abundant.

Bacillus campestres (Pammel). The rutabaga and turnip rot so common the past three or four years has not made its appearance on the cultivated rutabagas or turnips on the College grounds.

PERONOSPORACEAE.

The members of this group have been on the whole very scarce during the past season. Early in May and the latter part of April some of the species occurred on our weedy plants but our cultivated plants have been nearly free from these mildews.

Peronospora parisitica (Pers.), De Bary. This fungus occurred in April and May abundantly on the leaves of *Lepidium intermedium*, completely infesting the whole plant, giving them a yellow appearance and stunted in growth. It also occurred on *Capsella bursa-pastoria*, but less abundantly. Very little of thi fungus was seen during the rest of the season on any of the other crucifers.

Poronospora potentillae De Bary. This species was only found once in a shaded place near a house on the leaves of *Potentilla norvegica*.

Sclerospora graminicola (Sacc.), Schröter. This fungus has been abundant at times in past years on *Setaria viridis;* occurred

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* Proceedings Am. Assn. Adv. of Science. Washington Meeting, 1891, p. 315.

less frequently during the past season. During the month of May some patches here and there were seen, but not so common as it was in 1892. That year it took away whole patches of this miserable weed. After the fall rains in August the fungus slightly increased somewhat.

Plasmospara halstedii (Farlow), Berl et DeTon. Not observed, but a few years ago it was so abundant as to completely cover the plants of *Helianthus annuus*, *H. tuberosus* and other weeds of the *Compositæ*.

Plasmospara viticola (Berk et Curt.), Berl et DeTon. This fungus was so abundant in 1892–93 as to seriously threaten and injure cultivated grapes. It did not appear either on the wild grapes or cultivated, although a diligent search was made for it.

Bremia lactucæ Regel. Although abundant in 1893 on several wild species of *Lactuca*, in 1894 it was not found.

Albugo candida (Pers.), Kuntze. On *Raphanus sativa* was abundant, as it was also on *Capsella bursa-pastoris*, oospores abundant in inflorescence of radish.

A. portulacæ (D. C.) C. Kuntze. Was abundant during the entire season on *Portulaca oleracea*.

USTILAGINEÆ.

Smuts on some cultivated plants have been very abundant this year.

Tilletia striæformis (West), Magnus. Occurred in places on *Phleum pratense* but not so abundantly as a few years ago.

Tilletia foetans (B. & C.), Trelease. On wheat was not observed.

Urocystis agropyri (Preuss), Schroeter. On *Elymus canadensis* was quite abundant in places.

Ustilago tritici (Pers.), Jensen. Occurred to a considerable extent on both winter and spring wheats.

Ustilago hordei (Pers.), Kellermann & Swingle. Also occurred on barley.

Ustilago nuda (Jensen), Kellerman & Swingle. More common than *Ustilago hordei*.

Ustilago segetum (Bull), Dittm. The usual amount occurred on *Arrahentherum avenceaum*.

Ustilago avenæ (Pers.), Jensen. Abundant on oats.

Ustilago hypodytes (Schl.), Fr. Found on several occasions on *Stipa spartea* by Mr. Weaver, but not so abundant as reported by Mr. Stewart a few years ago.

Ustilago Rabenhorstiana Kühn. On *Panicum sanguinale* was extremely common everywhere during the latter part of September and early October. Solid blocks of diseased plants were found. Mr. Combs collected a peculiar form in which only a part of the infloresence was involved. Thus far I had only observed such forms in which the whole infloresence was involved and the masses covered over with a white membrane.

Ustilago maydis (D. C.), Corda. Corn smut has been unusually severe in many parts of the state this year. Numerous complaints were made showing the devastation and destructive nature of this fungus throughout the state. I have seen it especially abundant here at Ames, Onawa, Turin and Mason City and it is reported as common at Des Moines, Bedford and elsewhere.

Ustilago neglecta Neissl. On *Setaria glauca.* We have had an unusual amount of this fungus again.

Sorosporium syntherismæ (Schw.), Farlow=*S. ellisii* Winter. Dr. Farlow writes me that the smut on *Panicum sanguinale* and *P. capillare* after a careful examination from wide range is a *Sorosporium*, and that it is the original *Cæoma syntherismæ* of Schweinitz. On *Cenchrus tribuloides* it was very abundant in the western part of the state and also at Ames. As a rule the whole infloresence is involved as in the form on twitch grass, but this year I found in the western part of the state an abundance of smut on the sandbur in which some of the spikelets only produced long horns which gave the plants a very striking appearance. The same fungus on *Panicum capillare* was not so abundant.

From all these observations it certainly appears that dry weather is not conducive to the checking of smut. F. Lamson, Scribner and Seymour state that in Illinois and Texas they have seen much corn smut during dry seasons.

EXOASCEÆ.

The *Exoasceæ* on the whole were not so abundant this year. I could not find any of the *Exoascus aurea* which in 1892 was very abundant on several species of *Populus.* The *Exoascus deformans* (Berk), (Fuckel), so abundant on peach in 1892, could not be found. The *Exoasci* on various cultivated plums in this state were *Exoascus mirabilis* Atkinson* on *Prunus angustifolia,* Chickasaw county, *Exoascus communis* Sadebeck on *Prunus*

*Cornell University Experiment Station Bulletin No. 73, p. 334.

Americana, Baldwin and Cheney varieties. The Cheney plums and some forms of *Prunus angustifolia* were badly affected. I have never seen any indication of *Exoascus Pruni* on the cultivated *Prunus domestica* here at Ames.

DOTHIDIACEÆ.

Otthia morbosa (Schw.), Ellis & Everhart. There has been the usual amount of this fungus. As yet it has not made its appearance on the cultivated *Prunus Americana* or *Prunus angustifolia* nor *Prunus Cerasus*. It has, however, been very destructive to cultivated varieties of *Prunus domestica*. In fact there were but a few varieties which were not affected. I have also seen it on Japan plums here at Ames. It also occurred on *Prunus serotina* and *Prunus Americana* when growing in the woods.

Phyllachora Graminis (Pers.), Fuckel. There has been very little of this fungus on the usual hosts, *Elymus canadensis, Pan- dicotomum.*

Phyllachera Trifolii (Pers.), Fuckel, has been quite abundant this fall during the months of September and October after the rains. Red clover (*Trifolium pratense*) was especially affected.

UREDINEÆ.

*I have elsewhere in a paper indicated the scarcity of rusts in general this year, especially grain rusts, *Puccinia Graminis* (Pers.), *P. rubigo-vera* (D. C.), Winter, and *P. coronata* (Cda.) *P. graminis* appeared in considerable quantity on fall sown oats in September and October, beginning after the August rains. It may be interesting to note that the leaves were abundantly affected with *P. graminis* instead of *P. coronata* as is the usual case. Cockle-bur rust (*Puccinia Xanthii* Schw.) occurred in considerable quantity. *Puccinia compositarum* (N. A. F. 2252) was only found once on *Iva xanthiifolia* in the western part of the state. Corn rust (*Puccinia Sorghii*) on *Zea mays* has not been as abundant as heretofore.

Puccinia andropogonis on *Andropogon scoparaius* and *A. furcatus* has not been abundant.

Puccinia tanaceti (D. C.). Occurred in considerable quantities on the cultivated sunflower (*Helianthun annuus*), and the cultivated *Helianthus tuberosus*, also on the wild forms of *Helianthus annuus, H. tuberosus* and *H. grosse-serras*.

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*Agricultural Science, vol. 8, p. 287.

Uromyces trifolii (A. & S.), Wint. Occurred on *Trifolium pratense* during the month of September in certain places; more abundant during the month of October.

Aecidium grossulariæ (D. C.). Has been abundant on several members of the genus *Ribes*, especially *Ribes grossulariæ*, *R. gracile* and *R. rotundifolium*, except for Aecidia on the barberry, gooseberry, composites and *Oenothera* early in the season. The cluster cup fungi were not abundant.

Roestelia pyrata Thaxter. On *Pyrus Iowensis* was not as abundant as in 1890.

In the spring we found considerable quantities of the *Cæoma interstitiale* Schlechtendal on the blackberry (*Rubus villosus*). Whole bushes over considerable areas in places were affected. If this is connected with *Puccinia Peckiana* it is strange that this rust should be so extremely rare. It has not been found here, although Mr. E. W. D. Holway writes me that he has found it at Decorah.

Melampsora Populina (Jacq.), Lev. Occurred as usual on the cottonwood *Populus monilifera*. Some trees are more affected than others.

Melampsora Salicina Lev. Occurred in some quantities on some of the wild species of Salix.

Coleosporium Sonchi-arvensis (Pers.), Lev. Was not common except that Mr. G. W. Carver found a quantity of it growing on asters in the vicinity of Mud Lake, where there was considerable moisture.

Entomosporium maculatum Lev. Only a few specimens here and there on *Pyrus communis*.

HYPHOMYCETES.

Cercospora angulata Wint. Has occurred on *Ribes rubrum* but not severe. In 1893 it was very destructive everywhere in Iowa on this species.

Cercospora baeticola Sacc. Occurred in September but not as destructive as in 1893.

Monilia fructigena P. The total absence of this fungus during the early part of the season was very noticeable, whereas it was so abundant in 1891, 1892, and 1893 during the months of May, June and August. Later in the season, September and October, it was found on wild plums (*Prunus Americana*).

Cladosporum carpophilum Von Thümen. Although this fungus has been very destructive to *Prunus Americana*, and in some years also destructive to cherries, it has not appeared so far as I know on these nosts this year. Mr. Stewart called my attention to a *Cladosporium* on a species of *Crataegus*. Later the same was found on another tree by Mr. Carver, which produces similar spots frequently encircling the whole fruit at the blossom end. The mature spots have the characteristic olive brown color.

MELANCONIÆ.

Cylindrosporium padi Karst. The entire absence of this fungus is one of the peculiarities of the season. While in 1893 this fungus was very destructive to young cherry seedlings as well as older trees, it was at no time abundant on nursery stock the past season, and very few leaves could be found on other trees. The disease occurred, however, on *Prunus cerasus* and *P. avium*.

Helminthosporium graminium Rabh. This fungus, which for several years past has been very destructive, appeared on some plants, but much less severe than heretofore.

Cladosporium herbarum (Pers.) Link. *This fungus has been reported by several observers as parasitic. I have on several occasions seen spikelets covered with this fungus apparently parasitic. It is indeed hard to say, however, since this fungus so commonly occurs on plants in a dying condition, and in fact everywhere on dead plants, it may be questionable whether this species is parasitic. Dr. Cobb finds it a serious trouble in New South Wales.

TUBERCULARIÆ.

Fusarium culmorum W. G. Smith. A serious enemy to wheat. Some years very abundant. It was only seen and reported a few times this year.

PERISPORIACEÆ.

The mildews have been more noticeable this year than other fungi, although they were less abundant than during the latter part of 1893.

Sphærotheca mali (Daby) Burrill. This fungus appeared in considerable quantity on young suckers in nursery in June, July, and continued, with some interruption in August, till well into October.

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*Frank, Krankheiten der Pflanzen, p. 580.

N. A. Cobb, Plant Diseases and How to Prevent Them, separate p. 10 from Agricultural Gazette, N. S. Wales, December, 1892.

Podosphæra oxyacanthæ (D. C.) DeBary. I have never seen this fungus absent on the cultivated cherry, and this season is no exception to the rule. It began to appear on the cultivated cherry in July and continued till October, although older trees were less affected than young trees in nursery. It was very abundant on young trees of *Prunus pumila* in the nursery. It also occurred to a limited extent on *Prunus Americana.*

Microsphæra Alni (D. C.), Wint. Although occurring on *Syringa vulgaris* and *S. persica,* it did not disfigure the shrubs as usual. The same fungus also appeared on *Lonicera,* though less troublesome than in 1893.

Microsphæra quercinia (Schw.), Burrill. Appeared on the English oak, *Quercus robor,* in September, though not as abundant as in 1893.

Uncinula necator (Schwh.), Burrill. Appeared to a limited extent on Roger hybrids late in September.

Erystphecommunis (Wallr.), Schl. Appeared in considerable quantities on *Ranuaculus abortivus* and *R. lacustris* at Mud Lake, Iowa, where Mr. Carver found the plants covered.

Erisyphe cichoracearum D. C. Was very abundant on *Helianthus annuus,* H. *tuberosus* both cultivated and wild. Also on *Ambrosia artemisiasfolio* and *A. trefida.* It was less abundant on *Verbena stricta, V. hastata* and *V. Urticifolia* than in 1893.

COINCIDENCE OF PRESENT AND PREGLACIAL-DRAINAGE SYSTEM IN EXTREME SOUTH-EASTERN IOWA.

BY FRANCIS M. FULTZ.

[Abstract.]

The drainage system in southeastern Iowa is believed to be practically the same today that it was in preglacial times. By southeastern Iowa reference is made to the counties of Louisa, Des Moines, Lee, and the eastern part of Henry. Present evidence shows that every stream of any importance is now occupying a preglacial bed. This applies to the Mississippi river

except possibly that part of the great river which lies between Montrose and Keokuk, where, for ten or twelve miles, it flows over a rock bed, making rapids so shallow as to necessitate a canal for the accommodation of river traffic during low water stage.

A detailed explanation was given regarding the principal streams of the southeastern part of the state, and the conclusion reached that all except the Mississippi above Keokuk are running in old channels.

EXTENSION OF THE ILLINOIS LOBE OF THE GREAT ICE SHEET INTO IOWA.

BY FRANCIS M. FULTZ.

In the great southern flow of ice, two streams, one coming through Iowa and the other through Illinois, apparently merged their forces in the valley of the Mississippi. This union extended from somewhere near where Clinton now stands to about the present site of St. Louis. It is not at all likely that the ice streams first met at the northern point indicated; for the center of the movement on the Illinois side was well over towards the eastern part of the state, and likewise the center of the Iowa lobe was a goodly distance away from the Mississippi. From these centers the advancing fronts deployed to the right and left, thus producing movements diverging from the central axis. It was these spreading fan-like margins which first met somewhere near the present line of the Mississippi—just where it would be difficult to say—not unlikely as far south as the mouth of the Des Moines river. From this meeting point the ice would rapidly fill up the valley in both directions. To the southward the two streams would immediately merge and flow as one current. To the northward the ice would pile up until the general level of the two ice fields was attained, when the motion would practically stop, until, through the increasing volume of ice, the width of the direct forward motion in each stream had increased to such a degree that the angle at the point of meeting was very much reduced. When the angle had thus become small enough, the union of currents would practically be perfect from the junction point, and thence onward the movement would be nearly directly southward. The retreat would of course be in the reverse order of the advance. This might account for the varying direction of striæ; for where we find several sets of markings on the same surface, the oldest trend more nearly north and south and latest more nearly east and west.

There are other factors entering into this problem. This theory supposes that the two ice sheets were contemporaneous, and simultaneously moved up to the Mississippi, near which they met. Now it is by no means certain that they met at the channel of the river. It may have been in Illinois, it may have been in Iowa, or it may never have happened at all; for, as already intimated, the movements may not have been contemporaneous. But whatever doubts there may be concerning that phase of the question, it is reasonably sure that the Illinois glacier once invaded Iowa.

The witness most frequently summoned to testify to ice movements radiating from the region north of Lake Huron, is again called upon. It is the well-known jasper conglomerate. Erratics from this Canadian ledge had been found ranging from eastern Ohio to western Illinois. One from Kentucky is figured in Wright's "Great Ice Age." They are scattered over southern Illinois, even as far south as Louisville, in Clay county, where Mr. Frank Leverett, of the U. S. Geological Survey, recently found one. One has also been found at Alton, Ill., twenty-five miles above St. Louis, and another at Hamilton, Ill., opposite Keokuk. So it was pretty definitely settled that this Canadian ice stream had invaded the country to the present channel of the Mississippi, That it had crossed the river and moved into Iowa soil was thought scarcely possible; yet such is now shown to have been the case. During the present year two of the jasper boulders have been found in southeastern Iowa; one in Des Moines county, about six miles from the river, and one near Denmark, in Lee county, about twelve miles back from the river. The latter was discovered by Mr. Frank Leverett and the other was located by myself. Both were fully 200 feet above low water in the Mississippi.

The presence of these Huron erratics at so great an altitude and so far back from the river, shows conclusively that the ice sheet must have crossed from the Illinois side and invaded Iowa. It may have been that the two streams met somewhere near the Mississippi, and the Illinois current being the stronger, crowded back its weaker opponent; and then, when the retreat began, the Iowa ice field, released from its pressure, may have followed up for some time the withdrawal of its adversary. Of course thc reverse of this might be true. Besides there remains the possibility that the culmination on the one side antedated that of the other, But in any theorizing the invasion of Iowa by the Illinois glacier must be now considered an established fact.

Whatever may have been the earlier sequence of those movements, the Iowa ice stream was last to hold possession of the western bluff of the Mississippi. For this reason few of these Huron boulders will ever be found west of the river. The reasons are based on two different kinds of evidence, glacial scorings and terminal deposits. In Des Moines county glacial scorings have been discovered at no less than half a dozen places.[1] In nearly all instances the markings are deep, amounting to grooves, and, for the most part, remarkably well preserved; so there is no ambiguity as to their evidence. The direction varies from 15 degrees east of south to nearly 80 degrees east of south. This shows either a southeastward or a northwestward movement. Now it can be conceived how the ice from the Illinois glacier might flow westward. even due westward; but the imagination is not elastic enough to account for it moving northwestward at the angle indicated by most of these scratches. Besides, at least three of the scorings themselves give evidence as to the direction of the ice flow. One where the striation of the lateral surface occurs, another where the whole face of the bluff is glaciated, and the third where the intersecting striæ on the level limestone floor tell their story. These striæ, scratches and grooves give no evidence whatever of any other movement than towards the southeast.

Now as to terminal deposits. It is generally supposed that outside of the region occupied by the second ice invasion, marginal deposits are scarcely to be found. Yet there is no finer example of a terminal moraine than may be seen near Sandusky, in Lee county, about six miles north of Keokuk. This ridge is about a quarter of a mile from the Mississippi and parallel to it. It is about a mile and a quarter long and at its greatest depth

[1] White; Geol. of Iowa, Vol. I, p. 93. 1870.
Keyes; Iowa Geol. Sur., Vol. III, p. 155. 1893.
Fultz; Ibid, p. 158. 1893.

the deposit measures forty feet or more. The base is not more than thirty-five or forty feet above low water. The ridge is made up almost entirely of erratics. Some of them are quite large; one, which was particularly noticed, had one surface exposed which was fully six by ten feet. There are a few limestone boulders of local origin, but they are generally small and form a very little part of the whole. The ridge occupies the front of a broad depression in the high bluff, which, with this exception, borders the Mississippi from Montrose to Keokuk. It is apparently undisturbed, excepting at the south end, where Lamlee creek has cut its channel through and down into the limestone beneath. Surely no subsequent ice sheet ever moved over it. This boulder ridge marks the termination of a small lobe of the attenuated margin of the great Iowa ice sheet, just before its final retreat. The position of the ice lobe was locally determined by the depression already mentioned.

There is also a boulder bed in the southern part of the city of Keokuk. It is on the very margin of the bluff and lies on the very-much-disturbed surface of the St. Louis limestone. From its position it is not easy to tell from which direction its material came—possibly from both east and west. This Keokuk boulder bed is not brought up as evidence in the present discussion, but simply as a fact of concurrent interest.

The Sandusky boulder ridge and the glacial scratches are probably the dying records of the great ice sheet, when its attenuated margin would be much cut up, and the movements greatly influenced by the local topography. And to me the evidence at present seems clear that these last movements were from the west and northwest. Future developments may change these views. When some one has taken up the subject of erratics and made it a minute study, so as to positively identify them and locate their origin, then the question of ice flows in this locality will be a comparatively easy one.

GLACIAL MARKINGS IN SOUTHEASTERN IOWA

BY FRANCIS M. FULTZ.

In the third annual report of the Iowa Geological Survey Dr. C. R. Keyes has treated, at considerable length, of the glacial scorings in Iowa. Among others, several localities were given from Des Moines county, of which two were described somewhat in detail by the present writer. Since the above mentioned article was prepared a somewhat more extended and minute search has been made, with the result that several other localities showing glacial scratches have been discovered. Also, some attention has been given to a study of the phenomena accompanying these markings, with a view of determining the general direction and sequence of the ice streams. It is scarcely to be doubted, from the great variation in the direction of striæ, that the ice flow from time to time changed its course. While all markings show a northwest and southeast trend, some of them are very nearly north and south, others very nearly east and west. Again, it is commonly accepted that these scratches were necessarily made by the ice moving from somewhere in the north and west; but there is good evidence to show that this territory was once invaded by the ice from the Huron district moving through Illinois.

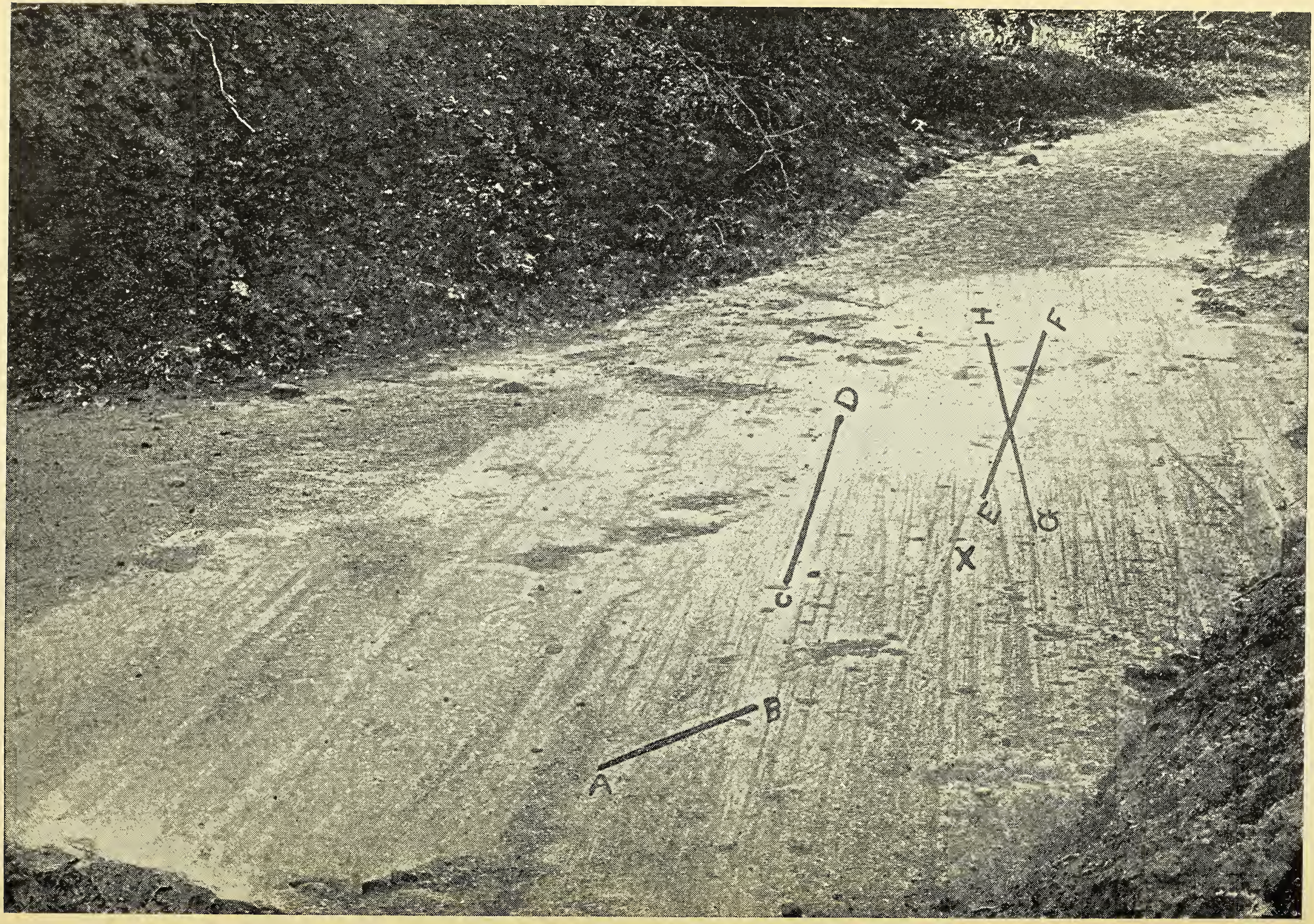
First, let the localities heretofore known and described from this section be briefly mentioned. From the vicinity of Burlington: by White, S. 15° E.; by Keyes, S. 63° E.; by Leverett, S. 65° E.; also by the present writer at points near West Burlington and at Kingston. As already mentioned, the last two exposures mentioned have been fully described elsewhere. The one at Kingston is at the very top of the bold bluff which borders the flood plain of the Mississippi. It was brought to light by the changing of a small water course, and exposes a glaciated surface 100 feet in length and 25 feet in width. It shows the top platform of rocks to have been planed off perfectly level.

On account of the recent breaking away of rock, this level floor extends out to the perpendicular face of the escarpment. The floor is crowded with striations and grooves, all finely preserved. Four different sets of scratches may easily be determined, each consisting of perfectly straight, parallel grooves. Some of these grooves in the latest series are fully an inch deep, while those from the earlier are nearly obliterated. The trends, given in the order of apparent age, are as follows:

1. South 30° 15′ east. *A–B*, Plate xxi.
2. South 64° east. *C–D*, Plate xxi.
3. South 60° 30′ east. *E–F*, Plate xxi.
4. South 72° 15′ east. *G–H*, Plate xxi.

These angles were taken with surveyor's compass and corrected 7° for deviation.

The oldest series is nearly obliterated by the planing of the later ice movements but its traces are very numerous, and it undoubtedly records a long unwavering movement of the ice stream in one direction. The second set shows the most prominently on account of the greater number of deep grooves, on which the later cross movements have made but little impression. The scratches of the third and fourth sets are not very numerous, but some of them are quite conspicuous. By a study of this glaciated surface, something may be learned concerning the relative time and continuance of the different ice movements in this locality. The rock floor is the hard, compact limestone of the Upper Burlington, which, since the passing of the ice sheet, has been covered by typical undisturbed drift. The markings of the two later movements are of like prominence; and which is the earlier is only determined by a study of the intersection of two of the grooves. This would indicate either, that the grooves formed very rapidly, or else that the planing of the rock floor was exceedingly slow. The grooves of the two later are not of much greater depth than those of the second; but the number of grooves in the second set is more than double those of the third and fourth combined. The oldest set of all was almost planed away by the ice stream of which the second set is the record. This clearly indicates that time was an important factor in deciding the number of grooves. In all probability the actual periods represented by the third and fourth sets were of considerable duration; but each was comparatively short in comparison with the second. It is easy to see how these grooves could be cut to a considerable depth



GLACIAL STRIÆ AT KINGSTON.

before many of them were formed or much of the surface worn away.

It might be taken for granted that the ice movement was from northwest to southeast as is universally conceded; but, as already stated, there is but little doubt that the Illinois ice sheet once held possession, and it is barely possible that those striæ which are more nearly east and west might be its product. However improbable it is, while the possibility remains, the question is open for argument. The accompanying phenomena here all indicate movement to the southeast. The depressions in the rock floor, caused by fossils or concretions, are more abrupt on the northwest side than on the southeast, and when a groove cuts through one of them it perceptibly widens on the southeast. But more conclusive evidence than this is where one groove intersects another. The angle to the northwest is sharp, clear-cut and distinct, while that to the southeast is blunted and rounded off, exactly the effect that would be expected with movement from the northwest. Fragments entering the intersection would be somewhat freed and would strike against the projecting angle, thus breaking it away. It seems conclusive that all movement indicated by these striæ, including that which is most nearly east and west, was from the northwest toward the southeast.

The trend of the bluff at this place is from north to south about 5° west. It will be seen that the latest scratches are nearly at right angles to the escarpment. while the earlier ones cut it at a comparatively sharp angle. The inference might be that the earlier ice flow was entirely independent of, while the later one was influenced by, the local topography. The Mississippi exerted little or no influence on the earlier flow, but near the close of the ice age it maintained a wide, open channel directly into which the ice stream pushed. If this were true, then we ought to find the valley full of erratics and terminal débris. There is great probability that the boulders lie thickly strewn beneath the surface of the old flood plain; but they lie deeply, for the valley has been silted up many feet. There is one place, however, where, in time of extreme low water, these erratics may be seen in great numbers in the present channel of the river; also, along the line of the bluff itself there is abundant evidence.

The other locality described in the article before referred to, is near West Burlington. This exposure is illustrated in figure

2, and also in plate xxii. This came to light by stripping in the Loftus quarry. The striated surface thus exposed was large, and was especially interesting because it showed both floor and lateral erosion; and also because the surface rose in benches. The markings of the floor surfaces were the same as that described from Kingston—continuous, parallel, straight grooves. But the lateral scoring, which showed on the rise from one bench to another, consisted of a multitude of fine

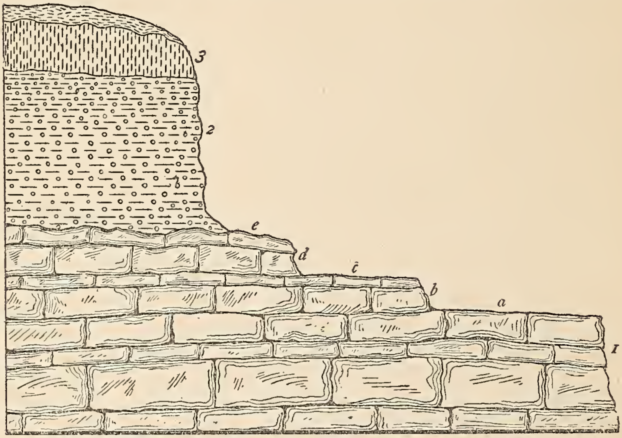
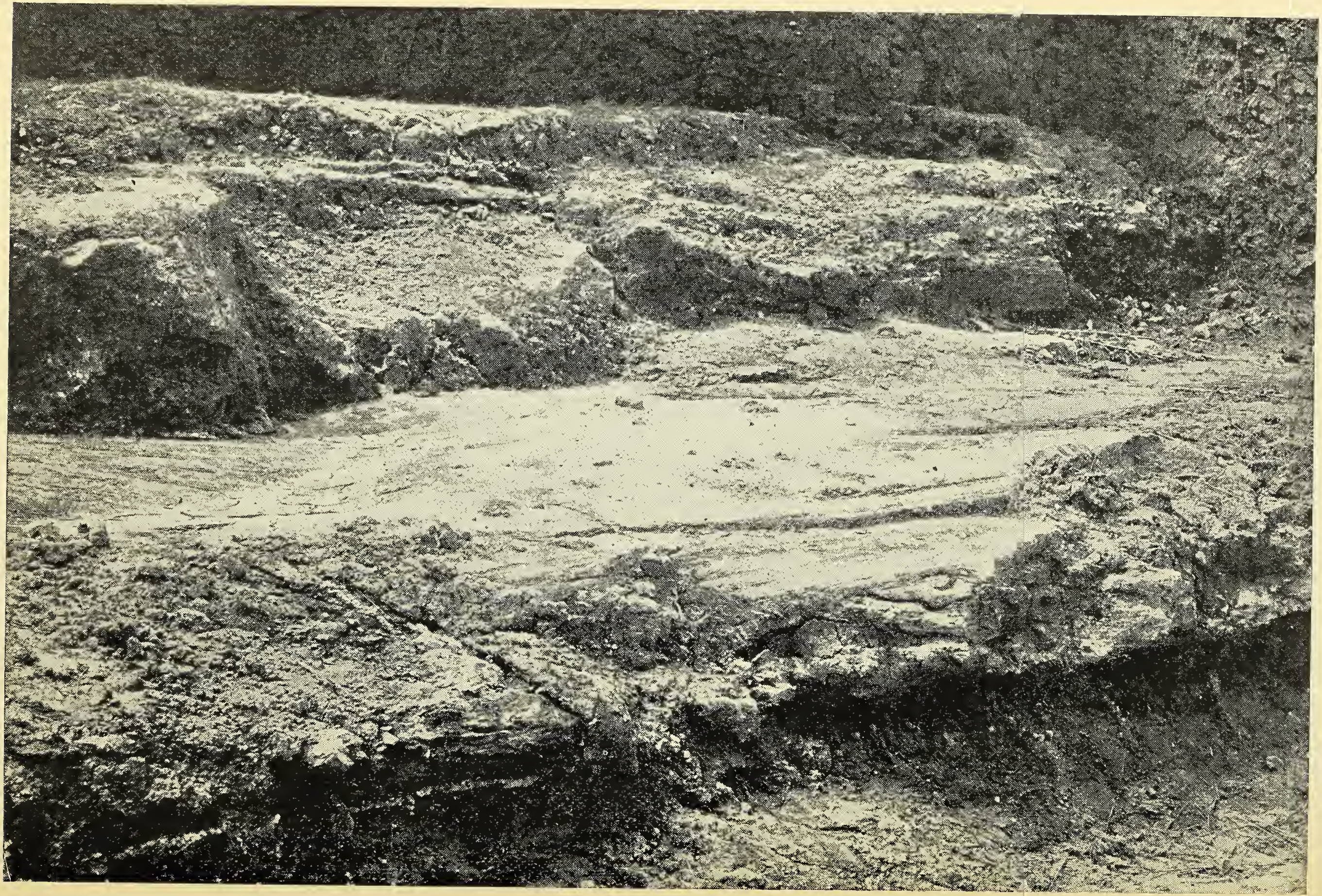


Figure 2. Section at Loftus quarry.

scratches, which were not parallel, but crossed one another at small angles. Where the angle of the bench had become much worn away it exhibited a tendency to grooving. The lateral surface also showed gouging where the rock was softer, while the floor surface did not. The direction of the striæ was south 75° east, which is also the trend of the bluff, which here borders the valley of a small stream. There was only one series of striæ, so the test of intersecting grooves cannot be applied to show in which direction the ice stream was moving. The lateral erosion indicates that the movement was towards the southeast; for, wherever a projection occurs, the shoulder toward the northwest is cut away to a much greater degree than the one to the southeast.

Recently three other areas of glacial scoring have been located. Two of these are in the vicinity of Starrs Cave, four miles northwest of Burlington. They are at the very summit of a projecting mural escarpment, 100 feet above the bed of Flint creek. They are not more than forty rods apart, yet one shows a direction of south 33° east and the other south 73° east. These



LATERAL ICE EROSION AT LOFTUS QUARRY.

angles were taken with a compass and corrected 7° for deviation. The trend of the bluff is in a curve, which, together with the difference in angle, brings the first mentioned scratches parallel, and the latter at right angles to the escarpment. The two surfaces are on about the same level. They are somewhat weather-worn, so that all the fine striations are gone; but the larger grooves show very distinctly. The locality is about two miles from the bluff bordering the Mississippi flood plain.

The other place is about half a mile distant from the one previously described from near Kingston. To distinguish between them, they have been designated as Kingston No. 1 and Kingston No. 2. This later discovery is on the brow of the bluff, and extends from the top some distance down the face. The bluff is rounded off, and descends at an angle of about 30°. It has no covering of loess, or drift and is but scantily concealed by occasional patches of soil. The scorings range over a considerable area, not continuously, but in numerous places. No fine striations show, for the rock is much weather-worn; but the larger grooves are very plain and distinct. These appear at intervals from the summit of the bluff some distance down the face. The direction was not taken with a compass, but is approximately south 70° to 75° east, which corresponds to the latest series of Kingston No. 1. The scorings at this place would seem to bring additional evidence that the ice movement was eastward. The bluff faces east and rises at an angle of about 30°; and while it is conceded that a glacier may move up a moderate incline, yet it is doubtful if there would be motion on the under surface, where the rise is as much as above given.

As already stated, there have been several well-authenticated discoveries of glacial scorings within the city of Burlington. The finds have always been on the verge of the escarpment crowning the North Hill bluff. Exposures at this place are not likely to remain any length of time, for, either the loess slides down and covers them, or else a portion of the ledge breaks away. Recently a very careful investigation of the bluff was made from the north end of the city to a distance three miles below, and the only piece of rock scoring found was on a detached block which had been previously pointed out by Mr. Frank Leverett, who reported that he had seen it in place not more than three or four years ago.

OPINIONS CONCERNING THE AGE OF THE SIOUX QUARTZITE.

BY CHARLES ROLLIN KEYES.

[Abstract.]

The Sioux quartzite is a formation made up of hard, flinty beds, of considerable thickness and extent, which are exposed principally along the Sioux river, in southeastern Dakota, southwestern Minnesota and northwestern Iowa. It is of particular interest to Iowans, for the reason it has been usually regarded as the most ancient geological formation occurring within the limits of the state—older than the lead-bearing rocks of northeastern Iowa, and older than the Cambrian sandstones which lie at the base of the Mississippi bluffs in the extreme corner of the state.

While most writers on the subject have agreed in assigning the Sioux quartzite a pre-Cambrian age, the evidence for so doing has usually been far from conclusive. The chief reason for giving this formation an antiquity greater than any other stratified rocks in this region has been the apparently thoroughly metamorphic character of the beds and their resemblance to the Baraboo and other quartzites of Wisconsin and Minnesota whose pre-Cambrian age is well known. But this in itself is far from positive proof, for Professor Calvin has lately found an extensive series of quartzites near the base of the Cretaceous, farther westward in the Black Hills region, and in all respects identical with the Sioux rock.

Although the Sioux quartzite has received considerable attention from time to time, the observations for the most partuntil recently have been somewhat cursory; incidental to other investigations rather than special examinations.

Among the earliest published accounts of the red quartzite area of the Big Sioux region is that of Catlin,* the well-known painter of Indian portraits. Although this traveler was not the first white person to visit the region, he was the first to give a

* Am. Jour. Sci., (1), Vol. XXXVIII, p. 18. 1837.

succinct description that is of interest geologically. Catlin was especially desirous of visiting the famous red pipestone quarry from which the various tribes of Indians had from time immemorial obtained material for their calumets. His account, therefore, centers around the layers yielding pipestone rather than the formations enclosing it. Incidentally, however, the characters of the red quartzite are well described. The stone from which the pipes are made is shown to be a sedimentary deposit. The specimens of this rock carried away were examined both mineralogically and chemically by Dr. C. T. Jackson, of Boston, who called it catlinite, after the explorer.

Half a decade later, Nicollet* published an account of his geographic explorations in the upper Mississippi region, and among the numerous descriptions of the geology of the region he calls special attention to the red pipestone locality. The appearance and relation of the rock in the vicinity and the lithological characters are minutely described. The names or initials of the members of the expedition cut in the quartzite, and still visible, show that the party visited the place in July, 1838.

In 1865, James Hall† visited southwestern Minnesota, making numerous geological observations throughout the region. Although visiting only a part of the quartzite outcrops, he came to the conclusion that the rocks were Huronian in age. This appears to be the first attempt to associate a definite geological age with the formation under consideration.

The following year Hayden‡ passed through southeastern Dakota, stopping at a number of quartzite outcrops, which were carefully examined. At Fort James, on the James river, it was noted that marls containing well preserved Cretaceous fossils directly overlie the quartzite beds. Exposures of the red quartzite were also found on the Vermillion river and on the Big Sioux at Sioux Falls and elsewhere. At the latter place Hayden believed that he found distinct outlines of bivalve shells in the quartzite. This writer also visited the pipestone quarry, which he describes with considerable detail. His remarks bearing especially upon the age of the rocks in question are as follows:

"Now the question arises as to the age of the rocks we have attempted to describe and which include the pipestone layer. Owing to the absence of well defined organic remains the problem becomes a difficult one. Their exceedingly close-grained, compact, apparently metamorphic character

*Report Intended to Illustrate a Map of the Hydrographic Basin of the Upper Mississippi River, Sen. Doc. No. 237, 26th Cong., 2d Sess., Vol. V, part 2. Washington, 1841.

†Trans. Am. Philosophical Soc., Vol. II, p. 15. Philadelphia, 1867.

‡Am. Jour. Sci., (2), Vol. XXXXIII, pp. 15-22. 1867.

would direct one's attention to the older rocks, perhaps some members of the Azoic series; but if the impressions seen at Sioux Falls are those of bivalve shells, we must look higher in the scale. But in order that we may arrive at an approximate conclusion, let us look at the geology of the surrounding country.

We already know that the limestones of the upper Coal Measures are exposed at Omaha City, and continue up the Missouri river to a point near De Soto, almost twenty miles farther, where they pass from view beneath the bed of the river. Overlying them is a coarse sandstone composed of an aggregation of particles of quartz cemented with the peroxide of iron. This assumes every color from a deep dull red to a nearly white. The layers of deposition are very much inclined and distorted. Near Blackbird hill numerous dicotyledonous leaves have been found, and many of these plants occur in a quartzite so close-grained that the lines of stratification are nearly or quite obliterated, yet the impressions are distinct. The quartzite forms a valuable quarry near Sioux City. The coal included in this formation (Lower Cretaceous No. 1, Dakota Group) crops out forty miles up the Big Sioux, or within sixty miles of Sioux Falls. Between Sioux City and Yankton we have at least three members of the Cretaceous series. Near Fort James we find that two members of the Cretaceous series (Nos. 2 and 3, Benton and Niobrara) rest upon the quartzites. The surface features of the whole country, with the soil and drift, indicate that the immediate underlying rocks are of Cretaceous age. Is it not impossible, therefore, that the quartzites that include the pipestone bed belong to the supra-Carboniferous, Triassic perhaps, or even to an extension downward of Cretaceous No. 1 (Dakota Group)?"

In the following year White* gave an account of a visit to the pipestone quarries, having traveled up the Big Sioux river from Sioux City. He called attention to a number of exposures of the quartzite in Iowa and Dakota.

The next year, in his report† on the Geology of Iowa, the same writer described at length the quartzitic formation of the northwestern part of the state, which he called the Sioux quartzite, referring it definitely to the Huronian. This is the first instance of giving the formation a distinct geological name by which it might be known.

In the brief description of the geological features of Osceola and Lyon counties, White‡ made several references to the exposures of quartzite in the extreme northwestern corner of the latter county.

In 1871 Kloos§ published some geological observations made in Minnesota, together with a geological map of the crystalline rocks of the state. He called and mapped the quartzite of southwestern Minnesota, Huronian.

*Am. Naturalist, Vol. II, pp. 644-653. Salem, 1869.
†Geology Iowa, Vol. I, pp. 167-171. Des Moines, 1870.
‡Geology Iowa, Vol. II, pp. 227, 228. Des Moines, 1870.
§Zeitsch. Deut. geol. Gesell. XXIII Band., p. 471. 1871.

In 1873 appeared the First Annual Report of the Minnesota Geological Survey, in which the quartzites of the southwestern part of the state are referred by Winchell* to the Potsdam of New York. The same author† described the celebrated pipestone quarry and neighboring localities in southwestern Minnesota in connection with a preliminary account of the geology of Pipestone and Rock counties.

Irving and Van Hise,‡ in a paper "On the Secondary Enlargement of Mineral Fragments in Certain Rocks," referred to a thin slice of the Sioux quartzite showing the quartz grains enlarged by the addition of secondary silicious matter. The quartzite rock is said to be closely interstratified with sandstone. It is referred to the Huronian.

In the first volume of the final report of the Geological Survey of Minnesota, Winchell§ gave a full description of the pipestone quarry and the exposures of quartzite in Rock and Pipestone counties. Here again the red quartzite is regarded as "probably equivalent to the New York Potsdam sandstone." The account published is perhaps the fullest ever given in regard to the formation as represented in the southwestern portion of that state.

The following year the same writer‖ claimed certain impressions in the pipestone of southwestern Minnesota to be of organic origin. A trilobite and brachipod are described and figured as new species. Since that time, however, considerable doubt has been raised as to whether or not these so-called fossils are really organic remains at all, and it has come to be believed generally that they are not.

In the same report Upham¶ published some notes on the geology of southeastern Dakota, in which the remarks on the quartzite are of importance. A number of localities are noted and its age referred to as Potsdam.

About the same time Irving** issued his preliminary investigations of the Archæan formations of the northwestern states. The Sioux quartzite is minutely described as regards its lithological characters. Its thickness is thought to be from 3,000 to 4,000 feet. The character of the juncture with the Cretaceous

* Geol. and Nat. Hist. Sur. Minnesota, First Ann. Rep., p 69. Minneapolis, 1873.
† Geol. and Nat. Hist. Sur. Minnesota, Sixth Ann. Rep., pp. 97–104. Minneapolis, 1878.
‡ U. S. Geol. Sur., Bul. No. 8. Washington, 1884.
§ Geol. and Nat. Hist. Sur. Minnesota, Vol. I, pp. 537-543. Minneapolis, 1884.
‖ Geol. and Nat. Hist. Sur. Minnesota, Thirteenth Ann. Rep., pp. 65–92. Minneapolis, 1885.
¶ Geol. and Nat. Hist. Sur. Minnesota, Thirteenth Ann. Rep., pp. 88-97. Minneapolis, 1885.
** U. S. Geol. Sur., Fifth Ann. Rep., pp. 199–202. Washington, 1885.

is considered as opposed to the idea that the formation is of that age; and it is referred to the Huronian.

Recently Culver§ reported the discovery of a large trap-like dike in the midst of the Sioux quartzite in Brandon township, Minnehaha county, South Dakota. Thin sections were examined by Hobbs‖ and pronounced to be a well-defined olivine bearing diabase.

A few months later, in a summary of what is known of the geological formations of Iowa¶, attention was called to the finding of quartz-porphyry in the sinking of deep wells in the northwestern part of the state as indicating very old eruptive rocks at no very great distance beneath the present surface. In bringing together the various views regarding the age of the Sioux formation, it was shown that the consensus of opinion led to the inference that it was pre-Cambrian.

Subsequently* the existence of eruptive rocks in the quartzite area was discussed at length and the conclusions reached by others in regard to geological age stated.

Since the remarks last mentioned were published the Sioux quartzite has been visited personally and many of the principal outcrops carefully examined.

Without going into details of the various observations, it may be stated that impressions were seen at several points in the bedding planes of the quartzite which resembled so much those of lamellibranchs of the Cardium and Cytherea types that it must be confessed that notwithstanding strong preconceived notions regarding the great antiquity of the Sioux rock, faith in its very old age was considerably shaken. The impressions were in such large slabs of quartzite that it was impossible at the time to obtain more than a single imperfect one; it was the intention to revisit the region and search carefully for additional and better material, but the opportunity did not again present itself. Hayden's reference to abundant casts in the argillaceous portion of the formation in another part of the region was recalled. Regarding the age of the Sioux formation, it may be said that while it should be considered as pre-Cambrian age—until indisputable evidence is produced to the contrary—there exists now a certain element of doubt concerning the accuracy of this view.

§ Trans. Wis. Acad. Sci., Vol. VIII, p. 208. Madison, 1891.

‖ Ibid.

¶ Keyes: Iowa Geol. Sur., Vol. I, pp. 15-19. Des Moines, 1892.

* Keyes: Proc. Iowa Acad. Sci., Vol. I, part 3, p. 21. Des Moines, 1893.

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