PROCEEDINGS

OF THE

IOWA ACADEMY

OF

SCIENCES

FOR

1887, 1888, 1889.

TOGETHER WITH THE CONSTITUTION, LISTS OF OFFICERS AND MEMBERS

EDITED BY THE SECRETARY.

DES MOINES, IOWA:
January, 1890.

OFFICERS OF THE ACADEMY.

1887-1888.

President—PROF. HERBERT OSBORN.
First Vice President—PROF. J. E. TODD.
Second Vice President—PROF. T. H. McBRIDE.
Secretary-Treasurer—PROF. R. E. CALL.

Executive Council consisted of these Officers and the following persons:

PROF. H. W. PARKER,
PROF. F. M. WITTER.

1888-1889.

President—PROF. J. E. TODD.
First Vice President—PROF. F. M. WITTER.
Second Vice President—PROF. B. D. HALSTED.
Secretary-Treasurer—PROF. R. E. CALL.

The Executive Council remained unchanged.

1889-1890.

President—PROF. F. M. WITTER.
First Vice President—PROF. C. C. NUTTING.
Second Vice President—PROF. C. P. GILLETTE.
Secretary-Treasurer—PROF. R. E. CALL.

The Executive Council was increased by the addition of

PROF. C. C. NUTTING.
PROF. C. P. GILLETTE.

E. E. ADAMS, PR., DES MOINES, IOWA.

FELLOWS OF THE ACADEMY.

PROF. B. D. HALSTED (I).
PROF. F. M. WITTER (I).
PROF. H. W. PARKER (I).
PROF. R. E. CALL (I).
PROF. HERBERT OSBORN (I).
PROF. J. E. TODD (I).
DR. H. S. WILLIAMS (II).
PROF. A. A. CROZIER (II).
PROF. W. J. McGEE (II).
PROF. C. P. GILLETTE (II).
PROF. C. C. NUTTING (III).
PROF. ERASMUS HAWORTH (III).
PROF. SETH E. MEEK (III).
PROF. L. H. PAMMEL (III).
PROF. C. H. GORDON (III).
PROF. F. W. MALLY (III).
PROF. A. S. HITCHCOCK (III).

The numbers in parentheses indicate the annual meeting at which the Fellow was elected.

CONSTITUTION.

Section I. This organization shall be known as the Iowa Academy of Science.

Sec. II. The object of the Academy shall be the encouragement of scientific work in the State of Iowa.

Sec. III. The membership of the Academy shall consist of Fellows, who shall be elected from residents of the State of Iowa, actively engaged in scientific work. Nomination by the council and assent of three-fourths of the Fellows present at any annual meeting shall be necessary to election.

Sec. 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.

Sec. V. (*a.*) The officers of the Academy shall be a President, two Vice-Presidents and 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 of 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.

SEC. VI. The Academy shall hold an annual meeting in Des Moines, commencing Thursday of the week of the State Fair. Other meetings may be called by the Council at times and places deemed advisable.

SEC. VII. All papers presented shall be the result of original investigation, but the Council may arrange for public lectures or addresses upon scientific subjects.

SEC. VIII. The Secretary-Treasurer shall each year publish the proceedings of the Academy in pamphlet (octavo) form, giving authors' abstracts 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 use of the Academy.

SEC. 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.

HISTORICAL NOTE.

The Iowa Academy of Science was organized on Tuesday, December 27, 1887, in response to a circular letter sent out by a committee consisting of Professors S. Calvin, T. H. McBride, L. W. Andrews, Herbert Osborn and R. E. Call.

The following named persons took part in the organization proceedings which were conducted in the parlors of the Kirkwood House in Des Moines:

Professor J. E. Todd,
Professor B. D. Halsted,
Professor F. M. Witter,
Professor H. W. Parker,
Professor R. E. Call,
Professor L. W. Andrews,
Professor Herbert Osborn.

The organization was determined upon as being the only practical method by which the working scientists of the State could be brought into close association.

At this first meeting the usual business of organization was supplemented by the presentation of a few scientific papers which are, so far as those reading them have responded to the request of the Secretary to furnish abstracts, presented herewith. The chief business of the session was rather more for purposes of permanently establishing the society on a useful basis than for the presentation of discoveries made in the course of original investigation. The Academy wishes to be understood as fostering only original investigations, and only such as are capable of work of this sort are knowingly admitted to Fellowship.

PROCEEDINGS

OF THE

Iowa Academy of Sciences,

FOR

1887, 1888, 1889.

Papers Presented at the First Session.

The following papers were read but no abstract was furnished by their authors for publication:

"On a New Astatic Galvanometer with a Spiral Needle," and one on the "Volumetric Determination of Lead, Barium and Sulphuric Acid," both papers being by Dr. L. W. Andrews, of the Iowa State University.

"Artificial Propagation of the Pollen of Certain Grapes," by Professor B. D. Halsted, of the Iowa Agricultural College at Ames.

The following abstracts were prepared by the respective authors who are severally to be held responsible for the opinions expressed:

ANIMAL INTELLIGENCE.

BY PROFESSOR H. W. PARKER.

(*Abstract.*)

So far as evolution is concerned, it really matters little at what point intelligence appears.

Intelligence proper includes the reasoning power as its chief and distinguishing characteristic. Facts regarded as proving a degree of this power in animals were reviewed in detail, and shown to be susceptible of a lower interpretation in harmony with the general phenomena of animal life. Some observations by the speaker were mentioned as illustrating the great principal that underlies the quasi-intelligence of brutes — marvellous keenness of senses along with no less wonderful quickness and retentiveness of association.

This, without the disturbing influence of reason, renders Darwin's theory of the building up of instincts a possible and credible solution. Spencer is right in classing these with reflex actions and referring, for example, the pursuit and capture of prey to the direct action of visual sensation or motor impulses. No line can be drawn except that we usually confine the word reflex to involuntary acts that immediately concern the integrity of the organism. Perception may or may not be present in either case.

The analogy between human and brute acts, which is sometimes so striking outwardly, is not valid psychologically,

1. Because instinct is unquestionably the ruling fact in animals. Besides there may be many latent or occasional instincts, or these may be simply modified by the force of circumstances in the outworking.

2. The exceptionality of the quasi-intelligent acts break in upon the analogy: and it is met by another analogy in the purely accidental character of some of man's seemingly wise deeds.

3. The superhuman senses and sense-associations of animals weaken the analogy, while accounting for much quasi-intelligence.

4. With such extraordinary senses, the frequent and gross blunders of brutes in perception should not occur on the theory of reason.

5. Animals low in the scale, including three sub-kingdoms, are not claimed to be intelligent: yet their acts, as given on good authority, offer as striking instances of seeming wisdom as in many of the higher divisions.

6. The quasi-reasoning of brutes is confined to specific lines of subsistence and defense, just where we may suppose their organism is endowed with all the activities needed.

7. It does not observably progress in the individual for life or in the species for ages. Such instances as new places of nest-building and increased wariness, are not of progressive mind; and this is not sustained by the facts used in favor of improvement or instinct by intelligence.

8. Rational mind, as we know it, begins in helpless ignorance and slowly comes to its powers by long trial and training.

9. The theory of rationality in brutes involves too high processes of thought in the simplest examples given.

10. There is no evidence in animals of a language of concepts — the necessity and accompaniment of reason in man.

11. The entire psychology of man is inseparable from his self-consciousness; and of such consciousness, which is the only kind we can really conceive, there is no evidence in brutes.

12. The analogy fails in the physical basis. The brain of even the highest ape is no better than a microcephalous idiot, in its volume. Below vertebrates, nothing has yet been proven to be homologous with the cerebrum, not even in ants. The best authorities show that the invertebrate brain, so-called, is shaped by the senses. It is a sensori-motor apparatus.

ANIMAL ÆSTHETICS.

BY PROF. H. W. PARKER.

(*Read by Title.*)

This is a review of all the material facts bearing on the appreciation of beauty by animals below man. The conclusion was that no such appreciation has been proven, and that it is excluded by the only theory of beauty that satisfies all demands.

THE TERRACES OF THE MISSOURI.

BY PROF. J. E. TODD.

(Abstract.)

This paper presented the results of observations made by the author, under the direction of the United States Geological Survey. It treated especially of the portion of the river between the Great Bend and the mouth of the Platte.

Three groups of terraces were recognized, viz: the Silt terraces, the Lower Bouldery terraces and the Higher Bouldery terraces.

The first are less than twenty-five feet above low water, below the mouth of the Niobrara, and rise gradually northward to the height of about one hundred and thirty feet near the mouth of Crow Creek. The second also rise northward from about seventy feet at the mouth of the Platte, to three hundred feet above the Great Bend. The third, which corresponds to the upper limit of the drift, below the mouth of the Niobrara, at an altitude of four hundred and twenty-five to four hundred and fifty feet, is traceable at about the same elevation, nearly to the mouth of the White. Irregularities in the elevation and number of these terraces were referred to the influence of tributaries, and to frequent changes while the trough was being deepened.

All of them, especially the higher ones, are largely composed of Cretaceous rocks. Above these, in the Bouldery terraces, there is generally a thick stratum of reddish till sometimes slightly banded or stratified. This is covered with a stratum of gravel and boulders, and above this is a thick layer of yellow silt. The Loess of Eastern Nebraska seems to be the continuation of the silt layer of the upper Bouldery terrace.

The Silt terraces were referred to recent time; the Lower Bouldery, to the occupation of the Second Moraine by an ice-sheet; the Upper Bouldery terraces to a similar occupation of the First Moraine.

The trough of the Missouri has been formed since the advent of the Ice Age. Lake Cheyenne lingered till the waters from the great ice-sheet replenished it. Above Yankton the Missouri owes its present course, and possibly its existence, to the influence and interference of the ice-sheet. The distribution of pre-glacial lacustrine deposits, and the drift and loess, the character and height of the terraces the continued corrasion of the bottom of the trough to the present time, all sustain these conclusions.

THE ORIGIN OF THE EXTRA-MORAINIC TILL.

BY PROF. J. E. TODD.

(*Abstract.*)

This paper treated particularly of the morainic till of the Missouri Valley. To explain the origin of this till, there are two theories acceptable; one that it is sub-glacial, the other, that it was formed at the bottom of a glacial lake, gradually filling with debris brought from a glacier and the shore, by ice-rafts.

The sub-glacial theory is favored by (1) its close resemblance to till unquestionably sub-glacial. (2) striae on the underlying rocks, (3) the presence of osar-like ridges. (4) its difference from the reddish bouldery clay, often found above it, which is certainly of sub-aqueous origin, and (5) the thickening, and greater elevation of this till, near its outer margin, as along the east side of the Big Blue in Nebraska, suggesting an imperfect moraine.

Against these points, respectively, it was urged: (1) Close examination, not infrequently, reveals traces of stratification, by differences of color, and in the distribution of pebbles and boulders. (2) Striæ are the exception, even on similarly prominent surfaces. They, in some cases, show on the same surface directions diverging 60 degrees, and with equal freshness. Their direction sometimes does not harmonize with their glacial origin. (3) The osar-like ridges are sometimes found on the outer slope of the outer moraine, and so related to channels across it as to indicate their contemporaneous or subsequent formation, and therefore cannot furnish evidence for an ice-sheet, which must have long antedated the moraine. (4) Notwithstanding the differences between the till and red clay, the former has been found to sometimes to pass gradually into the latter, and thick strata of the latter often present the same features and structure as the former. Therefore the relation of these formations to each other seems to favor sub-aqueous deposition of the former, rather than otherwise. (5) The thickened and elevated till does not exhibit the knob-and-basin structure common in moraines, and may be rationally referred to debris accumulated by bergs stranding on a shelving shore.

After replying thus to the arguments for the first theory, the following points were urged in favor of the second, or glacio-natant hypothesis:

1. Moraines and traces of ancient drainage channels found attending areas, which have been certainly glaciated, are not found attending the drift under consideration.

2. The rare and slight disturbance of underlying formations forbids the idea that the region has been occupied by an ice-sheet.

3. The slight proportion of local material, in the extra-morainic drift, indicates the same.

4. The evident former horizontality of the western margin of the drift, and the absence of drift at a higher elevation anywhere outside of the principal moraine.

5. The difficulty of conceiving an extension of an ice-sheet over the extra-morainic till, without violating well recognized conditions of glacial motion.

6. The filling of Lakes Agassiz, Minnesota and Dakota, with till to a considerable extent, argues strongly by analogy that Lake Missouri may have been similarly filled.

7. The correspondence of the upper limit of the drift in Nebraska to the upper bouldery terrace of the Missouri above

the mouth of the Niobrara, indicates that the drift mentioned was deposited under water.

8. The relation of the till to certain deposits of volcanic ashes which in some cases are below the drift, and in other localities are in it and above the till, suggests a possible demonstration of the sub-aqueous origin of the till under consideration. This ash deposit was made in still water. If there was but one deposition of volcanic ashes (and there is no proof yet known that such was not the fact), the evidence would be complete.

DIRECTIVE COLORATION IN ANIMALS.

BY PROF. J. E. TODD.

(*Abstract.*)

The paper was the outgrowth of observations made on the Western plains. It is published in full in the *American Naturalist* for 1888.

While recognizing the validity of protective, ornamental and typical coloration, as defined by Darwin, Wallace, Belt and others, the writer claimed that a very considerable amount of coloration in animals remained unexplained. For such as are of service somewhat after the manner of distinctive badges and uniforms to troops, or as signal flags and lights to boats and cars, he proposed the name *directive* coloration.

The following synopsis presents the principal features and applications of the principle.

Directive coloration is that which is in any way useful to a species by assisting in mutual recognition between individuals, or by indicating one to another their attitude and probable movements. To this head are referred:

1. Marks and tints promoting recognition at a distance, to guide in straggling flights, or to bring stragglers together, [A].

2. Those indicating the attitude of body, and its probable movement. [B] in darkness; [C] in close movements of

large numbers, in light as well as in darkness: [D] in sexual intercourse: [E] in the care of young.

A. [*a*] By general color contrasted with the environment: crows, blue birds, etc.

[*b*] By striking colors, which may be hidden when at rest, but automatically shown either during flight, at the moment of stopping, or during a calling cry, viz:

* About the tail, most mammals and birds which are protectively colored.

** About lateral appendages: ears in mammals, wings, in birds.

B. [*a*] By striking marks about the head and neck: raccoon, badger, etc., finches, etc., etc.

[*b*] By various spots and lines, on shoulders and sides: skunks, etc.

[*c*] By paleness of belly and inner sides of legs.

C. [*a*] Not only by marks already mentioned, but especially by vivid and extensive markings on shoulders, sides or flanks; zebra, etc.

[*b*] By special marks on feet and legs.

D. [*a*] By many of the lateral and caudal markings already mentioned.

[*b*] By different colors according to sex; night-hawks, etc., etc.

[*c*] By difference in extent or shape of markings according to sex: antelope, etc.

E. By various spots or lines appearing only in the young stages; deer, some *Suidæ*, and some *Felidæ*.

SOME FERNS OF THE OZARK REGION OF MISSOURI.

BY PROFESSOR R. ELLSWORTH CALL.

(*Abstract.*)

This paper lists with certain remarks on habitat and geographical distribution, the species of *Filices* incidentally collected during a two months exploration of Shannon, Reynolds and Texas counties, Missouri. The species collected and represented by specimens exhibited with the paper are the following: *Pteris aquilina* Linn. abundant; *Phegopteris* *hexagonoptera* Fee, rare; *Aspidium achrosticoides* Swz., among the specimens exhibited are many with bifurcated rachis or bifurcated pinnæ or pinnules; *Camptosorus rhizophyllus* Link, abundant on limestone cliffs; *Asplenium trichomanes* Linn.; common *Asplenium ebeneum* Aiton, somewhat rare; *Asplenium ruta muraria* Linn., rare; *Asplenium bradleyi* Eaton, occurred but once and then in some abundance on lime-stone rocks in Texas county; *Asplenium parvulum* rare; *Pellæa atropurpurea* Link, abundant; *Polypodium vulgare* Linn., not very abundant; *Polypodium incanum* Swz., very abundant in numerous localities; *Onoclea sensibilis* Linn., occurred but once in Shannon county, in a marsh-like area high up in the mountains; *Cheilanthes lanuginosa* Nutt., very abundant on limestone cliffs in dry situations and very large, occasionally; in some localities the rocks were entirely carpeted with this form; *Adiantum pedatum* Linn., occurred only in very damp situations and then was not common; *Adiantum capillus-veneris* Linn., occurred only once to us and then on limestone cliffs overhanging the Currant river, close to the water; *Woodsia obtusa* Torrey, abundant at one locality in Dent county, close to Shannon county; *Botrychium virgianum* Swz., rare; *Osmunda regalis* Linn., occurred once in a marshy area high up in the mountains; *Cystopteris fragilis* Bernh., abundant; *Cystopteris bulbifera* Bernh., abundant. The collection includes in all fourteen genera and twenty-one species. It is presented not as an illustration of the full fern flora, but as a contribution to a better knowledge of a little known area.

NOTES ON THE GROSS ANATOMY OF CAMPELOMA.

BY PROF. R. ELLSWORTH CALL.

(*Abstract.*)

This paper gave the results of certain studies made on abundant specimens of *Campeloma subsolidum*, completing certain details in the anatomy of the genus. Observations were made to determine whether there were any facts in the external anatomy that could be utilized in the determination of sex. This question was answered in the affirmative. The gross anatomy of the reproductive organs was then discussed and illustrations of the various parts were exhibited. Notes on fecundity were also submitted. The entire paper was published in the *American Naturalist*, Vol. XXII, pp. 491–497, in June, 1888.

ON A NEW FOSSIL LIMNÆID FROM THE POST-PLEIOCENE OF CALIFORNIA.

BY PROF. R. ELLSWORTH CALL.

Abstract.

This paper described as new to science, a fossil shell found in the post-pleiocene deposits of the Tassajara Hills, and now deposited in the collections of the University of California. It belongs to that sub-group of limnæid mollusks which is typified by the genus *Pompholyx*, but differs therefrom in some important particulars. It is made the type of a new genus and species, being described under the name of *Pompholopsis whitei*. The paper may be found in full in *The American Geologist*, for March, 1888, Vol. I, No. 3.

NOTES ON SOME SHELLS, FERNS, ETC.,

Collected in Decatur County, Iowa, and Lyon County, Kansas, in the Summer of 1886.

BY PROF. F. M. WITTER.

Abstract.

Grand River, Long Creek and the Little Rivers yielded almost no water mollusks.

Four examples of *Unio schoolcraftii* Lea, one *U. levissimus* Lea, and one *Helix clausa* Say. Of the Ferns the following were observed: *Osmunda claytoniana*, *Botrychium virginicum*, *Adiantum pedatum*, *Cystopteris fragilis*, *Asplenium felix-fœmina* and *Onoclea sensibilis*.

In Kansas, at Topeka, an abundance of *Physa* and *Planorbis* were seen along the river in a pond.

At Emporia in the Neosha, in an hour, the following were taken; 32 *Unio undulatus* Barnes, 21 *U. gibbosus* Barnes, 7 of which had white nacre, 11 *U. rubiginosus* Lea, 5 *U. schoolcraftii* Lea, 4 each of *occidens* Lea, *anodontoides* Lea, *lachrymosus* Lea, and *coccineus* Hild., 3 *purpuratus* Lam., 2 each of *subrostatus* Say, *tuberculatus* Barnes and *ligamentinus* Lam., 12 *Marg. complanata* Barnes. 1 *rugosa*, Barnes, and 1 *Ano. bealei*, Lea, in all, 108 specimens. In Allen Creek, near by, were found *Unio camptodon* Say, *subrostratus* Say, *Unio parvus* Barnes, *undulatus* Barnes, *Marg. complanata* Bar., *Ano. bealei* Lea, *Planorbis trivolvis* Say, *bicarinatus* Say, *Physa anatina* Lea, *Ancylus tardus* Say, *Sph. stamineum*, Con, *transversum* Say, *Succinea ovalis* Gould, and the curious little mimic insect *Helicopsyche arenifera*.

Unio camptodon (12 specimens) were found to be alive after remaining out of water, in a very dry place, from July 22d till August 29th, 1886. They were kept alive at Muscatine in a tub of water till about the 1st of January, 1887.

PROCEEDINGS

OF THE

Iowa Academy of Sciences,

FOR

1888.

The annual session for 1888 convened in the Hall of the Young Men's Christian Association, Des Moines, Iowa, on September 5th, with a full attendance of the recognized membership present. After the formal induction into the office of president of the president-elect, Prof. Herbert Osborn, of the Iowa Agricultural College, the Academy listened to the following annual address:

LOCAL PROBLEMS IN SCIENCE.

BY PRESIDENT HERBERT OSBORN.

It may be said, with truth, that science knows no boundaries of geography, politics, sect or race. That if there is to her credit, any characteristic of permanence, it is that of universality. But admitting this cosmopolitan, universal characteristic, we may agree that in every country, State and community, there are scientific questions of special local importance and interest, questions which, while entering into the science of the world, having their relationship of dependence upon, and of support to, allied questions the world over, are still so local in their nature that only local interest is the warrant for their special investigation.

I deem it unnecessary therefore to offer any apology for asking your attention to a brief outline of certain scientific problems whose solution has special relation to the State of Iowa.

My paper naturally assumes the form of a brief review of the scientific work in the State, the progress that has been made in certain lines and the hasty mention of such as force themselves on your attention for the future.

The prosecution of scientific investigation in the State has not, as a rule, been assisted by organized societies or institutions to the extent seen in sister States, but such as have existed should, perhaps, receive first mention.

The first of such organizations to operate in the State was a government exploring party and scientific work apparently began when Thomas Say, as a member of Long's expedition to the Northwest Territory in 1819-20, collected and subsequently described many forms of life occurring in the State. His descriptions are to be found in the reports of the expedition and in the publications of the Philadelphia Academy.

The geological survey of Wisconsin, Iowa and Minnesota in 1848-52 appears to have been the first careful investigation into the geological formations of the State, followed, shortly after, in 1855-9, by the first State geological survey under Professor James Hall.

The second State geological survey was organized in the spring of 1866 and placed in charge of Dr. C. A. White. This survey was continued till 1869 and reports printed in 1870.

The Davenport Academy of Natural Sciences was organized in 1867 and has since 1876 published proceedings which contain many valuable papers upon the geology, natural history, etc, of the State of Iowa, more especially the portion adjacent to Davenport.

The Iowa Academy of Sciences, the only State Society, previous to our own, devoted strictly to the sciences and embracing especially the scientific problems of the State, was organ_ ized in 1875, and after having been the means of encouraging investigation in many portions of the State unfortunately died in 1884. Its brief published record of proceedings contains titles and abstracts of many valuable papers, many of which were published in full in various scientific journals.

Other scientific organizations have existed here and there over the State, but none publish regular proceedings and it is difficult to arrive at any opinion as to the extent or character of their work.

Mention should be made, however, of the Iowa Assembly of the Agassiz Association, which is one of the most prosperous in the country, and from which we look for devoted scientific workers in the immediate future.

In the transactions of the Iowa State Horticultural Society and the State Agricultural Society there may be found occasional papers upon the botany, ornithology, entomology and geology of the State. Most of these were prepared with special reference to their relations to horticulture and agriculture, but many contain contributions to the scientific literature of the State not elsewhere accessible.

In the biennial reports and the bulletins of the Iowa Agricultural College may be found papers on the meteorology and natural history of the State.

The State Weather Service, organized as a volunteer service by Dr. G. Hinrichs in 1875, has since 1878 received financial assistance from the State and the published reports of the service contain records of observation at many stations throughout the State.

These have been the principal channels of publication for essentially local scientific contributions and almost the only ones not dependent upon individual enterprise.

Students of anthropology have found in Iowa some extremely interesting fields for study, and the work in this branch which has centered mainly in the Davenport Academy has resulted in bringing to light many valuable facts. Some of the discoveries there made have been of so great importance in affecting the views of leading anthropologists as to have been the source of severe contention. There still exists an opportunity in the Indian tribes on the reservation in Tama County to study some of the details of Indian life, but I am not aware that the opportunity has been improved by any Iowa anthropologist. Possibly these Indians have mingled too much with civilization around them to furnish much of value concerning their former mode of life, and it may be that the tribes are already too well known to need further study.

The great advance made of late years in all studies pertaining to the past inhabitants of this continent render the further investigation of prehistoric remains in this State not only more interesting and significant, but must render the prosecution of such work and the interpretation of results more easy, certain and reliable.

The desire to know all we can of the past inhabitants of the soil we occupy has in it more than idle curiosity. The fact that nations were born, developed to their fullest powers, grew old and died, and were replaced by others to follow the same cycle on this the soil where we have established in their place a higher civilization, should lead us to look well to all weak points in our social and political structure. The history of the Aborigines of America may have its place in our education as well as the histories of the dynasties of the Old World.

In the line of zoology, while there has never been official support or workers numerous, such progress has been made as may furnish ready foundation for the work of coming students. As elsewhere, and from the nature of the case, more is known of the local *fauna* in our State among the vertebrates than in the lower groups of animals. The mammals much the same as those of the adjoining States, but occupying the border land between the valley and the plain their distribution presents many interesting questions. The species now extinct or doomed to extinction by the invading presence of man have need of an historian, and his work can not be begun too soon.

The first attention given to the birds of the State was probably about the year 1820, by Thomas Say, though to what extent his collections were made strictly within our borders it is difficult to determine. Doubtless the famous Audubon in his many travels through the Mississippi Valley touched more than once upon our soil, and collected here some of the material for his famous drawings and descriptions. I do not recall, however, his statement of any localities now recognizable as within the State.

In 1868 Prof. J. A. Allen[1] published notes on Iowa birds, giving a list of many species occurring in the State. To this list Prof. H. W. Parker, of Iowa College at Grinnell, made a considerable addition in a note in the American Naturalist,[2] entitled, "Iowa Birds"; and in the report of the State geological survey under Dr. White, Prof. Allen presents a much more complete catalogue. Recently, Dr. H. S. Williams and Mr. C. R. Keyes have conjointly made an exhaustive study of the State bird *fauna*, and it is probable that but few species remain to be added to their catalogue.

Prof. F. E. L. Beal, Charles Aldrich, Prof. H. W. Parker, Mr. F. M. Tripp and others have contributed to our knowledge of local bird *fauna* within the State, breeding habits, migration, etc.

While little may be left to do upon the *avian fauna* of the State at large, much may be done concerning local distribution as to valley, hill, forest or prairie, breeding grounds and time of appearance and disappearance of migatory spe-

1—Mem. Bost. Soc. Nat. Hist. Vol. I, p. IV.
2—American Naturalist, Vol. V., p. 1[illegible].

cies. Especially is there the question so absorbing both economically and scientifically, as to their food, habits and the precise relation of each species to other branches of the organic world, all of which vary more or less with locality, and hence demand study in all parts of the State. The new division of ornithology and mammalogy in the United States Department of Agriculture furnishes opportunity for any disposed to assist in these problems to render contributions which may have far more than local value. Isolated observations, published in connection with many others on the same subject from different localities, become of far greater significance and value.

I am not aware of any record of the reptiles, batrachians or fishes, which pretends to represent the *fauna* of the State in these classes, and in the latter classes especially there is opportunity for rich returning to the investigator. A beginning has been made by Profs. Jordan and Meek who, a few years since, collected in some of the streams of Southern Iowa and published a list of species collected in Iowa, in the Proceedings of the National Museum. The economic aspects of the fishes are probably not fully appreciated by the people of the State, but are recognized to the extent of an official fish commissioner. A better knowledge of the breeding habits and food supply and enemies of the food fishes common to our streams and lakes would doubtless be of great advantage in assisting their multiplication, and alongside of attempts to introduce food fishes from abroad (and it seems to me more important than them) there should be an intelligent effort to further theproduction of the best species native to the State.

Of the invertebrates, no group can equal the insects, both in scientific and economic importance. Contributions in this branch have been made by Hoffmeister, Parker, Bessey, Putnam, Witter, Walton and the writer, with others whose names not now in mind may deserve equal mention.

Much of the work done has very naturally been upon the life histories of species, and frequently with reference to the vast economic relations they assume. While there is much of complexity in their study, and the beginner soon becomes appalled at the multiplicity of forms observed in his own locality, there is much to whet his interest and repay his efforts in study. Collections are easily made, and with a little attention to important details for their preservation might form useful and permanent adjuncts to education in every school district.

No faunal list in this group approximating completeness has been published, and for the present is out of the question.

Prof. C. E. Bessey published a preliminary list of the *Orthoptera* of Iowa in 1877.[3] Mr. J. Duncan Putnam published lists of the *Lepidoptera* and *Coleoptera* for Davenport, and also lists of *Coleoptera* collected at Monticello and Frederick.[4] Miss Alice Walton has given a lists of *Lepidoptera* for Muscatine[4] including mostly *Macro-lepidoptera*.[5] The writer has presented lists of *Rhopalocera Sphingidae* and *Odonata* for the central part of the State to the Iowa Academy of Sciences, and at the last meeting of this association a preliminary list of the *Hemiptera* of the State. Also in connection with Mr. H. F. Wickham, of Iowa City, the fragment of a catalogue of the *Coleoptera* of the State.

Entomologically we occupy interesting territory, since in our fauna we have a mingling not of eastern with western forms, but of southern and northern. Many southern species find their northern limit within the borders of the State, and similarly northern species reach their southern boundary here. Moreover, we have frequent evidence of the partial innovation of southern forms—species which, apparently, reaching us as stragglers are able some seasons to fix them-

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3—Seventh Biennial Report of the Iowa Agricultural College, 1877, p. 205-10.
4—Proc. Dav. Acad. Nat. Sci., Vol I, 1876, p. 169-177.
5—Proc. Dav. Acad. Nat. Sci., Vol. II, p. 141-?.

selves and for a few generations, at least, to live and multiply.

Aside from the questions of native species and of the distribution in the State, there is work for any number of investigators upon the life-histories and habits of our native insects. There are hundreds, nay, I doubt not, thousands of insects, native to the State, concerning whose life history we know the merest fragment or nothing whatsoever. Of those which have been studied the ones best known seem to present the greatest number of problems open for further study.

In the *Crustacea* we have a wealth of material which no Iowan has as yet seen fit to mine. While doubtless our *fauna* agrees closely with that of Illinois or Minnesota, where this group has been studied more thoroughly, it would be both interesting and useful for some student to give the group his attention so far as to determine to what extent they are identical.

The *mollusks* of the State are receiving the attention of our worthy secretary, Prof. R. E. Call, and have been studied also by Profs. Pratt, Witter, Pilsbry, Shimek and others. We have as yet no complete faunal list, though the list by Prof. Pratt[6] and Prof. Call[7] given for certain localities cover pretty well the fauna of the State in the groups treated.

The economic relations they bear to aquatic life and to higher animals as the intermediate hosts for numerous parasites renders them important objects to study.

Of worms we know comparatively little. A few parasitic species and the universal earth worm (which means several genera and species) have been studied, but much remains to be done. Darwin (in his admirable memoir on the Earth-worm) has shown us plainly the great importance of this apparently insignificant animal, and other forms await

6—Proc. Dav. Acad. Nat. Sci., Vol. I., p. 165-67.
7—Bull. Des Moines Sci., Vol. I., No. 1, p. 5-67.

future Darwins to show their relations to the economy of nature.

Our streams, ponds, ditches and swamps, like those of other States, swarm with the minute forms of life whose size renders them unnoticed, but whose existence is as full of incident as that of higher forms. I know of no attempt as yet to even enumerate the common forms found in the State. They are everywhere abundant, and to every possessor of a fairly good microscope offer a most delightful field of research.

Of such aquatic forms the *Crustacea* have already been mentioned. Prof. F. E. L. Beal has contributed notes on the *Tardigrada*. Of *Hydroids* we have, so far as yet known, but one or two forms though it is probable that others may occur. Of sponges a few of the fresh water species have been determined by Mr. Edward Potts, of Philadelphia, from specimens sent from Ames and recorded in his Monograph of fresh water sponges.[8] Of the *Protozoa* there are innumerable forms but so far as known except the description of one species by Prof. C. C. Nutting,[9] of Iowa City, no attempt at a systematic study of them has been made.

The flora of Iowa is to be congratulated on the fact that it has received the attention of some of the most eminent botanists of the day. Parry, Bessey, Arthur, Halsted, Holway, McBride and many others have contributed to a knowledge of our native plants.

The first contribution which has come to my notice is an elaborate list of species by Dr. C. C. Parry, published in the Report of the Geological Survey of the Northwest. The list enumerates above eight hundred species, a large part of which are credited to Iowa.

Messrs. Haupt and Nagel have listed the flowering plants of Davenport.[10]

8—Proc. Phil. Acad. Nat. Sci., 1887, p. 157-270.
9—Amer. Nat. Vol. XXII., p. 13.
10—Proc. Dav. Acad. Nat. Sci., Vol. I., p. 153-164.

Of the higher forms—especially the flowering plants—the catalogues by Prof. J. C. Arthur in the proceedings of the Davenport Academy may be taken as fairly complete for the State, but in the lower groups—to judge by the number of recent additions—the list is but begun, while their relations to agriculture call for careful study. Even for the better known part of the flora there is work for local collectors in determining the richness of their localities, in fixing the boundaries of species, or recording the progress of invading forms.

Among the lower forms, whose presence is of so much importance as sources of disease to both animals and plants, we have our full quota, and, while many of these are of equal importance elsewhere, there is every reason to push their investigation on Iowa soil. The mildews, rusts and blights as well as the hosts of bacterial forms present us with an array of problems so vital to the well-being of the community that it is not strange we should find investigations in progress on all hands. It is to be hoped that the State of Iowa shall produce its full share of investigators and reap as rich rewards as other States in the harvest of discoveries that have but begun. In this branch of study we have the contributions by Prof. C. E. Bessey, also numerous papers by Dr. J. C. Arthur, Dr. B. D. Halsted, Prof. T. H. McBride, Dr. C. M. Hobby and others.

I have already mentioned briefly the existence of the various geological surveys of the State. The first organized under the general government as the Northwest survey, and embracing Wisconsin, Iowa and Minnesota. So far as Iowa was concerned it must be considered as but a partial reconnaissance, and scarcely more than touched upon the geological problems in the State which are of most vital interest to her people and the science. It went far enough, however, to locate in general the different geological areas of the State, limited to some extent the coal area and described in a general way the rich sources of agricultural wealth, sources which have since been so abundantly utilized. Its reports contain also valuable papers upon the paleontology and botany of the State, and many chemical analyses of rocks, soils, fossil bones, etc.

The first State survey, organized when only a narrow border of the eastern portion had been settled, naturally directed all its efforts to that portion of the State, and as a consequence many of the most interesting and important portions of the State, geologically, were not even visited. The investigation of the lead region of Dubuque by Prof. Whitney was, however, so exhaustive and accurate that Dr. White considered it unnessary in the following survey to give it any attention. In addition to this, the survey did a great deal to make known the fossils of the older strata in the State and lay a foundation for further geological work.

This survey was, however, brought to a sudden close, and in a way that has ever since left discredit upon the legislature that permitted it. The director was left without funds for the prosecution of his work when but partially finished, a portion of his salary unpaid, and the State even refused to reimburse him for money he had advanced to pay his assistants and prepare plates for his reports.

The second survey, under State support, endeavored to operate more particularly in the portions of the State not previously examined, but in order to give a correct outline of the geology of the State as a whole and fill gaps in the previous survey, had necessarily to re-examine much of the ground already traversed. This second survey had scarcely completed a general reconnaissance of the State when it too was brought to a sudden termination; not, however, with so much of discredit in the manner of its termination.

In view of the circumstance of its preparation we must consider this report upon this survey as a most valuable contribution to the geology of the State. The formations were mapped with approximate accuracy, and in the location of the coal areas alone there has doubtless been a saving of vast sums of money to the State in prevention of useless prospecting for coal in portions of the State where coal could not possibly occur. Prof. W. J. McGee gives in the Tenth Census Report an excellent review of the quarries and quarry products of the State.

Of individual workers in geology we have had many of whom we may feel proud, and the contributions to this subject by Profs. Todd, Calvin, McGee, Call, Barris, Wachsmith and others* have added much to our knowledge.

Of especial interest and importance have been the studies of recent deposits, drift, lœss, etc., by Profs. McGee, Call and Todd, which, owing to the paramount importance of agriculture in our State, are of direct interest to the people of every portion of the State.

But how much remains to be studied in this direction? The recent discoveries and great advances in utilization of oil and gas render of absorbing interest all the geological formations where these may possibly occur. Their careful examination would be of great service to the people of the State, and might be the means of saving thousands of dollars by preventing useless prospecting.

The coal formations merit further investigation, and peat bogs, quarries, gypsum and other mineral deposits, with a host of minor subjects, in one part of the State or another, await scientific examination. The location of areas where artesian wells are liable to be secured would also be of great service, and even an approximate outline of such areas, possible from a knowledge of the character and slope of the geological strata in given localities might save large sums

* Since the above was penned we have been pleased to note the appearance of several papers on Iowa geology, from Mr. Clement L. Webster and Mr. C. R. Keyes, in The American Geologist and American Naturalist.

expended in boring for artesian wells in places where such wells cannot be expected.

Our State, with others in its latitude, has undergone the interesting phenomenon of glaciation, and every student of geology must have become absorbed in the problems presented, the exact outline of the moraines, the depth of the drift, the nature and origin of the detritus, the course of glacial and pre-glacial streams, and a host of other questions which repeat themselves in every neighborhood of the State, offer abundant opportunity for the local student of geology, and every contribution to the subject, no matter how local it may appear, helps to swell our knowledge of the ground on which we live.

Erratic boulders greet us on every hand, like sphinxes, each burdened with unanswered questions. Whence came they? How did they come, where and how were they formed? What their composition, their structure, their history? Surely, these questions cannot be answered alike for all we see. While some we may consider as for the present, at least, apparently settled, what we know must certainly be far less than that which is unknown. In elucidation of these the chemist, the physicist, and the geologist have all a part with test tube, crucible, microscope and a host of other appliances.

Closely intermingled with the geological problems of the State are certain lines of investigation in physics and chemistry.

The physical conditions connected with the formation of our soils and various geological deposits, while many of them universal in their nature, have all a local interest and many may be studied to excellent advantage at various parts in the State. The causes and conditions incident to glaciation, the phenomena of erosion and sedimentation which have so much to do with the present condition of our surface soils have all a physical explanation to be applied in individual localities.

Here, too, we may consider those physical conditions of the atmosphere whose changes have so much of vital concern for the organisms which exist upon the earth's surface.

The subject of meteorology has received a considerable amount of attention in the State. It will be, of course, impossible to mention all the parties who have contributed to this subject, either as individual observers or as reporters for some of the organized weather services. Records by Prof. Parvin were begun at Muscatine in 1859, and his record for 1850-6 is published in the First Geological Report. The United States Signal Service has had a number of stations in the State since its first organization, some of which have been volunteer and others supported by the service. The records have, for the most part, only appeared in the reports of the service, but for the station at Ames and conducted by Profs. Macomber and Hainer summaries of the more important observations have been published in the College Biennial reports.

The State Weather Service already mentioned, organized and directed by Dr. Gustavus Hinrichs, receives reports from some fifty volunteer observers scattered over the State, and the published records contain extensive tabulations of their reports.

Inasmuch as this service receives direct support from the State and the expense of publication is borne by the State. people naturally look for some return in the way of assistance in meeting the idiosyncracies of the "weather".

It is perhaps too much to expect that people in general will appreciate a mere record of the weather which is past. no matter what its scientific value or interest may be, nor will many appreciate the claim that long series of observations are still necessary as a basis for useful forecasts. The farmer gathering his crops, the merchant with perishable articles on hand, the man in any calling whose work or whose pursuit of pleasure is affected by the condition of the weather is far more interested in what the conditions will be in the twenty-four to forty-eight hours ahead of him than he can be in the weather of six months or a year in the past.

The occasional wail which is heard when the weather fore-caster makes a mistake affecting any large area is in itself strong evidence that the predictions of the Signal Service are consulted daily by thousands of interested people, and that to a certain extent, at least, they base their plans for the day on such predictions. Such could not be the case if the service did not in the majority of cases prove useful by giving accurate predictions.

I believe that both science and the public welfare would be benefitted if there could be a proper connection between the State and Government services. The Signal Service spends annually large sums of money in supporting observers and distributing predictions by telegraph in our State. In so far as the State Service duplicates such work, there is loss of effort and money. The observations taken at different hours and under different instructions, are not readily compared for lack of uniformity.

I would not be understood as depreciating the work of our State Service or favoring any reduction of its resources but as suggesting merely the effort to so combine the work now carried on in entirely independent ways as to secure records capable of exact comparison, and distribute the greatest amount of valuable information to the people of the State.

In all of the various geological surveys a prominent place was given to chemical determinations of the different rocks belonging to various formations, and in a general way we have information upon this subject for the most important strata. The survey by Owens seems to have confined its work in this line to the Lake Superior region. In the survey under Prof. Hall much attention to the subject was given and the report by Prof. C. D. Whitney contains many analyses of rocks and minerals. In the second survey the report on chemistry, from Prof. Rush Emery shows a great amount of work upon the rocks, minerals, waters and coal of the State.

Aside from this, however, no little work has been done in the way of analyses of water from the various streams and other water supplies of the State, largely through the efforts of the State Board of Health. Messrs. Pope, Robbins, Shearer, Bennett, Andrews, Herrick and others have done much in this line, and while in many cases these analyses have not been published in any form accessible to the scientific world, I believe that a careful collection and comparative statement of all that could be brought together would furnish an exceedingly valuable and interesting document.

Aside from the economic question of water supply for cities and towns, and omitting the question of mere organic contamination, such analyses must furnish a hint, at least, as to the mineral constituents of the soils from which the water is collected, and especially in the case of mineral springs or artesian wells some information as to the character of the deeper geological deposits, of their respective areas.

Chemical analyses upon rocks, coals, fossils, etc., throw light upon the conditions of their formation and though repeated for every locality in the State where a certain geological formation occurs each one would have its especial value in comparison with the others as determining difference in condition during formation at such various localities. Moreover the immense changes in chemical composition between contiguous strata of different formations and even in different strata of the same geological age indicate some striking change of physical conditions in the waters from which such rocks were precipitated, changes which we may never be able to discover but which must apparently be approached from the chemical standpoint and for which very complete series of determinations for related rocks must be essential.

The chemistry of plants and animals is a subject as yet but slightly worked, and one of growing importance. While it cannot be considered as local in its nature, the question as to how much of variation in composition is possible, and to what extent such variation is influenced by climatic and other physical conditions, is one which can only be determined by local investigations. Not only the organisms themselves but the product of organic activity and organic decay and dissolution are rich with unsolved problems.

The principal means at present existing for the illustration of the fauna, flora, geology and mineralogy of the State are connected with educational institutions. The State University, Agricultural College, Iowa College at Grinnell, Cornell College at Mt. Vernon, and possibly some others possess collections of some extent. In all of these, however, and necessarily from the educational standpoint, it will be found that much space is given to foreign animals, and that our local fauna is meagerly represented. In none of them is there anything like a comprehensive exhibit of the State fauna. The State University is rich in mammals from the Hornaday collection, and will doubtless have a good representation of the mammalian fauna of the State. The Agricultural College has a fairly complete series of the birds of the State, either mounted or in skins, also considerable collections of reptiles and insects.

The museum of the Davenport Academy has a more local object, and its museum is especially rich in anthropology. It will be seen that in no place in the State is there a collection especially devoted to exhibiting the resources of the State.

For the purpose of bringing such material together and making it available for purposes of knowledge, we have great need of a State collection which may be said to have for its special purpose the illustrations of the natural history of the

State. Until provided with such State cabinet or laboratory of natural history, Iowa will be behind her sister States in means for presenting to her citizens in concrete form a knowledge of her wealth in animal and vegetable life, in fossils, rocks, minerals, ores and soils, with all the other stores of geologic wealth, a knowledge of which has just begun. Such a cabinet and laboratory should have for its scope the illustration by properly mounted specimens of all the mammals that are resident in the State, or that have been known to occupy its territory in past time. The bison, the cayote, the deer, bear and panther thus brought out in the midst of our civilization would furnish us striking pictures of the rapid progress our State has seen, and these with the relics of their human contemporary, who occupied but did not possess, who inhabited but did not develop, who existed but did not *live*, whose history is but one of gluttony or starvation, warfare or animal enjoyment, all these so grouped as to teach their lesson of possibilities in human progress and attainment might well occupy an important position in the metropolis and political center of our wealthy State, a place where the thousands who annually travel in quest of pleasure or instruction, might be both entertained and instructed.

But not dwelling upon these forms which are past, such a collection would embrace, too, those living species that in one way or another force themselves on our attention. Some vitally affect the wealth of the State, and a collection illustrating their habits, open to the State at large, would be an object lesson that could but leave an impress on those who visited it.

The birds and mammals should be so arranged as to illustrate their habits and their relations to each and to other organisms and to the agriculture, horticulture, etc., of the State, the native insects in their multitudinous phases of existence, with other objects in like completeness. Such an enterprise may seem fanciful and visionary, but we need only to look to other States to see such work in progress. It would need time and perpetual aid from the State to keep it in progress when established, but compared with the importance of the matter to the State the outlay need be but insignificant. With it might be combined such scientific work in the State as a geological survey, and the investigation of the zoological, entomological and botanical problems of the State.

Many of the problems here mentioned are of such strictly local interest that we cannot expect scientific men or societies from without the State to engage upon them. Being connected with the sources of wealth in the State, of vital economic interest to the State at large, it would seem that no argument would be necessary to show the propriety of the State's assisting in their study. From the very nature of the case their full solution is impossible, and cannot be expected from private enterprise or even from community, town or county effort. The sources of wealth they affect are vital to the people of every section of the State, and as all would be benefitted all should bear part in support.

A geological survey of the State, for instance, can never be hoped for from private enterprise, though many scientific men have by their individual and unpaid efforts brought to light many facts of value to the State at large. Such a survey would not be confined in its direct assistance to the mining interests of the State, the study of regions likely to produce coal, oil and gas, or the quarries scattered here and there. Even if it was the benefit from fuller development of these resources must accrue to people throughout the State as well as to the immediate operators of such industries.

But the geology of the State of Iowa cannot but be occupied in large part with the more recent formations. The lœss and the drift, the alluvial deposits along our streams, in short, the formation and character of all our surface soils with their special aptitudes for agriculture. In these lie the great wealth of our State, richer than the silver sprinkled hills of the Rockies or the golden threaded quartz of California; more precious than the diamond strewed fields of Africa. The prairie soil of this fair State is rich in all that brings comfort and enjoyment to an honest, earnest people in quest of the means for self-improvement. Rich because it furnishes a never-failing mine of wealth. Its treasures are not exhausted with a single turning of the earth, but will remain a perpetual source of revenue to any people who will intelligently conserve and protect it.

It may be noted that I have not referred to the science of political economy, psychology, etc., but this is not because I underrate in any degree their importance in human progress and attainment. From their nature they are both local and universal, but it would prolong this address too much to give them any adequate consideration.

Problems of social life are being studied on every hand, and it may perhaps not be stating it too strongly to say that their results can be of great value only as they proceed upon the scientific method. The relations of individuals, communities, States and nations are not to be adjusted by the bombast of the politician or the mere oratory of the statesman. A scientific analysis of the conditions, complete as they may be, and accurate appreciation of cause and effect, are necessary in the study of these as well as biological or geological problems, and the best statesman is he whose talent and training enable him to follow the method of the scientist.

In the founding of this Society which meets now on the first anniversary, we have recognized the existence of problems in our State demanding scientific investigation. We have recognized, too, the well known principle of advantage in organized effort, the added stimulus and benefit accruing to associated work. We find the field broad and the work in waiting great. We find our numbers small and frequently broken into by removals of our members to more remunerative or attractive fields of labor. We find much that might discourage, but we may look with profit to what has been here accomplished under conditions possibly more discouraging than ours.

We should strive to make our work enduring, so that those who follow will not need to repeat what we have done. We should strive for that perfection of result that may challenge the inspection and criticism of the world of science. We should hold our science as above any comparison with the wages which may be paid for scientific work, scientific opinion or support to any theory as beyond the reach of contamination with money.

The laws of Nature do not change, and he who gives a wrong expression to them knowingly subverts the very foundation of scientific progress, for the progress of science is the progress of truth.

The following papers were also read and are here given in abstract:

ON THE METAMORPHOSIS OF A SPECIES OF ALEYRODES.

BY PRESIDENT HERBERT OSBORN.

(*Abstract.*)

A species of *Aleyrodes* occurring on *Festuca* was studied at time of emergence of *imagines* and presented the following points. The pupal scale is oval, slightly convex and marked above with four dusky spots. Within the scale may be seen, at the earliest stage noted, only a granular mass without distinction of head or other parts; later eyes become conspicuous, head distinct from body and the *prothoracic* and abdominal segments extend in flattened lobes to the margin of the scale, while the *mesothoracic* and *metathoracic* segments are contracted and thicker. The *imago* issues from a compound fissure on the dorsal surface, one limb of which is transverse and located over the thorax; the other arises from the median point of this fissure and extends anteriorly to the cephalic margin. Fresh *imagos* when subjected to slight pressure, as under the cover glass when mounted in balsam, have an extensive protrusion of the pleural fold on the *prothorax* and abdomen corresponding to the lobes of these parts in the *pupa*. The *imago* does not acquire its farinose character until some hours after emergence. The extension of the pleural fold on all but the wing bearing segments of the body suggests some interesting inferences on the origin of these organs (in *Aleyrodes*, at least), and it is hoped that more thorough study of the material in hand will furnish some basis for conclusions.

THE HEMIPTEROUS FAUNA OF IOWA.

BY PROF. HERBERT OSBORN.

(*Abstract*.)

No attempt at a catalogue of the insects of this order has yet been made, and though for several years attention has been given by the author to gathering material for such a catalogue, many of the families are as yet certainly very incomplete. The following groups are represented:

Heteroptera, twenty-one families, as follows: *Scutelleridæ*, two genera, two species; *Corimelænidæ*, one genus, three species; *Cydnidæ*, two genera, two species; *Pentatomidæ*, seventeen genera, twenty-six species; *Coreidæ*, eight genera, twelve species; *Berytidæ*, three genera, four species; *Lygæidæ*, seventeen genera, nineteen species; *Capsidæ*, twelve genera, fourteen species; *Acanthidæ*, two genera, two species; *Tingitidæ*, two genera, three species; *Aradidæ*, one

genus, four species: *Phymatidæ*, one genus, one species; *Nabidæ*, two genera, four species: *Reduviidæ*, seven genera, eight species: *Hydrobatidæ*, three genera, four species: *Veliidæ*, one genus, one species; *Saldidæ*, one genus, two species: *Belostomidæ*, two genera, two species: *Nepidæ*, two genera, two species: *Notonectidæ*, two genera, two species; *Corisidæ*, one genus, two species.

Homoptera, nine families: *Jassidæ*, ten genera, fourteen species; *Cercopidæ*, two genera, three species: *Fulgoridæ*, five genera, ten species: *Cicadidæ*, one genus, three species: *Membracidæ*, nine genera, thirteen species: *Psyllidæ*, one genus, two species; *Aphidæ*, fifteen genera, thirty-two species; *Aleyrodidæ*, one genus, two species: *Coccidæ*, seven genera, twelve species.

Parasita, one family: *Pediculidæ*, three [four?] genera, fourteen species.

CATALOGUE OF THE MAMMALS OF IOWA.

BY PROF. HERBERT OSBORN.

I have here brought together all the species known to exist or that recently existed in the State, and unless otherwise indicated assume the responsibility of a correct record. I have consulted Audubon, Coues and Allen, Jordan, and also a list by Dr. M. F. Goding, published in the Transactions of the Iowa State Agricultural Society (1882), page 329, and where the species is not known to me to occur in the State I have added in parentheses the name of the author who is taken as authority. I must add that a very few of the species included in Dr. Goding's list seem to me extremely doubtful.

CARNIVORA.

Felis concolor L. Panther. Doubtless once common.
Lynx canadensis Raf. Lynx. Rare at present.
Lynx rufus Raf. Wild cat. Becoming rare.
Canis lupus L. Wolf. In timber regions.

Chrysocyon latrans. Prairie wolf, coyote. Formerly very common.

Vulpes vulgaris Fl. Red fox. Not common.

Urocyon virginianus Erx. Gray fox. Western prairies (Aud.) (Goding).

Mustela martes L. Sable. Not common.

Mustela pennantii Erx. Fisher. Northern N. A. (Jordan). Iowa (Goding).

Putorius vulgaris Cuv. Least weasel: N. U. S. (Jordan). Iowa (Goding).

Putorius ermineus Cuv. Common weasel. Abundant.

Putorius vireolus Cuv. Mink. Common.

Gulo luscus L. Wolverine. N. U. S. (Jordan). Iowa (Goding).

Taxidea americana Baird. American Badger. Becoming rare.

Mephitis mephitica Shaw. Skunk. Common.

Lutra canadensis Sabine. Otter. Rather rare.

Ursus arctos L. Bear. Once common, now confined to zoological gardens, traveling shows, etc.

Procyon lotor L. Raccoon. Common in wooded regions.

UNGULATA.

Bison americanus. Buffalo. evidently once abundant.

Cervus canadensis Erx. American Elk. Once common.

Cervus virginianus Bodd. Deer. Once common. now rare or gone.

CHIROPTERA.

Vespertilio subulatus Say. Little brown bat.

Vespertilio lucifugus LeC. Very similar to preceding.

Vesperugo noctivagans LeC. Silver black bat. Not rare.

Vesperugo serotina. Dusky bat. Two forms occur.

Atalapha crepuscularis LeC. Twilight bat. Not abundant.

Atalapha cinereus Beau. Hoary bat. Rather rare.

Atalapha noveboracensis Erx. Red bat. Our most abundant species.

INSECTIVORA.

Scalops aquaticus L. Mole. Probably common, but I am unable to say as to relative abundance of this and the following species.

Scalops argentatus Aud. and Bach. Prairie mole.

Condylura cristata L. Star-nosed mole. Not seen. U. S. chiefly northerly (Jordan). Iowa (Goding).

Sorex cooperi Bach. Western shrew. Fairly common.

Blarina brevicauda Say. Not seen. Iowa (Goding).

Blarina talpoides Say. Not seen. Iowa (Goding).

Blarina exilipes. One specimen in Iowa Agricultural College museum.

RODENTIA.

Sciuropterus volans L. Flying squirrel. Common.

Sciurus cinereus L. Fox squirrel. Abundant. Var. *ludovicianus*.

Sciurus carolinensis Aud. Gray squirrel. Abundant.

Tamias striatus L. Chipmunk. Common.

Spermophilus tridecemlineatus Mitch. Striped gopher. Very abundant.

Spermophilus franklini Sab. Gray gopher. Common.

Arctomys monax L. Woodchuck, ground hog. Common.

Castor fiber L. Beaver. Becoming rather rare.

Geomys bursarius Shaw. Pocket gopher. Abundant.

Zapus hudsonius Zimm. Jumping mouse. Fairly common.

Mus decumanus Pall. Brown or Norway rat. Common.

Mus rattus L. Black rat. Being supplanted by preceding (Jordan).

Mus musculus L. Mouse. Very abundant everywhere.

Neotoma floridana S. and C. Wood rat. One specimen at Iowa Agricultural College, probably taken at Ames.

Hesperomys leucopus Raf. Deer mouse. Not rare.

Hesperomys michiganensis Aud. and Bach. Michigan mouse (Goding).

Hesperomys aureolus Aud. and Bach. (Goding) Not seen, and I think doubtful.

Ochetodon humilis Aud. and Bach. (Coues and Allen)

Arvicola riparius Ord. Meadow mouse. Common.

Arvicola austerus LeC. Perhaps as common as preceding.

Synaptomys cooperi Baird. Coopers' mouse.

Fiber zibethicus L. Muskrat. Abundant.

Lepus sylvaticus. Common rabbit. Abundant everywhere.

Lepus campestris Bach. Prairie hare. One specimen at Ames.

Lepus callotis Wag. Jack rabbit (Goding). Very doubtful.

MARSUPIALIA.

Diadelphys virginiana Shaw. Opossum. Confined to wooded regions.

FRAGMENT OF A CATALOGUE OF THE COLEOPTERA OF IOWA.

BY PROFS. HERBERT OSBORN AND H. F. WICKHAM

(*Abstract.*)

The collections in this extensive order of Insects, are now sufficiently full to give us, we believe, a fair idea of the *Coleopterous fauna* of the State. We desire however to make the list as complete as possible and present this fragment at this time mainly for the purpose of requesting that individuals having a collection of Iowa *Coleoptera* would send us either specimens or, if accurately determined, lists of the species they possess to be incorporated in the list. Some credit will of course be given for all such assistance and names of species returned if desired.

The list will have as its principal basis, first, the private collection of H. F. Wickham, second the collection of the Iowa Agricultural College, and third, the private collection of Herbert Osborn.

The fragment herewith presented embraces twenty one families containing two hundred and thirty-nine species.

As a number of the most extensive families are not included the enumeration will possibly exceed five times the number registered.

MY EXPERIENCE IN REARING VANESSA ANTIOPA.

BY PROF. F. M. WITTER.

(*No Abstract.*)

SOME ADDITIONAL OBSERVATIONS ON THE LŒSS IN AND ABOUT MUSCATINE.

BY PROF. F. M. WITTER

Abstract.

The unconsolidated material resting on the drift in and about Muscatine possesses many of the characters of the lœss and since it passes by insensible gradations into the latter it seems rather to belong to the lœss than to the drift.

The lower portion is generally most perfectly and beautifully stratified, the strata consisting of sand, clay, and occasionally some gravel, with small boulders of the granitic series, fragments of bituminous coal, etc. A very few calcareous concretions are found in the stratified basal beds and at one point good specimens of these concretions have imbedded pebbles. In the less evidently stratified portions abound several species of land shells and the eggs of one species are found. But little sand and this of the finest grain is found in the unstratified higher portions. In this have been found the teeth and largely the bones of two examples of *Rangifer caribou* and the greater portion of the antler of the same species most probably. Two or three species of fresh water mollusks have been found in what appears to be lœss.

THE PARVUS GROUP OF UNIONIDÆ.

BY PROF. R. ELLSWORTH CALL

(*Abstract.*)

This paper gave a resume of the known facts in the geographical distribution of these small *Unios* and proposed the reduction of a number of forms to synonymy. The relation of the assumed specific differences to conditions clearly connected with environment was pointed out and a somewhat close relationship of forms hitherto supposed to be very distinct was evidenced by the specimens exhibited. The dis-

tribution of the various forms was adduced as an argument in support of identity particularly of those species which occur in Texas and in Georgia.

The type of the group is the very small form described by Barnes from the waters of Ohio. This form with considerable variations occurs throughout the eastern half of the Unites States as far as the State of New York. To the south it ranges westward to Texas and has there been subjected to such environmental conditions as to become very much prolonged posteriorly. The sexual variations here are so marked that the two forms, male and female, have been described under at least two specific names. In Georgia occur two or three forms which have been called species mainly on the differences of color of the *nacre*. Some of these at least are but modifications of the common *Unio parvus* of the North.

The group includes the following species described by Dr. Isaac Lea, of which list those in italics are believed to be synonyms. In the list the forms which it is proposed to recognize as species are given in the order of the date of their description, so that, if for any reason the reader should wish to determine the chronologic arrangement of the species it will be possible to do so.

Unio glans Lea.

(Read May 7, 1830.)

"Observations on the *Genus Unio*," Vol. I, p. 92, Pl. VIII, Fig. 12.

Unio paulus Lea.

(Read October 2, 1840.)

"Observations on the *Genus Unio*," Vol. III, p. 51, Pl. XV, Fig. 29.

Unio minor Lea.

(Read August 18, 1843.)

"Observations on the *Genus Unio*," Vol. IV, p. 276, Pl. XXXIX, Fig, 3.

Unio texasensis Lea.

(Read March 24, 1857.)

"Observations on the *Genus Unio*," Vol. VIII, p. 39, Pl. LXI, Fig. 184.

Unio bairdianus Lea.

(Read April 7, 1857.)

"Observations on the *Genus Unio*," Vol. VIII, p. 42, Pl. LXI, Fig. 186.

Unio granulatus Lea.

(Read March 5, 1860.)

"Observations on the *Genus Unio*," Vol. XI, p. 52, Pl. XVI, Fig. 46.

Unio germanus Lea.

(Read February 5, 1861.)

"Observations on the *Genus Unio*," Vol. XI, p. 53, Pl. XIX, Fig. 54.

Unio bealii Lea.

(Read June 2, 1862.)

"Observations on the *Genus Unio*, Vol. IX, p. 26, Pl. XXX, Fig. 273.

Unio marginis Lea.

(Read May 16, 1865.)

"Observations on the *Genus Unio*," Vol. XII, p. 15, Pl. XXXI, Fig. 69.

Unio cromwellii Lea.

(Read May 16, 1865.)

"Observations on the *Genus Unio*," Vol. XII, p. 18, Pl. XXXI, Fig. 54.

Unio cylindrellus Lea.

(Read June 2, 1868.)

"Observations on the *Genus Unio*, Vol. XII, p. 68, Pl. XLVIII, Fig. 121.

Unio corvinus Lea.

(Read June 2, 1868.)

"Observations on the *Genus Unio*, Vol. XII, p. 70, Pl. XLVIII, Fig. 123.

Unio corvunculus Lea.

(Read June 2, 1868.)

"Observations on the *Genus Unio*, Vol. XII, p. 74, Pl. L, Fig. 127.

Unio vesicularis Lea.

(Read September 15, 1873.)

"Observations on the *Genus Unio*," Vol. XIII, p. 41, Pl. XII, Fig. 34.

The synonymy of this group, therefore, will stand as in the subjoined lists and even here there is some doubt that the Texas forms should be held to be distinct.

Unio parvus Barnes.

U. paulus Lea.
U. minor Lea.
U. marginis Lea.
U. corvinus Lea.
U. vesicularis Lea.

Unio texasensis Lea.

U. bairdianus Lea.
U. bealii Lea.

Unio glans Lea.

U. pullus Conrad.
U. granulatus Lea.
U. germanus Lea.
U. cromwellii Lea.
U. cylindrellus Lea.
U. corvunculus Lea.

The type of the group is the form described by Dr. Barnes to which both in anatomy, habits and general characters all the shells herein named show most marked resemblances. If the Texas forms be excluded as synonyms, then they will fall under the division headed by *U. parvus*.

The main facts on which this species reduction is based are set forth in the subjoined tabular synopsis. The various species have been studied in such detail as large series of shells from all sections of the south and the west would enable. In some cases authors' types have been available.

SYNOPSIS OF THE SPECIFIC CHARACTERS OF THE PARVUS GROUP.

UNIO.	PARVUS.	CORVINUS.	MARGINIS.	PAULUS.	GLANS.	CYLINDRELLUS.	CROMWELLII.	GRANULATUS.
Outline	Elliptical, somewhat compressed.	Elliptical, inflated.	Elliptical, inflated.	Elliptical, inflated.	Ovate-elliptical, inflated.	Widely elliptical, somewhat cylindrical.	Elliptical, somewhat inflated.	Elliptical, somewhat inflated.
Substance of shell	Thin, slightly thicker before.	Somewhat thick, thicker before.	Somewhat thick, thicker before.	Thick, thinner behind.	Rather thick.	Thick, thicker before.	Rather thin, thicker before.	Rather thin, slightly thicker before.
Beaks	Slightly prominent, coarsely and concentrically wrinkled.	A little prominent.	Somewhat prominent.	Somewhat prominent.	Somewhat prominent.	Slightly prominent.	Somewhat prominent; concentrically folded.	A little prominent, undulate, granulate.
Ligament	Small, thin, light straw-colored.	Short, thin, very dark brown.	Small, thin, light brown.	Short, thin.	Small.	Rather long, thin.	Small, thin, rather light brown.	Small, thin, light brown.
Epidermis	Yellowish green, lighter on beaks, striated, lines of growth distant, black.	Black, eradiate, subsquamose, growth lines close.	Dark olive striate, obscurely rayed, margin greenish-yellow.	Nearly black.	Black or dark brown sometimes rayed.	Yellowish, eradiate; lines of growth distant.	Striate, brownish or greenish rayed, growth lines distant, broad.	Dark olive, eradiate, striate, lines of growth distant.
Cardinal teeth	Small, elevated, acuminate, crenulate, double in the left, single in the right valve.	Small, decussate.	Small, sulcate, crenulate.	Small, disposed to be double in both valves.	Rather large, elevated, double in left, single in right valve.	Small, sub-conical, corrugate.	Small, compressed, corrugate, double in both valves.	Small, compressed, crenulate, oblique, double in both valves.
Lateral teeth	Slightly curved, long, lamellar,	Long, somewhat straight.	Rather short. straight.	Long, curved.	Straight, lamelliform	Long, somewhat curved.	Rather long, somewhat curved.	Long, acicular, nearly straight.
Anterior cicatrices	Distinct, moderately impressed.	Distinct, small, well-impressed.	Confluent, small, deeply impressed.	Distinct.	Distinct.	Distinct, small, well impressed.	Scarcely distinct, large, well impres'd	Distinct, rather l'rge well impressed.
Posterior cicatrices	Confluent, slightly impressed.	Confluent, slightly impressed.	Confluent, small, slightly impressed.	Confluent.	Confluent.	Distinct, small, slightly impressed.	Confluent, rather l'rg slightly impressed.	Confluent, rather l'rg slightly impressed.
Dorsal cicatrices	Center of cavity of the beaks.	Center of cavity or the beaks.	Center of cavity of shell [beaks?]	On inferior part of tooth.	Center of cavity of the beaks.	Center of the cavity of the shell.	Center of cavity of the beaks.	Center of cavity of the beaks.
Cavity of shell	Shallow, white.	Deep, wide.	Rather shallow.	Deep.	* * * *	Deep, wide.	Deep, wide.	Deep, wide.
Cavity of beak	Shallow, rounded.	Shallow, obtusely angular.	Shallow, rounded.	Very small.	Wide, subangulated.	Rather deep sub-angular.	Small, obtusely angular.	Shallow, sub-angular.
Nacre	White, inclined to salmon in cavity of beaks.	White, iridescent.	White, iridescent.	White, iridescent.	Purple.	Purple, iridescent.	Purple, iridescent.	Purplish, iridescent.
Habitat	Ohio river.	Flint River, Ga. Neuse River, N. C.	Dougherty Co., Ga.	Chattahoochee River, Ga.	Ohio River.	E. Tennessee, N. Ga., N. Ala.	Kiokee Creek, Albany, Ga.	Big Prairie Creek, Ala.
Diameter	.6 inch.	.7 inch.	.5 inch.	.4 inch.	.7 inch.	.7 inch.	.4 inch.	.45 inch.
Length	8 inch.	.8 inch.	1.0 inch.	.6 inch.	.8 inch.	.8 inch.	.7 inch.	.62 inch.
Breadth	1.6 inch.	1.3 inch.	1.1 inch.	.9 inch.	1 3 inch.	1.5 inch.	1.1 inch.	1.10 inch.

SYNOPSIS OF THE SPECIFIC CHARACTERS OF THE PARVUS GROUP.

GERMANUS.	CORVUNCULUS.	PULLUS.	VESICULARIS.	TEXASENSIS.	BAIRDIANUS.	BEALII.	MINOR.
Elliptical, somewhat inflated.	Elliptical, somewhat inflated.	Elliptical, somewhat inflated.	Elliptical, inflated.	Elliptical, sub-compressed.	Elliptical, slightly inflated.	Elliptical, somewhat compressed.	Eliptical, rather inflated.
Somewhat thick, thicker before.	A little thick, thicker before.	* * * * *	A little thick, thicker before.	Rather thin, thicker before.	Rather thin, thicker before.	Slightly thickened, thicker before.	Thick, thinner behind.
Rather prominent, concentrically undulate.	A little prominent, concentrically undulate.	Slightly prominent.	Slightly prominent.	Slightly prominent, subconcentrically undulate.	Slightly prominent, concentrically undulate.	A little prominent.	Rather prominent.
Short, thin, lightish brown.	Short, thin, brown.	* * * * *	Rather long and thin.	Small, thin, yellowish-brown.	Small, thin, yellowish-brown.	Short, thin, dark brown.	Short, thin.
Dark brown, eradiate, transversely striate.	Blackish, eradiate; lines of growth distant.	Dark, olivaceous, wrinkled.	Dark olive, obscurely rayed, growth marks distant.	Dark olive, shining, obsoletely rayed, marks of growth distant.	Dark brown, obsoletely radiate, growth lines distant.	Dark brown or blackish, obscurely radiate, marks of growth distant.	Striate, nearly black
Small, erect, compressed, crenulate, acuminate.	Small, erect, compressed, crenulate.	Oblique, single in one, double in the other valve.	Small, sulcate, somewhat compressed, double in both valves.	Small, erect, crenulate.	Small, erect, acuminate, crenulate, double in both valves.	Small, compressed, crenulate, pointed, double in both valves.	Rather large.
Thin, somewhat curved.	Rather long, slightly curved.	* * * * *	Rather long, lamellar, nearly straight.	Long, lamellar, somewhat curved.	Long, lamellar, somewhat curved.	Very long, slightly curved, lamellar.	Small, curved.
Distinct, small, well impressed.	Distinct, small, well impressed.	* * * * *	Distinct, small, well impressed.	Distinct, small, well impressed.	Distinct, small, somewhat impressed.	Distinct, rather large, moderately impressed.	Distinct.
Confluent, slightly impressed.	* * * *	* * * * *	Confluent, rather large, moderately impressed.	Confluent, slightly impressed.	Confluent, slightly impressed.	Confluent, slightly impressed.	Confluent.
Center of cavity of beaks.	Center of cavity of the beaks.	* * * * *	Center of cavity of the beaks.	Across the cavity of the beaks.	Across the cavity of the beaks.	Across center of cavity of the beaks.	Center of cavity of the beaks.
Rather deep, wide.	Deep, wide.	Very capacious.	Deep, wide.	Somewhat deep, wide.	Small, wide.	Shallow, wide.	Deep.
Shallow, obtusely angular.	Shallow, obtusely angular	Very capacious.	Shallow, obtusely angular.	Shallow, obtusely angular.	Shallow, obtusely angular.	Shallow, obtusely angular.	Rather deep, angular.
Purplish, iridescent.	Purple, iridescent.	Chocolate purple.	Whitish, iridescent.	Bluish, very iridescent.	White, very iridescent.	White or pale salmon, iridescent.	Pearly white, iridescent.
Coosa River, Ala.	Swamp Creek, Whitfield Co., Ga.	Wateree River, S. C., Warm Spa, N. C.	Lake Ocheechobee, Fla.	DeWitt Co., Texas.	Devil's River, Texas.	Leon Co. and Rutersville, Texas.	Lakes Monroe and George, Fla.
[illegible] inch.	.5 inch.	* * * * *	.5 inch.	.5 inch.	.4 inch.	.6 inch.	.4 inch.
[illegible] inch.	.7 inch.	* * * * *	.7 inch.	.8 inch.	.7 inch.	1. inch.	.6 inch.
1.40 inch.	1.2 inch.	* * * * *	1.3 inch.	1.4 inch.	1.2 inch.	1.7 inch.	.9 inch.

THE GEOLOGY OF CROWLEY'S RIDGE, ARKANSAS.

BY PROF. R. ELLSWORTH CALL.

(*Abstract.*)

Crowley's Ridge is a low range of hills forming the only conspicuous feature in the topography of Northeastern Arkansas, and extends in a general north and south direction from the Missouri state line to the city of Helena, where it ends abruptly. The total length is therefore about 145 miles. It is a range of hills of varying width, its average being about four to six miles. The elevation is, on the average, from 175 to 250 feet above the surrounding country. The general surface is very irregular and presents a fine example of quaquaversal erosion, the heads of the numerous ravines often departing from the same point.

The age of the ridge is a matter of some question for it is largely made up of deposits that are believed to be of the age of the Orange Sand deposits. That the age of these sands is yet in dispute results from the fact that their mode of origin is not well understood, and besides they differ so widely at many points of their distribution. It has, however, been assumed in these notes that they are properly to be classed with the quaternary, and that has been the constant reference made; whether this treatment is a proper one must be determined by additional work in the field.

In general, the ridge may be said to be composed of tertiary strata of Eocene age representing the Claiborne beds of Alabama. These beds contain many Clairbornian fossils, though the *Ostreidæ* occur in the greatest abundance. The localities in which these forms occur most numerously are few and widely scattered, but are of the same age and of the same value petrographically. The ridge is capped with deposits of lœss that are the same in all essential features as are the deposits in the regions farther north. These lœss beds lie directly upon the gravels of the Orange Sand, and are sometimes, though not always, separated therefrom by beds of sand apparently derived from the tertiary deposits of the circumjacent region. The characteristic loess-kindchen are present, but different from those of the north in being solid and never hollow. The ridge represents a mass of quaternary and tertiary sands and clays that have escaped, thus far, the great erosion to which the whole region has been subjected since tertiary times. It represents, therefore, the plateau of tertiary beds which resulted from the retirement of the Gulf in the early quaternary. There is little of economic value in these deposits, although the shell marl of one or two localities promises to have some local value. No mineral deposits of any moment are to be found in the ridge, and its top is of little agricultural value because of the difficulty of tilling. The paper was to be considered as tentative only as an additional season of field work was needed to settle some facts connected with the genesis of certain sands thought to be tertiary in age. The final results will appear in the annual reports of the Arkansas Geologic Survey, under the auspices of which organization the work was done.

CYNIPIDS AND CYNIPIDOUS GALLS ON OAKS COMMON TO IOWA.

BY PROF. C. P. GILLETTE.

(*Abstract.*)

For full scientific descriptions of the species herein mentioned see the Report of the Michigan Agricultural Society for 1888.

Andricus foliaformis, n. sp. The galls of this species occur on the under side of the leaves of the white oak (*Q. alba*). They consist of small wart-like projections which spread out in a leafy expanse on all sides so as to remind one of the corolla of a rotate flower. Rare. The fly measures about six-tenths of an inch in length; color of head and thorax black, fading into brown; abdomen a shining brown, darkest above; scutellum with two pits at base; *antennæ*, 13-jointed. Male not known.

Biorhiza rubinus, n. sp. The galls appear in the fall on the leaves of the white oak (*Q. alba*), a little before the foliage begins to turn dark brown. They are sub-globular in form, and while growing are rosy in color (sometimes almost white), and are translucent and pulpy like a green grape. Large specimens measure one-eighth of an inch in diameter. After reaching their growth, the galls turn brown and become only a thin shell which is very smooth and glossy next to the leaf. The mature gall is somewhat flattened above and below. I have found this gall quite common both in Michigan and Iowa. The flies emerge late the following summer. The fly is about six-tenths of an inch in length, is shining black in color, and has on the joints of the legs a yellowish-brown. When highly magnified, the body appears to be covered with minute scales. The fly is sparsely haired; *antennæ*, 13-jointed; parapsidal grooves shallow and indistinct; scutellum with two shallow pits at the base. Males not known.

Holcaspis basettii, n. sp. The gall of this and of the succeeding species I have taken on the swamp white oak (*Q. bicolor*) only, but have no doubt but what they also occur on the burr oak (*Q. macrocarpa*). The galls of *H. bassettii* are usually found in clusters of from two to thirty or more crowded together about small limbs. The galls, unless pressed out of shape in the cluster, are sub-globular in outline with a stout teat-like projection which seems to be a drawn out portion of the substance of the gall. Medium sized galls measure five-eights of an inch in diameter. The gall is composed of a corky substance, and has an egg-shaped central cell that is easily removed by cutting open the gall.

This gall differs from a very similar species, *H. duricoria*, Bass., which occurs on the same oaks, in that the latter has a very small, almost horny, teat-like projection, is more globular in form and has the central cell with its greatest diameter parallel with the limb. *H. bassettii* on the other hand, has the greatest diameter of the central cell perpendicular to the limb at the point of attachment of the gall. I am sure that one who has seen typical forms of both species will never mistake the one for the other. The flies appear in November, and are all females. Length, one-sixth of an inch; prevailing colors, black and brown; but on account of a dense gray pubescence which covers nearly all parts, they have a grayish appearance until denuded; *antennæ*, 13-jointed, third joint the longest. Thorax marked with what seems to be six longitudinal black lines which extend partially or entirely across it; abdomen shining black with a patch of gray pubescence beneath the wings on either side.

Cynips nigricens, n. sp. Irregular cone-shaped galls which occur in clusters on the under side of the leaves of the swamp oak (*Q. bicolor*). The galls are attached to the mid-rib and fall to the ground a little before the leaves begin to drop in October. These resemble very much small clusters of *Cynips strobilana* O. S. Fly, black in color; nearly one-eighth of an inch in length; body appearing to be covered with minute scales, when viewed with a high power; *antennæ*, 13-jointed and slightly clubbed; parapsidal grooves deep and narrow and widely separated at collar; abdomen minutely punctate and set with hairs. Only known in female form.

Acraspis villosus, n. sp. The galls are very hard globular excrescences on the under side of the leaves of the burr oak (*Q. macrocarpa*). The galls are light yellow in color and are covered with a dense growth of stout hair of the same color. Large specimens of this gall measure over one-fourth of an inch in diameter. The galls contain a single fly each, appear about mid-summer, and the flies begin to escape about the last of October. Fly, nearly one-sixth of an inch in length; prevailing colors, cinnamon brown and black. The sides of the abdomen have a beautiful velvety luster, caused by a dense yellowish-gray pubescence which suggests the name of the species. The wings are aborted, being only short stubs. Females only have been reared.

Neuroterous nigrum, n. sp. The galls of this species appear as small pimples on the leaves of the white oak (*Q. alba*), and the burr oak (*Q. macrocarpa*). They are from one-sixteenth to one-twelfth of an inch in diameter, and show equally well from either surface of the leaf. The galls appear in August and the flies emerge the following summer. Fly, very small, about one-twenty-fifth of an inch in length, and black in color except the tarsi and joints of the legs, which are brown.

Amphibolips cookii, n. sp. Globular galls with central cells and stout radiating fibers. They occur in the fall of the year on the buds of the red oak (*Q. rubra*). The growing gall resembles very much the gall of *A. inanis*, O. S., but it is smaller, and the radiating fibers and the outer shell are much heavier. A little before the leaves fall these galls drop to the ground, turn brown in color, and soon become much shriveled up. The flies do not appear until late the following summer. Fly, only females were reared. Length, one-fifth of an inch; general color, black; *antennæ*, 13-jointed, with the third joint the longest; face deeply pitted or sculptured; thorax and scutellum deeply sculptured; legs, amber colored; wings somewhat smoky and with a large stigmal spot. Only females reared.

THE LINEAGE OF LAKE AGASSIZ.

BY PROF. J. E. TODD.

[Abstract.]

As Lake Winnipeg has succeeded Lake Agassiz, so the latter may trace its lineage back three ages, as follows:

First. When the ice sheet filled the basins of Lake Agassiz and blocked the valley connecting the Red River and James River valleys, Lake Dakota extended 140 miles long, ten to thirty miles broad from Oakes to Mitchell, Dak. A level plain 1300 feet above the sea now occupies its former basin.

Second. When the Ice Sheet occupied the second or Gray Moraine in the James Valley, filling the basin of Lake Dakota, there was a quite extensive White Lake, occupying the basin of a diminutive descendant of that name in Aurora County, Dak., its altitude about 1557 feet. Also, a smaller and more transient lake — James Lake — southwest of Mitchell, extending into Douglass County: the present altitude of its western border is about 1450 feet.

Third. Still earlier, when the ice occupied the first or Altamont Moraine, or as some leading glacialists would say far antecedent to that time, during the latter part of a first glacial epoch, a great body of water occupied all eastern Nebraska, western Iowa and adjacent parts of Minnesota and Dakota. Its most characteristic deposit is the lœss. This lake was named Lake Missouri about ten years ago (*vide* Proc. A. A. A. S. 1877, p. 291). The general level of the lœss slopes southward, two feet to the mile: and eastward three to five feet, west of the Missouri, and one to two feet east of it. Its altitude is 1800 feet in Wayne County, Neb., and 1000 feet at Marysville, Missouri.

Under the drift in the Missouri Valley are Lacustrine clays and sand, which, further west lie directly beneath the loess, strongly suggesting the conclusion that Lake Missouri may have been the direct successor of the line of grand Tertiary lakes, so ably outlined by King (Expl. 40th Paral., vol. I, p. 458).

Fourth. Lake Cheyenne occupied the plains from Texas to Manitoba and eastward well toward the Mississippi during the Pliocene.

Fifth. Sioux Lake in the Miocene covered the western portion of the Great Plains.

Sixth. In the Eocene, the surface of the plains was dry, but probably not so further north. If not, then this Eocene lake or bay would fill the gap and connect this royal line of lakes with the ocean. Possibly Lake Missouri may have done so much later with the Gulf of Mexico.

ON THE FOLDING OF CARBONIFEROUS STRATA IN SOUTHWESTERN IOWA.

BY PROF. J. E. TODD

(*Abstract.*)

Most who examined the rocks along the Missouri River in the region under consideration have been constrained to record some folding, but such statements have been rather indefinite and have hardly expressed sufficiently the abruptness of the folds.

Before noting the evidence of foldings it will be well for us to briefly notice the character of the strata folded. They consist of a mixture of limestone, clays, marlites, slates and sandstone. The change from one to another is usually abrupt and frequent. Meek concluded that the nature of a stratum changed so much horizontally that lithological characters were of little importance in determining equivalence in adjacent localities. This may be true compared with some regions, but the more frequent exposures of the present time make it quite possible to shew that the strata have fair persistence, and may be traced scores of miles, by their lithological and stratigraphical characters alone.

A fairly complete section of the rocks of southwestern Iowa may be found by placing in order the section at Wyoming, the section at Nebraska City, with Croxton's boring, (*vide* Hayden's Final Report, Nebraska, pp. 101, 106), the sections at Wilson's, (White's Report on Iowa, Vol. I, p. 358), the section at Rock Bluff, and the section below Plattsmouth, (Hayden's Report). Giving this in brief form, omitting the finer details we have the following:

SECTION OF UPPER CARBONIFEROUS ROCKS IN SOUTHWESTERN IOWA.

1. 18 to 19 ft. Blue, red and ash colored clays, with two distinct layers of limestone 2 feet and 4 feet in thickness respectively.

2. 10 ft. Yellowish, micaceous, soft sandstone.

3. 39 ft. Drab, ash, lead colored and chocolate colored clays, with only one thin layer of bluish limestone.

4. 12 ft. Limestone in thin layers, light yellow and gray.

5. 185 ft. Thin layers, mostly of gray shades, though red and blue occur, with five thin beds of limestone and four of sandstone. (This is derived only from Croxton's boring and is quite indefinite both as to its real character and as to its relation to observed sections).

6. 12 ft. Bluish limestone, inter-stratified with black shades and with nearly one foot of fair coal near its center.

7. 30 ft. Drab clays, enclosing three distinct shades of limestone, 2 to 4 feet thick.

8. 20 to 24 ft. Compact limestone, thin bedded and stylolitic more or less.

9. 6 to 12 ft. Drab clays carbonaceous in two horizons and containing two thin strata of limestone.

10. 12 to 25 ft. Soft, fine-grained, yellow sandstone.

11. 35 to 45 ft. Clays and slates, bluish and gray, containing 3 or 4 strata of limestone, one much the thickest, sometimes 7 feet thick.

12. 16 to 20 ft. Limestone yellow and gray (*Fusilina*).

13. 5 ft. Clays.

14. 4 ft. Yellowish incoherent sand.

15. 10 to 12 ft. Limestone.

16. 25 ft. Greenish and chocolate clays above and shales below.

449 to 490 ft. Total thickness.

This is a rather surprising result, after we have been accustomed to referring only 200 feet to the upper carboniferous, as estimated by Dr. White. Some of this may be considered somewhat doubtful still, but at least 350 feet is demanded by facts, as we shall see. The most frequently exposed members of the series are the upper and lower beds of limestone, Nos. 8 and 13, which, from their relation to the clays and sand, are especially apt to form benches, cliffs and rock-houses. It is the upper of these which has furnished the most stone in quarries as at South Bend, Weeping Water, Bennett and Roca, in Nebraska, and Shaw's and Wilson's, in Iowa. The sandstone 12 to 15 feet below the limestone was considered by Dr. White to be the lowest stratum exposed in southwestern Iowa. Several years residence in the region, and numerous observations of many exposures which were not accessible to Meek and White, have led the writer to conclude:

First. That thirty to fifty feet of strata below the said sandstone are exposed in the vicinity of Pacific Junction, as also at Plattsmouth.

Second. That the sandstone which Dr. White discovered south of Fremont City is not the equivalent of the said sandstone in the lower part of Wilson's Quarry, as he inferred. (White's Geol. Vol. 1, *in loc.*), but is of a considerable higher geological horizon. This is shown by the following facts.

(1.) Although the two sandstone strata may be traced at nearly the same level within a half a mile of each other, yet their associated strata are entirely different. One is No. 2, the other No. 11. The former is the sandstone in the Nebraska City and Wyoming sections, the latter that in the Cedar Bluff and Rock Bluff sections, on the Nebraska side.

(2.) At Jones' Point, just above the junction of the Weeping Water with the Missouri, there is a fine expanse, which seems to have escaped Meek and Hayden. It shows a dip of four to five degrees to the south-southeast, which carries over 100 feet of strata, which are exposed as the summit of an anticlinal, shown about a mile north, entirely below the level of the river, in less than that distance.

(3.) The highest limestone in Croxton's boring at all comparable with stratum 8, is that of Nos. 34 and 35, (*vide* Hayden's Final Report, Nebraska, p. 106), 200 feet below the surface of the Missouri. As this stratum has been quite constant for twelve to fifteen miles east and west, it may fairly presumed to be so to this distance south, and making fair allowance for the obscurities of boring records we may consider the identification quite probable if not demonstrated.

(4.) Taking the bottom of stratum 8 as our plane of reference, we find a high anticlinal axis in the vicinity of Plattsmouth on the Missouri, and a little east of Weeping Water town, on the stream of that name, and a lower one more clearly exposed one and one-fourth miles above Jones' Point on the Nebraska side of the Missouri, and a little south of Wilson's on the Iowa side of the valley. The sharp fold immediately south of the latter which has been noted at Jones' Point may become a fault south of Wilson's.

The position of the bottom of stratum 8 is illustrated concisely in the following table:

	Omaha	Bellevue	La Platte	Plattsmouth	Rock Valley	Kenosha	North of Jones' Point	Jones' Point	Wyoming	Nebraska City
Altitude of limestone above Missouri River	38.?	0.	35.?	140.	103.	50.	00.	-50.	-200.	-225.
Distance in miles south of Omaha	0.	5.	8.	14.	19.	22.	26.	27.	30.	35.

(5.) The trend of the fold at Jones' Point is north 50 degrees, east 60 degrees, approximately parallel with the northern border of the carboniferous, viz: a line passing through Dunlap, Iowa, and Rockport, Omaha and Ashland, Nebraska. Also with several exposures in Nebraska and Iowa which may be found to be along the higher anticlinal, viz: Roca, Bennett, Weeping Water, Glenwood, Malvern Macedonia, etc.

(6.) Paleontological evidence seems to coincide with the conclusions from stratigraphy. Of the more than one hundred species, listed by Meek as found in eastern Nebraska, twenty are found north the steep fold at Jones' Point and not south; forty-seven are found south which are not north, and thirty-five are found on both sides of the line.

PROCEEDINGS

OF THE

Iowa Academy of Sciences,

FOR

1889.

The third annual session of the Academy was held in the city of Des Moines on September 5th, 1889, in the Science Rooms of the High School building. There were present a goodly number of the working naturalists of the State. At this session the following papers were presented, and are here given in abstract.

THE BLUE QUAIL (CALLIPEPLA SQUAMATA) IN IOWA.

BY PROF. J. E. TODD

(*Abstract.*)

A specimen of this bird was exhibited, which was shot at Tabor, Iowa, May 20, 1889. The occurrence of this species, which ranges from Texas southward, was connected with the mildness of the past winter, and the great reduction in numbers of the common quail, in southwestern Iowa for the last few years.

IS THE PLUM CURCULIO DOUBLE-BROODED?

BY PROF. C. P. GILLETTE.

(*Abstract*)

In this paper it was concluded that the plum curculio is not wholly or even very largely double-brooded at Ames, Iowa. The more important facts gathered during the past summer bearing upon this subject were:

Egg laying began about the 25th of May and practically ceased by the last of June. Eggs began again to be deposited in considerable numbers about the 20th of July. Unhatched eggs were found constantly from July 22 to August 22. The number of eggs laid after July 20, on trees where counts were made, was over one-fifth as great as the number laid before that date. The beetles reared from early stung plums began appearing in the breeding cages as early as July 22. Beetles were seen pairing July 22. The eggs of the late punctures hatch as well as any and the larvæ develop in the plums.

ON THE DISTRIBUTION OF CERTAIN HEMIPTERA.

BY PROF. HERBERT OSBORN.

(*Abstract.*)

The *Hemiptera* present some instructing cases of special distribution, a few of which are considered. The relation of the distribution to distribution of food plants is discussed and cases cited where there is apparently entire independence of climate, latitude, altitude, etc. For several of the species localities are recorded which extend the range of the species as heretofore known. The species mentioned more particularly are: *Anasa armigera*, *Alydus pilosulus*, *Leptocoris trivittatus* (recorded for eastern Iowa), *Macrocoleus coagulatus*, *Emblethis arenarius*, *Calocoris rapidus*, *Pygolampis pectoralis*, *Melanocaryphus bicrucis*.

ON THE WAX GLANDS OF THE PEMPHIGINÆ.

BY PROF. HERBERT OSBORN.

(*Abstract.*)

After considering the accepted ideas concerning the wax glands of the *Coccidæ* and *Aphidæ*, the paper describes the

structure of these glands in *Pemphigus tessellata* Fitch as an illustration of the unicellular form, (apparently the only form hitherto recognized), and in *Schizoneura crataegi* Oestlund, as illustrating a complex gland. In the latter the waxy secretion is forced through chitinous rims to cup like glands, the glands arranged in clusters four to six or seven in a cluster and each composed of numerous cells.

ADDITIONS TO THE CATALOGUE OF IOWA HEMIPTERA.

BY PROF. HERBERT OSBORN.

The additions to my list of two years ago presented in this contribution number thirty and I have a few species undetermined that can probably be included by the time the full list is published.

LIFE HISTORY AND EMBRYOLOGY OF MONOSTEGIA (SELANDRIA) IGNOTIA (NOR).

BY PROF. FREDERICK W. MALLY, M. S.

(*Abstract.*)

This paper was a brief extract, giving the more important results of a study of the above named species as effecting the strawberry, and included in a Thesis prepared for the degree of Master of Science at the Iowa Agricultural College, Ames, Iowa, and is published in Insect Life, Vol. II.

The adults of this new strawberry pest appear about the 1st of April and begin egg deposition soon after. The period of greatest deposition being about the middle of April. In two weeks the eggs hatch. Larvæ are found from the middle of April, being most abundant during the first half of May, and by the 1st of June all the larvæ have matured and entered the earth.

The larvæ of *Monostegia ignota* (*Nor.*), are distinguished from those of *Harpiphorus maculatus* by having a uniform pale brown head, while the latter have one black spot back of each eye and one on the vertex. *M. ignota* is probably single brooded, as none of the larvæ which entered the earth June 1st have pupated, but up to date, September 2d, have only contracted to one-half the length.

Monostegia ignota appears and again disappears about a month earlier than the old pest *H. maculatus* (*Nor.*). The young larvæ, therefore, are plenty before the strawberry plants begin blooming and hence can be easily exterminated by the application of any of the arsenical poisons without the danger of poisoning the berries. These poisons can be effectively applied about the latter part of April or first of May.

THE CRYSTALLINE ROCKS OF MISSOURI.[1]

BY PROF. ERASMUS HAWORTH, PH. D.

(*Abstract.*)

In the May and June numbers American Geologist the writer published a preliminary description and classification of the crystalline rocks of Missouri. Since that time considerable more field work has been done, and much new material gathered which is now being examined in the laboratory. Thus far nothing has been discovered which would originate any new ideas regarding the geology or petrography of the district under discussion, but a great deal of evidence has been obtained confirming views advanced in the publication above mentioned.

The relative ages of the crystalline and sedimentary rocks may now be considered established. The sedimentary rocks are younger than the underlying granites and porphyries. This has been stated by every geologist who has written on the subject, but the evidence, so far as made known, was simply that of super-position. This evidently is not conclusive:

1. Read by consent of the Director of the U. S. Geological Survey.

for if the granites and porphyries are eruptives they might be beneath the sedimentary rocks in many places and still be the younger.

The writer observed, in many localities, limestones and sandstones, and conglomerates which had fragments of the crystalline rocks imbedded in them, varying in size from very small to more than two feet in diameter. It is the rule rather than the exception that these fragments are present. There can therefore be no doubt whatever but that the sedimentary rocks are younger than the underlying granites and porphyries. This is all the more interesting on account of the conclusion reached by the Director of the Arkansas State Geological Survey, which had heretofore been counted archæan.[2]

The porphyries and probably the granites of Missouri are unquestionably of eruptive origin. Both the field and petrographical evidence in support of this proposition has been greatly increased since June, 1888.

The interesting relations between the porphyries and granites have been studied in detail in several localities. At present positive statements cannot be made, but it seems probable that the granites and porphyries belong to one and the same eruptive mass. The granite areas are quite small, some of them measuring only a fraction of a mile in diameter while others are three or four miles. The boundaries between the two rocks were traced in different places, and hand specimens carefully taken for petrographic study. All the evidence gathered favors the view advanced above.

In the American Geologist, Vol. I, p. 290-291, the writer has figured certain enlargements of feldspar crystals in the granite, and explained this secondary growth by supposing that the enlargement took place prior to the final consolidation of the magma. Prof. J. W. Judd has done me the

2. Am. J. Science; [illegible], July, [illegible].

honor to reproduce these drawings in the Quarterly Journal of the Geological Society for May, 1889, p. 183, in an article: "On the Growth of Crystals in Igneous Rocks after Consolidation." In this interesting paper Prof. Judd concludes that the crystal enlargements from Missouri belong to the same general class observed in fragmental rocks by different workers, especially by Irving and Van Hise.[3]

It seems to the writer that the examples produced by Prof. Judd from Mull, in the Western Isles of Scotland, are so dissimilar to the Missouri specimens that it is unsafe to class them together. His is a *Labradorite-andesite* with large porphyritic crystals of labradorite, and a glassy base. The Missouri specimens are from a fairly well crystallized granite: one having idiomorphic crystals, it is true, but which is very far removed from a rock with a glassy base. Judd's idea is that "the growth of crystals of felspar and quartz goes on, at the expense of a more or less vitreous matrix, long after the solidification of the rock," etc.

Neither the field work nor the laboratory work on the Missouri crystalline rocks is completed. The writer will hold himself ready to alter his views on any of the subjects, or to entirely abandon them, should subsequent evidence demand it.

THE NATIVE FOOD FISHES OF IOWA.

BY PROF. SETH E. MEEK, M. S.

(*Abstract.*)

In the waters of Iowa, including the Mississippi River along her eastern border, are found about one hundred species of fishes, of these about thirty-six are usually found in our markets, and are regarded as food fishes of more or less value. About eight of the remaining species are large enough for food, but for various and just reasons, have no market

3. See Bull. 8, U. S. G. S. and Am. J. Science, (3). 30. 233, 35.

value. In some the flesh is poor, tough and rank flavored, while in others it is dry, tasteless and full of very small bones. Among such are the shovel-nosed sturgeon, the dog fish, the garpikes, the hickery shad, the skip jack and others never used more than once for food by the same person.

The remaining species are all small, and while directly are of no value, yet indirectly are of much importance. These small fishes, together with the young of all species, furnish much of the food for the large predatory fishes.

In the present paper is given a systematic list of our native food fishes together with a few notes as to their distribution in our waters, their habits and their value as good fishes.

Detailed descriptions of all the fishes enumerated in this paper can be found (1) in Jordan and Gilbert's "Synopsis of the Fishes of North America," published by the Department of the Interior. (2) "Jordan's Manual of Vertebrates of Eastern United States," published by A. C. McClurg & Co. Descriptions and figures of most of them are found in "History of Aquatic Animals," published by the Census Bureau.

Family 1—POLYODONTIDÆ.

2. *Polyodon spathula* Walbaum. Paddle Fish.

This species is known by the prolongation of the long, flat blade which overhangs the broad terminal snout: it inhabits only the larger streams of the Mississippi basin. In this State specimens are occassionally taken from the Cedar River, the Iowa River, the Missouri River and from the Mississippi River. It no doubt inhabits all of the larger streams of the State. Fishermen on the Mississippi River find it more common in the fall and then in bayous. It lives chiefly on small forms of animal life which it stirs up from the mud with its long snout. This remarkable fish attains a length of six feet and is but little esteemed for food.

Family 2—ACIPENSERIDÆ.

2. *Acipenser rubicundus* Le Sueur. Lake Sturgeon, Rock Sturgeon.

This species may be known from the shovel-nosed sturgeon by the presence of spiracles, the sub-conic snout and by the tail which is not depressed nor completely mailed. This species is common in the Mississippi River in the spring, rather scarce at other times of the year. I have no positive record of its being taken in streams within the state, yet it no doubt inhabits them. It reaches a length of six feet and is a fairly good food fish.

Family 3—SILURIDÆ.

3. *Ictalurus furcatus*, Cuv. and Val. Chuckle Headed Cat.

This species may be known by its deeply forked tail, and long anal fin, the latter with thirty-two to thirty-five rays. This species is not common in the state, and is found only in the larger rivers. It reaches a length of two and one-half feet and is the best food fish in the family.

Ictalurus punctatus, Rafinesque. Channel Cat, Silver Cat.

This species differs from the above in having twenty-four to thirty rays in the anal fin. It is common in all the streams and the larger bodies of water in the state. It is larger than the preceding, and as a food fish is not distinguished from it.

4. *Ameiurus nigricans*, Le Sueur.

This species is distinguished from the other *Ameiuri* by having a forked tail, and from the two preceding it can be recognized by its more robust form and darker color. I know of no specimens of this species being taken in this state except from the Mississippi River. It no doubt inhabits the larger streams. This is the largest cat-fish found in the state. Specimens of immense size used to be taken from the Mississippi River, some said to weigh two hundred pounds. At present one is seldom taken reaching a weight of sixty pounds. It is a good food fish though its flesh is rather tough.

5. *Ameiurus natalis*, Le Sueur. Yellow Cat.

The tail is not forked in this species and the following species of the genus. Anal rays twenty-four to twenty-six rays. I have collected but one specimen of this species in the State: it was taken from Indian Creek near Marion. This species attains a length of twelve to fifteen inches. It frequents sluggish streams and still bodies of water. The large head and small body prevents this species as well as the two following from ever being used extensively as a food fish, all rank fairly well as food fishes, especially when not taken from warm stagnant pools.

6. *Ameiurus nebulosus*, Le Sueur. Bull Head, Horn Pout.

Anal rays twenty-two, similar to the preceding. This fish is very tenacious of life. It is common everywhere in the State yet less so than the following. Length twelve inches.

7. *Ameiurus melas*, Rafinesque. Small Black Cat.

Anal rays eighteen to twenty. Found with the preceding from which it not distinguished by fishermen.

8. *Leptops olivaris*, Rafinesque. Mud Cat, Flat Head Cat.

This is the largest of the cat fishes except *A. nigricans* from which it may be distinguished by its flat head and shorter anal fin. Anal rays twelve to fifteen. It inhabits the larger streams of the State and is less common in the Mississippi River than in former years. It reaches a weight of seventy-five pounds, but seldom one is found at present which reaches half this weight. A very good food fish.

Family 4—**CATOSTOMIDÆ**. The Suckers.

9. *Ictiobus cyprinella*, Cuv. and Val. Common Buffalo Fish.

This species may be distinguished from the other buffalo fishes by its thin lips, large terminal mouth, which is protractible forward. It inhabits still water and is seldom found in the river currents. Very common in bayous. It is extensively used as a food fish, though its flesh is rather coarse and full of small bones. It frequently reaches a weight of thirty pounds.

10. *Ictiobus urus*, Agassiz. Razor Backed Buffalo.

Known by the thin lips and the sub-inferior mouth which is protractible downwards. It is very similar to the preceding, and more frequently found in the river current. Length about two and one-half feet.

11. *Ictiobus bubalus*, Rafinesque. Small Mouthed Buffalo.

Lips thick and sucker-like, mouth sub-inferior. Common in Mississippi River, less frequently taken in bayous. It reaches a length of two and one-half feet and is usually more abundant in the market than any of the buffalo fishes.

12. *Cycleptus elongatus*, Le Sueur. Black Horse, Missouri Sucker.

This species is known by the very long head, pointed snout and small eye. Not common, and found only in the larger streams. It reaches a length of two and one-half feet, and is more highly esteemed for food than any other of the suckers.

13. *Catostomus teres*, Mitchell. Common Sucker, White Sucker, Fine Scaled Sucker.

Known from the other suckers by the smaller size of the scales on anterior part of body, sixty-five to seventy scales in lateral line. This is one of the most abundant fishes in Iowa. It reaches a length of one and one-half feet. As a food fish it is of little value.

14. *Erimyzon sucetta*, Lacepede. Chub Sucker.

This is the only sucker found in the State without a lateral line. It is not common in the streams of Iowa. It seldom exceeds a foot in length and is little valued as a food fish.

15. *Minytrema melanops*, Jordan. Striped Sucker.

On each scale is a black spot, these spots forming dark longitudinal stripes. I have found this fish only in Squaw Creek, near Ames, Iowa, and in the bayous near Muscatine. It is not very common and is usually taken in the spring. Too small to be regarded as a good food fish.

16. *Moxostoma duquesnei*, Le Sueur. Common Red Horse, Mullet.

This species may be known by its slender form and the larger scales on the body, about forty-five in the lateral line, pale and silvery. The species is very abundant in the State. It reaches a length of two feet and is not regarded as a valuable food fish. It is found usually in clear water.

Family 5—**SALMONIDÆ.** The Salmons.

17. *Salvelinus fontinalis*, Mitchill. Brook Trout, Speckled Trout.

On May, 14, 1889, a specimen of this species was taken from Mad Creek, Muscatine, Iowa. I am also informed by Mr. Minott, a well known hunter and fisherman on the Cedar River, that they used to be found frequently in a small tributary of the Cedar River, near Mt. Vernon. At present but few are taken in Iowa and these are stragglers from farther north. I do not know of other salmon being taken in Iowa. As a food fish the brook trout ranks among the very best.

Family 6—**ESOCIDÆ.** The Pikes.

18. *Esox vermiculatus*, Le Sueur. Little Pickerel.

This species is known from the other pikes of this region by its entirely scaled cheeks and opercles. It is quite common in this State. It attains a length of twelve to fifteen inches. Its flesh is excellent, but its small size makes it a food fish of little importance. "It delights to quietly loiter in the shelter of the pads of the pond-lily and in the shadows of the dense masses of *Potamogeton*, a few inches below the surface of the water. Motionless, in such situations, it awaits the coming of the unwary minnow, when, quicker than thought, it darts upon its prey, and while you look sinks slowly from sight. There is no apparent motion of fin or tail, but ere you realize it, the ravenous beauty is gone. Its coming to the surface is as motionless and unexpected."—*Call.*

19. *Esox lucius*, Linnæus. Pike, Northern Pickerel.

This species is known by the half bare opercles and by being light spotted on a darker back ground. The habits of this species are similar to the preceding. It attains a length of four feet and is one of our very best food fishes. It is a favorite game fish and many are caught each year by anglers in the lakes in this state.

20. *Esox nobilior*, Thompson. Muskallunge.

This species is known by the absence of scales on the lower half of the cheeks and opercles and by being dark spotted on a lighter back ground. The muskallunge reaches a length of six feet and attains a weight of over eighty pounds. It is one of the most voracious of fishes and decidedly gamey. They are found only in small numbers. Specimens are occasionally taken in the Mississippi River. The head of a large specimen taken from the Skunk River, near Ames, is in the Iowa Agricultaral College Museum, others are said to have been taken from the same place. This species is not always distinguished from the preceding. It is an excellent food fish.

Family 7—**ANGUILLIDÆ.** The Eels.

21. *Anguilla rostrata*, Le Sueur. Common American Eel.

The common eel is found in all the larger streams of the State, though it is not abundant anywhere. As a food fish it ranks well.

Family 8—**CENTRARCHIDÆ.** The Sun Fishes.

22. *Pomoxis sparoides*, Lacepede. Calico Bass, Grass Bass, Crappie.

This species is very abundant near Muscatine. It is usually called crappie and usually not distinguished from the latter by the fishermen. It can be told from other sun-fishes in this State by the presence of seven or eight dorsal spines and seven anal spines. It reaches a length of twelve inches and is a fairly good food fish.

23. *Pomoxis annularis*, Rafinesque. Crappie, Batchelor, New Light.

Apparently much less abundant than the former, from which it differs chiefly in color and one less dorsal spine.

24. *Ambloplites rupestris*, Rafinesque. Rock Bass, Red Eye, Goggle Eye.

The only sun-fish found in this State with nine dorsal and six anal spines. It is quite common in this State. It attains a length of about twelve inches and is a good food fish.

25. *Chaenobryttus gulosus*, Cuv. and Val. War-Mouth, Red Eyed Bream.

Similar to the preceding but with three anal spines. It is a very voracious fish, living in sluggish and grassy waters, quite common in bayous along the Mississippi River. I have not seen it elsewhere in the State. Length twelve inches: a good food fish.

26. *Lepomis cyanellus*, Rafinesque. Green Sun Fish.

27. *Lepomis megalotis*, Rafinesque. Long Eared Sun Fish

28. *Lepomis pallidus*, Mitchill. Blue Sun Fish.

29. *Lepomis gibbosus*, Linnaeus. Common Sun Fish, Pumpkinseed.

These four species are found throughout the State, the last being the more abundant. Their flesh is fine but their small size prevents them from being important food fishes.

30. *Micropterus dolomieu*, Lacepede. Small Mouthed Black Bass.

31. *Micropterus salmoides*, Lacepede. Large Mouthed Black Bass, Oswego Bass

These two species are perhaps our best game fishes. They are found in considerable numbers in the rivers and lakes of the State, one seems about as abundant as the other. They grow about the same size, seldom exceeding a weight of eight pounds. The small mouthed bass is a dull olive green, the young with cross bars. The large mouthed is lighter with usually a broad dark lateral band. As food fishes both are among our best.

Family 9—**PERCIDÆ.** The Perches.

32. *Perca flavescens*, Mitchill. Yellow Perch, Ringed Perch.

This species is quite common in this State especially in some of our northern lakes. It seldom reaches a length of fifteen inches. It is a good game fish. Its small size prevents its being an important food fish.

33. *Stizostedion vitreum.* Wall Eyed Pike, Jack Salmon.

This species is one of our most important food fishes. It is taken in large numbers every year in Spirit Lake and in our larger streams. It is an excellent game fish, reaching a weight of twenty to forty pounds.

34. *Stizostedion canadense*, Smith. Sanger, Sand Pike, Gray Pike.

Similar to the above but smaller, and perhaps less abundant.

Family 10—**SERANIDÆ.** The Sea Basses.

35. *Roccus chysops*, Rafinesque. White Bass. Striped Bass.

This species is not very abundant in the State. It seldom reaches a length of fifteen inches. It possesses some of the qualities of a game fish and as a food fish is not very inferior to the black bass.

Family 11—**SCIENIDÆ.** The Drums.

36. *Aploidonotus grunnicus*, Rafinesque. Fresh Water Drum, Croaker.

This species attains a length of two feet or more but is a food fish of inferior quality.

NOTES ON THE NATIVE FOREST TREES OF EASTERN ARKANSAS.

BY PROF. R. ELLSWORTH CALL.

(*Abstract.*)

During the summers of 1888 and 1889 opportunity was presented the writer, in connection with geologic work on

the Geological Survey, to study somewhat carefully the tree flora of the region east of the Iron Mountain Railroad and north of the Arkansas River. These original notes, thus made, have been checked by various fragmentary publications, chief of which are those by Prof. Leo Lesquereaux.* Prof. F. L. Harvey,† Dr Charles S. Sargent‡ and Dr. George Englemann.**

So far as known to the writer these references contain the only reliable information on the forest regions of eastern Arkansas accessible to the student. The value of the first, great as it unquestionably is, is somewhat lessened by the too general statements pertaining to habitat and, further, by the questionable identification of certain forms.

These causes of error could not well have been avoided, however, since the observations included in the report were made under great limitations of time, having been commenced in the month of October and ended in December. It is understood that neither flower nor fruit was accessible in many instances and thus it happened that on the most trivial general characters alone, plants including trees, were credited to the flora of Arkansas that have not since been seen by any observer. With respect to the other references, little need be said, more than that they are generally quite accurate and afford valuable and reliable information for the State generally. Little, however, can be gleaned from them except in a most general way, respecting the trees of the area limited above. It is hoped to contribute, herein, a little specific information based upon careful and extended observation, particularly of every county from Helena north to the Missouri line and west of the St. Francis River.

* "Recent Botany and General Distribution of the Plants of Arkansas," in Second Report of the Arkansas Geological Survey for the years 1859 and 1860. (Philadelphia 1860), pp. 346–399.

† "The Forest Trees of Arkansas," (Cincinnati, 1883, being a reprint from the American Journal of Forestry, for June and July, 1883.

‡ Tenth Census of the United States, Vol. IX, "The Forest Trees of the United States." Washington 1884.)

** Transactions of the Academy of Natural Science of St. Louis, Vol. III, No. 3, p. 371, *et seq.* (1876). and Vol. III, No. 4, pp. 385 and 584 *et seq.* "About the Oaks of the United States."

Fully four-fifths of the State of Arkansas is still covered with primitive forest. During the last decade only has much been done by the hand of man toward the removal of this vast forest, but so suited appear to be the soils and climatic conditions to the great development of an arboreal flora that even in those regions once practically cleared of the forest there is now a rank growth of the common forms of hardwood trees; the cleared pine areas, too, give promise of future valuable forests. So that Arkansas is still, practically, a forest covered State.

As a whole the State may be divided roughly into two prime areas, the greater of which may be denominated the lowlands. Something more than one-half of the total area of the State will be included in this division. The remaining section comprises the Arkansas portion of the Ozark uplift, which consists of numerous somewhat parallel ranges of high rocky hills or low mountains trending south of westward, and which have a constantly lessening altitude as they are traversed at right angles or toward the south. To the eastward the highland area is limited by the palaeozoic scarp, which may be, for our purposes, indicated by the course of the St. Louis, Iron Mountain & Southern Railroad. The total area above sea level is only about eight hundred square miles or little more than one and one-half per cent, while by far the greater portion of the State will fall below four hundred feet elevation. This higher portion has a large number of interesting trees and shrubs, some of which are peculiar to it, but lying without the area personally examined, is without the proper scope of this paper. Attention may, however, be called to the fact that very many of the lowland trees penetrate far within this hilly country but keep in the main, along the valleys of the larger streams—the Arkansas, the Little Red, the White and the Black Rivers. This is especially true of the cypress, sweet gum, willow-oak, overcup-oak and post-oak.

For the purposes of this sketch eastern Arkansas may be considered a great alluvial plain underlain more or less deeply with deposits of quarternary age overlying—though the quarternary is sometimes wanting—the heavy beds of clays and sands of tertiary age which constitute the chief geologic feature of the area. The soils are generally stiff and clayey, sometimes containing considerable sand and are always cold and wet. That is, the subsoil is a hardpan, often of great thickness, and utterly incapable of complete drainage by either natural channels or artificial methods. The tree flora, therefore responds in character to these physiographic and geologic conditions. A few large and sluggish streams traverse the area among which are the Arkansas, White, Cache, Anguille and St. Francis Rivers. In the bottom swamps of all these streams occur great patches, often miles in extent, of cypress-*Taxodium distichum* Mich., while around the borders of the cypress swamps are found dense growths of hardwoods, among them the willow or water-oak, white-oak, post-oak, black and sweet gum, winged elm, and several forms of *Carya*, notably the shell-bark hickory and pecan.

Within this area the chief topographic feature of importance is Crowley's Ridge, a range of low hills which enters the State from Missouri in the northeast part of Clay County and extends southward, with varying width, to Helena, in Phillips County, a distance of some one hundred and forty-five miles. The geology of the ridge is, briefly, about as follows: Deposits of quaternary age cap it, the lœss being the chief petrographic feature of the southern half. This lacustrine or fluviatile terrane lies directly upon a gravel bed, of varying thickness, which is believed to be correlated properly with the Orange Sand gravels. Following this member are vari-colored cross-bedded, and sometimes indurated, sandstones and clays of tertiary age, the lowest strata yet observed being Eocene in age and belonging to the Claibornian.

These tertiary strata out-crop in the ravines throughout the ridge wherever erosion has removed the quaternary deposits, and also, in a measure, may be seen throughout the ridge at its foot, particularly along the eastern portion of the southern half and the western portion of the northern half. Aside from the lœss deposits the soils of the ridge are noted for the amounts of silicious matter, including sands which they contain, and for the paucity of lime in the form of the carbonate. Except in the case of the pine—*Pinus mitis*—the tree flora does not respond, in any certain measure to this chemic condition of the soil. The ridge is botanically interesting as fostering the growth of a few tree-forms found nowhere else in the State of Arkansas, though abundant in other States in similar and likewise in diverse soils.

Of the *Coniferæ* only the short leaved pine—*Pinus mitis*—and the cypress occur. North of the Arkansas Prof. F. L. Harvey reports the occasional occurrence of the "old-field pine" —*Pinus tæda*—but it is confined mainly to the suitable areas south of that stream and is never conspicuous north. Only the common short leaved form may be seen at any point north of Helena. In connection with this form it may be observed that the distribution of trees in eastern Arkansas is determined more by the general uniformity of soils and topographic features presented than by any marked differences in climatic influences. This species is found mainly, on sandy or gravelly ridges and is confined almost solely to the highest portions of Crowley's ridge, though small areas, as narrow strips, are found along the White River, but mainly south of the latitude of St. Francis County. North of that latitude the pines do not, as a rule, descend to the bottom lands at all. On these highest ridges there is a thin covering of quaternary soils, mixed with varying quantities of tertiary sands and clays. It is, as a whole, a highly silicious soil, of no possible agricultural value when the forests shall have been once removed. Crowning as it does the tops of these highest ridges the pine zone, in this portion of Arkansas, is comprised within a single narrow strip of country, usually not more than one-half to three-fourths of a mile wide, though in Greene and Poinsett Counties the greater width of Crowley's Ridge permits of a series of somewhat parallel ridges the tops of which are often crowned with pines. At such places the zone may widen to two or even three miles.

So great have been the inroads on the pines of this narrow belt that comparatively little of marketable value now remains and that little is difficult of access, being, for the most part, far removed from railroads. The topography of the ridge likewise renders its removal a matter of extreme difficulty, and the slow moving ox team can alone be used to advantage among its steep slopes. But since pine replaces pine in this region a judicious cutting of the intermixed oaks and hickories of the pine belt will, in future years, again render this portion of Arkansas attractive to the commercial lumberer.

Perhaps sufficient has already been said respecting the cypress. Little more may be added than to say that scarcely have the quantities of that timber which have been taken from the swamps of this region sensibly diminished its area. It is found from the Missouri line southward in abandoned channels of the St. Francis and other lesser streams and in the great swamps which are scattered throughout these wet lowlands generally. It penetrates some distance within the palæozoic area of the northwest portion of the State, along the greater water courses, but apparently reaches its maximum development in the White, St. Francis and Arkansas River bottoms.

The cypress is difficult of access in the larger swamps and the supplies for shingle and other uses have been obtained chiefly along their margins. The tree is one of comparatively rapid growth and attention to the laws of forestry will render forever valuable a great portion of eastern Arkansas useful for no other purpose. The species is a light loving tree, that is to say, the crown must have the full force of the light and heat of the sun. No matter then how somber the shadows that enshrine its trunk it will thrive. By one standing on the higher portions of the face of Crowley's Ridge whence a stretch of country full sixty miles in width may be commanded, the cypress patches and zones may be easily distinguished as dark green islets or even belts which tower far above the surrounding forests. The size attained is often very great occasional specimens having been noted by the writer over seven feet in diameter. Aside from the manufacture of shingles the chief use to which the lumber is put is in fence building, for posts, its power of resistance to the action of water being very great.

The tree of present chief value in eastern Arkansas is the white oak—*Quercus alba*. It attains a very great size on Crowley's Ridge and is, beyond question, the largest tree there growing. It extends, also, into the bottom lands of the Anguille and Cache Rivers, on the west. On the east of the ridge, in the bottom land of the lower St. Francis comparatively little white oak occurs, it being there replaced by the "over cup" and "cow oak"—*Quercus lyrata* and *Quercus micheauxii*—together with other less useful forms. Many specimens occur one hundred and thirty to one hundred and forty feet in height and five to six feet in diameter. It once constituted the glory of the eastern forest but the richest areas have been thrice cut over and the most of this valuable timber is gone. The use to which this timber is put is chiefly in the manufacture of staves for whiskey and alcohol barrels, and for export, much of the product being made into barrels, which are then "knocked down" and shipped to Europe. Their use abroad is understood to be for wine and spirit barrels, the close and fine texture of the wood rendering it an especial favorite for this purpose. Large quantities of culled wood of the white oak goes into pork and oil barrels, though the timber of the cow oak is rapidly coming into favor for this purpose. The complete felling of this valuable species is now a question of a very short time and the closeness with the timberer cuts leaves, when coupled with the extremely slow growth of the tree, little hope that a second growth will become available. It is felled with a wanton hand, a comparatively small portion of the tree is utilized—the bark not all—the balance allowed to decay. Stave mills and factories, for both rough and finished products, are found at intervals of a few miles only, along the railroads and away from them, of which the total annual output of staves must run into the millions in numbers.

A very large and beautiful tree of eastern Arkansas is the sweet gum, or *Liquidamber styraciflua*, which abounds throughout the low country. Occasional specimens were noted in the St. Francis bottoms, the diameter of which exceeded six feet, while in Craighead County, trees of five feet diameter were common. This species is probably the most beautiful of the native forest trees of the south. The five-pointed, star-like, leaves, crowding the branches and stems, even to within a few feet of the ground, render its dense foliage of dark green color, which trembles in the breezes somewhat after the manner of the poplar or aspen, peculiarly attractive. The branches of the younger forms are winged after the likeness of the winged elm, but with broader and somewhat thicker alæ. Its wood will sometime become valuable though the degree to which it warps or twists in drying renders it unfit for very many purposes to which its texture admirably adapts it. It is, however, largely used for heavy timbers in barn and house construction, and by manufacturers as a veneer, a large portion of the so-called mahogany furniture being made from this species. The wood takes a high polish and maintains well its position as a rival to cherry.

Two species of forest trees, one of great economic value the other of none, occur on Crowley's Ridge and one of them is found nowhere else in the State. These are the so-called "yellow poplar"—*Liriodendron tulipifera*—and the American beech—*Fagus ferruginea*. The first, the tulip tree, occurs throughout Crowley's Ridge, along its base on either side. Notwithstanding that immense quantities have been removed and sold in northern markets under the name of "poplar" and "yellow poplar" immense quantities are still standing, especially in sections somewhat removed from the railroads. It is a noble tree, often one hundred feet high and with its great trunk extending, frequently with slight variation in diameter and devoid of branches, for forty to sixty feet, is peculiarly valuable for many economic uses. I do not know how or why the tulip tree came to be called a poplar. It is one of the *Magnoliaceæ*, while the poplar proper belongs to the *Salicaceæ*—two families botanically far removed and utterly unlike. But by the name of "poplar" it has long been known in eastern Arkansas and will so be known, probably, so long as sufficiently abundant to attract attention.

The beech, of which no use is made except for firewood, is found on both slopes of Crowley's Ridge and occasionally, though sparingly, on its summit. It attains wonderful proportions equal to those attained by the same species in southern New England and central New York, though this area appears to be quite the limit of its southern distribution in the southwest. A peculiar feature of very many of the larger trees of this form is that all are hollow or if not hollow the heart is dead. Whether this be characteristic also, of the species as it occurs in New England and New York the recollections of my boyhood days are too indefinite to be certain.

These general notes were followed by a register of the species observed in which were given notes on size, abundance, distribution, variations and other facts of observation. The total number of species on which data were obtained were about eighty, the oaks being the most important economically. The botanical relations of the area need a thorough sifting and promise a rich field to whoever shall undertake the study.

ON THE GEOLOGY OF EASTERN ARKANSAS.

BY PROF. R. ELLSWORTH CALL.

(Abstract.)

This paper was a continuation and extension of the one presented at the meeting of 1888, and like it was based on the field work done under the auspices of the Arkansas Geological survey. The area studied was much more extensive than that reported on in the preceding year.

The general region examined is all that portion of the State which lies east of the St. Louis, Iron Mountain and Southern Railroad and north of the Arkansas River. The region particularly examined extends from Helena north to the Missouri State line, included a particular study of the geological formations seen in Crowley's Ridge and sought to connect these terranes with those of similar age in other portions of the State. The more obvious facts gleaned during the field investigations are the following:

The eastern half of the State of Arkansas is included within an area which, until comparatively recent geological time, was entirely submerged under a northward extension of the Gulf of Mexico. Reaching away southwestward from near the mouth of the Ohio River, in a nearly direct line, this old gulf found a western limit at the palæozoic escarpment which is approximately, if not exactly, indicated in the state of Arkansas by the railway line above named. From Newport southwards to near Little Rock, the strata composing the oldest series of tertiary rocks—to which series the subjacent strata throughout this area belong—lie uncomformably upon carboniferous shales and sandstones. At and about Little Rock these same strata lie in direct relation to slates of possibly similar geologic age and also to crystalline rocks of uncertain age. Southwestward from the capital of the State to near Arkadelphia and onwards to the State line near Texarkana the strata lie comformably upon rocks of cretaceous age. So gradual is the change in the macroscopic and lithologic characters of the rocks along the Ouachita at Arkadelphia that the line of demarkation between the cretaceous and tertiary cannot possibly be drawn. Here, if anywhere in the State, is to be seen absolute conformity both in stratigraphic and chronologic sequence.

No effort has been made herein to correlate the various subdivisions of the tertiary in this State with the divisions recognized by other observers. Such correlation would be premature, and would be authentic only after very extended and careful observations on the whole tertiary area of the State, while as above noted our observations have been somewhat limited in respect to area. It must suffice to say that the study made shows that the tertiary series included within the scope of this report belong to the eo-lignitic of recent writers and that possibly the Jacksonian group, now considered to attain its most northern extension at Helena, in Phillips County, outcrops in the southwestern portion of Clay County, that is, must be extended northward more than one hundred and forty miles.

One other general conclusion is here deserving of mention, viz: Whatever distinctions or divisions are, in the future, to be recognized within this area must be based upon stratigraphic and petrographic rather than upon palæontologic data. The paucity of fossil remains in all fossiliferous divisions, except in that which is tentatively, herein, denominated the Ostrea bed, and the absolute dearth of such remains in most of the strata lithologically recognized as Eocene tertiary precludes a classification based upon their faunal contents. As has been above indicated the facies of the fauna which has been collected and studied appears to necessitate the correlation of the lowest beds with the Clairbornian.

To sum up the stratigraphic or geologic history of Crowley's Ridge and with it that of the region of which it forms a considerable topographic feature it may be said that the ridge is the remains of a former extensive plateau, the western limit of which was the palæozoic scarp of middle Arkansas, as noted above. That erosion occurred from the west, by the waters which are now represented by the White River and other streams, to which, nearly at the northern boundary of the State, the Mississippi added enormous volumes of water, either continuously or periodically. These did their work so completely that the whole of the country between Crowley's Ridge and the palæozoic rocks on the west has been lowered and carried away except where a few unimportant secondary ridges, such as that at Augusta, in Woodruff County, remain to bear witness to the past former height of the whole country. To the eastward the Mississippi was engaged likewise in the work of destruction and denudation, ploughing out an immense trough to which the present Mississippi bed is but the merest pigmy. But while it dug its valley wider it also dug it deeper. Nor has the refilling which for centuries has been occurring yet brought the eastern level up to that west of Crowley's Ridge. During the progress of denudation, the whole southern basin of the Mississippi was slowly sinking, the gulf traveled northwards, until Crowley's Ridge became entirely sumerged while the silt laden waters which came slowly flowing from the north deposited their burdens as the great blanket of lœss the remains of which caps it throughout nearly its entire length. Then came the time of continental resurrection since which periods the rivers and their tributary creeks and brooks aided by frost, wind and rain, have recommenced the work of destruction, the task of the removal of Crowley's Ridge.

The surface soils of the region are roughly divisible into two groups, each one of which maintains well its chief features in all sections. To the east of the ridge and in the valley of the L'Anguille the surface soil is a rich black loam, such as is usually found on lands subject to overflow and which may stand as the type of the first group. The cultivable soils in the St. Francis-Mississippi bottoms are deeper and richer than any other locality, but they are limited to, comparatively speaking, small areas and these are ridge-like in their distribution. In the L'Anguille bottom the area of black loamy soil is not only a minimum but is also less in depth, rarely exceeding two or three feet at most. This group of soils on both sides of the ridge is remarkably productive, but, since they are in both sections underlaid—generally on the west but only locally so on the east of the ridge—with a limonitic clay or "buckshot" hardpan which in many places comes quite to the surface they have a defective drainage. While these lands produce abundantly certain cereals, such as oats and less abundantly corn, they give but light yields of the staple of the region which in common with all the south is cotton. The yield of this product is usually about one-half bale to the acre.

The ridge soils are the type of group two and are the least adapted for cultivation profitably. They are usually light colored, reddish or yellow predominating, and always more or less sandy, though in many localities they are stiff with abundant clay. Wherever the native dense grasses or other vegetation is removed the soils wash badly and since the slopes of the ridge are precipitous soon very large gullies are formed, which in time grow into extensive ravines or even deep canon-like embayments. Nevertheless these soils yield a fair return to careful husbandry, but are liable to speedy exhaustion, a condition due to the generally prevalent method of farming, a method which does not contemplate rotation of crops as one of its leading principles. These soils will prove permanently valuable only through the greatest care and a complete change in the methods of culture now in vogue.

To the second group of soils belong, also, all those lands which lie along the slopes of the ridge, on both sides, the western of which are, however, by far the most extensive. These soils are the products of erosion and are largely composed of the lœssian clays which cap the ridge. They are generally mingled with much sand and occasional pebbles from the generally distributed orange sands. They are generally deficient in lime, though this deficiency could be easily remedied by the use of the extensive beds of calcareous marls which are found in some portions of the eastern part of the State, notably in St. Francis County.

With a view to the determination of the value of certain of these soils for agricultural purposes the chemist of the survey, Dr. R. N. Brackett, has made such analyses as are usual in determining the actual value as far as this can be decided by the chemical study of the soil. A chemical analysis in itself, however, does not represent a verdict definitive of the value of a soil for farming purposes. Soils are very complex, the major portions of the elements entering into their constitution are very small in quantities, and their fertility is dependent somewhat on the rate and completeness of the decomposition to which the mineral elements are subject. The analysis then decides nothing as to its agricultural value save within rather narrow limits. But it may decide (a) the absence of some important element or (b) the presence of some element deleterious to plant growth. Analysis of the soils of the region, it may be said generally, show that its cultivable area is composed of a soil containing plant food in fair abundance and in a tolerably soluble condition; that its chief deficiency is lime and available phosphoric acid; that the ridge soils are easily tilled and thrifty when new but possess little durability; that, for the future as now, the best farming lands will be those that lie along the gentle slopes of the ridge. In this brief estimate, of course, the rich alluvium of the overflowed regions is not considered, for from the presence of abundant decomposing and decomposed organic matter, as well as because of constant additions of fine soil from other regions, this quality of land is always fertile and easily tillable.

There are no economic products of a distinctively geologic character to be found in northeastern Arkansas. There are no ores nor are there any deposits of coal. Its abundant lignite is unavailable for fuel, first, because it is a rather poor variety of brown lignite, with much hygroscopic moisture and comparatively little volatile matter and a minimum of fixed carbon, and second, because its stratigraphic relations to overlying and underlying soft clays are such as to render its mining difficult and expensive.

BEGGIATOA ALBA AND THE DYING OF FISH IN IOWA.

BY PROF. L. H. PAMMEL.

(Abstract.)

The secretary of the State Board of Health found fish dying in great numbers at Tama City, Marshalltown and Des Moines. The odor after the removal of ice was very disgusting, partly due to the decomposition of dead fish and other

organic matter contained in the water, but also to the growth of a micro-organism. The water below the glucose and starch works at the above places contained large quantities of a greyish gelatinous substance. In microscopical examination this was found to contain large numbers of putrefactive bacteria, but especially common was *Beggiatoa alba*, which is not uncommon on the dead filaments of *algæ* and other decaying organic matter in water. The odor of hydrogen sulphide was very pronounced in the fresh material. After the heavy rains in June the gelatinous masses were washed away and caused little trouble for the rest of the season.[1]

SOME FUNGOUS DISEASES OF FRUIT TREES IN IOWA.

BY PROF. L. H. PAMMEL.

(*Abstract.*)

LEAF BLIGHT OF THE PEAR. ENTOMOSPORIUM MACULATUM LEV.

Last summer while investigating a cotton disease in Texas, Mr. R. D. Blackshaw called my attention to a disease among some of his Le Conte pear trees. This was in the latter part of June, the leaves were falling rapidly and of some all had fallen. Since then new leaves and flowers have been produced. On returning to Ames I found that many of the seedling pear trees in the orchard were affected in a similar way. The disease was especially bad in the nursery. With the exception of some of the Chinese pears every variety in the orchard suffered more or less.

Nearly all of the young trees set out by Captain Speer in the experimental orchard of the experimental station lost most of their foliage prematurely, regardless of variety. The

1—The reader is referred to Dr. Kennedy's paper in July Bull. Iowa State Board of Health, 1892, for an extended account. For an account of the life history, Zopf, "Die Spaltpilze," 1884, p. [illegible]; De Bary, "Vorlesungen uber Bacterien," English translation Garnsey and Balfour, p. [illegible]; Flugge Mikro-organismen, p. 30, Warming, Om nogle ved Danmarks Kyster levende Bacterier in Videnskabelige Meddelelser fra d. Naturhist. Forening Copenhagen, 1875; Farlow Marine Algae of New England, p. 28 and p. 32; Cohn. Beitrage, I Heft 3, p. 157, etc., etc.

disease is widespread in both Europe and America.[2] In Iowa it has been known for some time as Dr. Halsted writes me, and occurs in different parts of the State. Mr. Beach sent some good material from Atlantic. In this abstract I cannot enter into the development of the fungus and its life history nor is it necessary as that is freely given by authors cited in foot-notes. The spores, however, seem to vary considerably. Mr. Kelsey, a special student in the laboratory, found that a good many leaves were uniformly brown, and that such leaves had an abundance of black pustules independent of the spots, and in these the spores were larger and much better developed than in the pustules found in the spots. The disease is known to occur on several species of *Pyrus*, (*cydonia*, *mespilus*), and on a closely related genus *Catoneaster*. It is quite troublesome at times on the fruit of the quince and pear. It also occurs on the apple (*Pyrus malus*), but is not common. Among a row of seedling pear trees in the college nursery a few apple tree seedlings had accidently gotten in the leaves of these and they were also affected, though the fungus was found on no other trees on the grounds. Experiments with fungicides have not been made on the grounds, but Galloway[3] has recently shown that the application of fungicides at the proper time has proved beneficial.

A CHERRY DISEASE.

BY PROF. L. H. PAMMEL.

(*Abstract.*)

The past season has been a very severe one on a good many of our cherry trees in the experimental orchards at Ames. Several kinds of parasitic fungi have been especially common.

2—New York; Arthur, Report New York Agricultural Experiment Station, 1884 p. 371. and 1885, p. 276. Illinois, F. S. Earl, Prairie Farmer Feb. 12, 1887. New Jersey; Byron D. Halsted, Rural New Yorker. Georgia, New Jersey; B. T. Galloway, Report the Chief of the Section of Vegetable Pathology, 1888, p. 357. Europe: Sorauer, Pflanzen Krankheiten, Second Edition, Vol. II, p. 371. Frank, Die Krankheiten der Pflanzen, Vol. II, p. 590.

3—Experiments in the treatment of Pear Leaf Blight and the Apple Powdery Mildew, Circular No. 8, United States Department of Agriculture, Division of Vegetable Pathology.

The "Powdery Mildew," *Podosphæra oxyacanthæ*, has been very destructive to many of the seedlings and the leaves of the young terminal shoots of nearly every variety of cultivated cherry on the ground suffered badly. But far more troublesome than the "Powdery Mildew," is the "Imperfect fungus," *Cylindrosporium padi* Karst. Like the pear disease the leaves fall prematurely, which must very materially lessen the amount of starch stored away for future growth and development and a diminished crop of fruit may be expected. I cannot here give a list of the numerous varieties which suffer from it and those which do not. It will be sufficient to state that a large number of varieties on the grounds lost their foliage by the middle of August, while others lost only a small proportion. Scarcely a variety is wholly exempt. The mahaleb had the best foliage, being attacked only to a slight degree and usually only on the lower leaves by this fungus, while it was entirely free from *Podosphæra oxyacanthæ*. The disease is very wide spread in this country, while in Europe it appears to cause little trouble judging from the meager account found in European works. Prof. Budd informs me he has been familiar with it for many years and has noticed it especially troublesome on the Early Richmond, Mr. Beach found it on the mahaleb at Atlantic, while Mr. J. S. Harris reports it from La Crescent, Minn. Mr. Ellis[4] has distributed it from New Jersey. Prof. Arthur[5] found it very troublesome in New York and in his report has given quite a full account of it. Kellerman[6] has distributed it from Kentucky. Mr. T. T. Lyon[7] finds it occurs on the following hosts: *Prunus domestica*, *P. padus*, *P. cerasus*, *P. americana*, *P. armeniaca*, *P. persica*, *P. serotina*. At Ames it has been found most commonly on the cultivated cherry. Mr. Morris, a special student at the laboratory, found it on the

4—North American Fungi, Series II, Cent. XXIII, No. 2251.
5—New York Agricultural Experiment Station, 1886, p. [illegible], and 1887, pp. 347, [illegible]
6—North American Fungi, No. 1151.
7—Michigan Horticulturist, Vol. I, 1886, p. 134.

apricot, though only on a few leaves. Little seems to have been written about this fungus. Prof. Arthur gave considerable attention to it but it was first described by Karsten,[8] but I find few European references. Prof. Peck[9] described the fungus as *Septoria cerasina*. Some specimens of the Iowa fungus were sent to Mr. Ellis who writes that he compared it with Karsten's *Cylindrosporium padi* with which it agrees and that 1699 of his distribution is apparently the same thing. The specimens on plum collected by Arthur are certainly like the form on cherry only our specimens seem to be a little more vigorous. Arthur[10] considers *Septoria pruni* Ellis, to be a synonym of *S. cerasina*. They are certainly much alike and I think it is safer to refer these *Septoriæ* to *Cylindrosporium padi* Karst.

The fungus may be briefly characterized as follows: Dull or red spots make their appearance on the upper surface of the leaves in June and July, later these become brownish, and on examination of the under surface of the leaf a yellowish pustule is readily distinguished. When mature, the epidermal cells become ruptured and a large number of colorless one-celled spores issue. The spores are borne on colorless vertical threads, and usually collect in whitish patches near the pustule. It is easily recognized by this character.

Prof. Arthur considers this fungus to be connected with an ascosporic form, which he has not named. A more detailed account of this stage was given in his Sixth Report. The conidia do not germinate readily, several media were tried but all proved unsuccessful. The leaves on the terminal shoots are usually affected worse than any of the others. In mahaleb the lower leaves on lateral branches are spotted and diseased.

8—Karsten, Sym. Myc., Fenn. XV p. 150. Saccardo, Sylloge, Fungorum III. p. 7?8. Sorauer, Pflanzen Krankheiten, Second Edition, Vol. II, p. 424. Roumeguere, Fungi Europaei præcipue Gallici exsiccati Revue Mycologique, 1888, p. 15.

9—Twenty-Ninth Report New York State Museum of Natural History, p. 48.

10—Loc. cit., 1888, p. ?7.

NEMATOCYSTS.

BY PROF. C. C. NUTTING, M. S.

Abstract.

Nematocysts or cnidocells or "stinging cells" as they have been variously called, are found in many *Cœlenterates* and some *Planarians*.

Three types occur in *Hydræ*, namely: First, small pear-shaped; second, small oval with long thread; third, flask-shaped with barbs, the latter occuring also in *Millepora* and known as the *hydroid* type.

In *Physalia arethusa* they are found in bead-like purple bodies which are arranged along the locomotor tentacles and curled around them when retracted. These tentacles are homologous with the "fighting *Hydræ*" of *Hydromedusæ*. The nematocysts are round, purple and project a crimped thread.

Very complicated nematocysts occur in certain corals, notably *Isophyllia dipsacia* where they are found packed along one side of tentacles which protrude from the mouth of the coral. These large and complicated nematocysts were described and experiments and observations regarding them related.

The use of these cells was discussed, and the testimony of Agassiz, Dana, Tarr and Gosse to the fact that the thread penetrated the substances attacked, was given.

The testimony of Lewes and observations of the author were given in opposition to the views of those who upheld that penetration was necessary to effective use of nematocysts. The author stated that the nematocysts of *Physalia* could act or at least produce irritation long after they had been completely dried and presumably incapable of projecting their threads.

The author held that "water fleas" when coming in contact with the tentacles of *Hydræ* were seldom killed or even paralyzed for any length of time and that they often acted in the same way when touched by any unfamiliar object. The difficulty of provoking a discharge of nematocysts by mechanical stimulus was mentioned and experiments and observations on living corals related.

The author denied that the threads were projected with lightning-like rapidity, as stated by Agassiz and others.

The manner of projection was discussed at some length, and it was considered probable that it was by partial eversion.

The mechanism of these cells was touched upon as offering interesting mechanical problems not yet solved.

The nematocysts are thought to originate in the nucleus of ectodermal cells, and the author thought that several sometimes originated in one cell.

The apparent absence of nematocysts in *Gorgonidæ* was announced and the systematic importance of this fact insisted upon.

(The paper was illustrated by sketches by the author.)

THE FERNS OF MUSCATINE COUNTY, IOWA.

BY. PROF. F. M. WITTER.

(*Abstract.*)

The following ferns have been noted or collected by me in Muscatine County. They are included in thirteen genera and twenty species:

Adiantum pedatum, *Aspidium achrosticoides*, *Aspidium goldianum*,* *Aspidium thelypteris*, *Aspidium spinulosum*, *Asplenium felix-fœmina*, *Asplenium angustifolium*, *Asplenium the-*

* The correctness of this determination is somewhat questionable.—EDITOR.

lypteroides, *Botrychium virginicum*, *Camptosorus rhizophyllus*. *Cystopteris bulbifera*, *Cystopteris fragilis*, *Onoclea sensibilis*. *Osmunda claytoniana*, *Osmunda cinnamomea*, *Phegopteris hexagonoptera*, *Polypodium vulgare*, *Pteris aquilina*, *Pellea atropurpurea*, *Woodsia obtusa*.

PEARL BEARING UNIOS.

BY PROF. F. M. WITTER.

(No Abstract.)

NOTES ON A FOSSIL WOOD FROM THE KEOKUK LIMESTONE, KEOKUK, IOWA.

BY PROF. C. H. GORDON.

(Abstract.)

Some years since a portion of supposed fossil wood was obtained from an eighteen inch limestone layer about six or eight feet below the Geode bed. It was secured by Mr. S. J. Wallace and placed in the rooms of the Keokuk Library Association. A brief mention was made of it in a letter to the editors of the *American Journal of Science and Arts*, as noted in the May issue of 1878.

It consists of a "section about three feet long, one end of which disappears in the bank and the other apparently taken off in quarrying years before. It is flattened into a thin coaly layer one-sixteenth to one-sixth of an inch thick and twelve inches across, and seems to be separated by pressure into two parts apparently not quite on the same plane." The flattened layer of carbonaceous matter has largely disappeared though enough remains to show its nature, and the cast of the woody fiber in the limestone is well marked.

At one place a leaf scar is quite clearly defined and at others small transverse ridges probably due to pressure. It shows coarsely the costate structure of *Sigillaria*. The arrangement of the areoles cannot be made out though probably distant and not continuous. As stated by Lesquereux the decorticated layers are of little if any specific value, but the fact that, so far as we can learn, this formation has thus far proven destitute of land plants gives this example peculiar interest and on this account a name may prove serviceable. We therefore designate it *Sigillaria wallacii*, in honor of its finder.

GEOLOGICAL HORIZON AND LOCALITY.

From the Keokuk limestone six or eight feet below the base of the Geode bed; found in the bluff just below the Keokuk and Des Moines depot, Keokuk, Iowa.

ON THE KEOKUK BEDS AND THEIR CONTAINED FOSSILS IN THE VICINITY OF KEOKUK, IOWA.

BY PROF. C. H. GORDON.

(*Abstract.*)

AREA AND THICKNESS.

Outside the region covered by this paper, the most notable exposure of this formation occurs at Crawfordsville, Indiana, where its thickness is said to be two hundred and eighty feet. [1]

South of the Iowa line, exposures occur along the Mississippi in limited areas, and southwestward in Missouri, yielding most of the lead mined in that region.

At Keokuk it consists of two well defined divisions—the lower or Calcareous and the upper or Geode division. The Calcareous division consists of forty to sixty feet of limestone in varying layers, with clay or shale partings one to six inches thick. About the middle of this division occurs a pure massive layer termed the "white ledge" which furnished

1—American Geologist, Vol. II, p. 407.

the stone for the noted Mormon temple at Nauvoo. Some of these layers abound in chert.

The upper division or Geode bed consists principally of argillaceous shale through which the geodes are more or less thickly disseminated. Below it is more calcareous and contains the largest geodes.

II. GEODE BED.

11. Fine, blue sandy layer. Rarely found. Seventeen species. *Poteriocrinidæ. Batocrinus laquneulus* Hall.......................... 5 inches
10. Soft gritty shale that decomposes readily. Filled with geodes from size of marble to four inches in diameter.......................... 15 feet
9. Shale, more calcareous. Geodes larger; occasional bands of limestone.......................... 20 feet

I. CALCAREOUS DIVISION.

8. Limestone, hard in thin variable layers.......... 2 feet
7. Shale, argillaceous.......................... 2 feet
6. Limestone; layers thin and cherty below. *Dorycrinus* bed at top containing *D. mississippiensis* Rœmer; *Batocrinus nashvillæ* Troost; *B. biturbinatus* Hall; *Agaricocrinus wortheni* Hall; *Barrycrinus tumidus* Hall; *Archimedes oweniana* Hall; and other forms.................. 5 feet
5. Blue, sub-crystalline limestone in layers six to twelve inches thick alternating with similar layers of shale. Shell bed; notably *Spirifer keokuk* Hall; *Orthis keokuk* Hall; and fish teeth. The upper part is termed the upper fish bed.. 9 feet
4. Limestone, massive, white, sub-crystalline. Occasional fish teeth and spines. Termed the white ledge.......................... 4 feet
3. Shale, hard, calcareous, approaching a rotten limestone. Occasional bands of chert. Pockets of calcite. *Actinocrinus, Agaricocrinus, Barrycrinus magister* Hall. The layer containing crinoids is not persistent. It occurs in the upper part and usually associated with reniform or lenticular masses of chert; called the rolyboly bed.......................... 6 feet

2. Blue or drab, sub-crystalline limestone, massive. Good quarry rock. Lower crinoid bed above. *Agaricocrinus* with shallow concavity. *A.* with sixteen arms. *Actinocrinus pernodosus* Hall. Stems and plates of *Eucladocrinus* below. Fish remains. . . . . 3 feet
1. Limestone in thin layers. Cherty. Lower fish bed. *Platyceras fissurella* Hall. *Platyceras equicatera* Hall. . . . . 6 feet

No. 1 is but partially exposed here, its full thickness probably aggregating twenty feet.

CORRELATION.

The uppermost layer, No. 11, was discovered at a single locality by Mr. L. A. Cox. In its lithological character as well as its fossil remains, it very much resembles the crinoid beds of Crawfordsville. The most common forms in the calcareous division at Keokuk are wanting at Crawfordsville. We are disposed to consider the lower part of those beds consisting of twenty-five feet of shale as the equivalent of the goede bed at Keokuk.

FOSSILS.

The crinoids, the most prominent form, though not the most numerous. One-half the Keokuk forms appear at Keokuk and about one-fourth at Crawfordsville.

Brachipods numerous, *Spirifera* and *Productidæ* predominating. Most interesting collections of crinoids made by Mr. L. A. Cox and Mr. N. K. Burket.

OBSERVATIONS ON THE KEOKUK SPECIES OF AGARICOCRINUS.

BY PROF. C. H. GORDON.

(Abstract.)

Six species of *Agaricocrinus* obtained from the Keokuk beds, of which three, viz: *A. americanus* Roemer; *A.*

whitfieldi Hall; and *A. wortheni* Hall, occur at Keokuk. *A. americanus* and *A. wortheni* apparently well distinguished. The latter apparently the culmination of this generic form which becomes extinct at the close of this period.

A. americanus presents many differences of structure. Species sadly in need of revision. Forms before us have very shallow concavity not "deeply concave" as defined by Wachsmuth and Springer;* allied to *A. whitfieldi* in having the secondary radial of one of the posterior rays unequally quadrangular, while the other has its upper acute angle truncated by one of the interradial plates. Arms regularly twelve in number. Found in the lower crinoid beds.

Specimens of this subexcavate form in collections of N. K. Barker, L. A. Cox and the writer.

The sixteen armed forms of *A. americanus* present persistent characters that may be sufficient to entitle them to more than varietal distinction. Arrangement of arms generally according to common plan. Basal concavity exceptionally deep, involving the whole series of radials up to and partially including the secondary radials. Nearly all examples with sixteen arms derived from the lower crinoid beds, associated with the subexcavate form above noticed.

* Revision of Palæocrinoidea, Part II, p. [illegible]

PROCEEDINGS

OF THE

IOWA ACADEMY OF SCIENCES

FOR 1890-1891.

VOLUME I, PART II.

EDITED BY THE SECRETARY,
Herbert Osborn, Ames, Iowa.

PRINTED BY ORDER OF THE GENERAL ASSEMBLY.

DES MOINES:
G. H. RAGSDALE, STATE PRINTER.
1892.

OFFICERS OF THE ACADEMY.

1890-1891.

President—C. C. Nutting.

1st Vice-President—C. P. Gillette.

2nd Vice-President—S. E. Meek.

Secretary-Treasurer—R. E. Call.

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Ex-Officio—C. C. Nutting, C. P. Gillette, S. E. Meek, R. E. Call.
Elective—H. Osborn, L. H. Pammel, J. E. Todd.

1891-1892.

President—C. C. Nutting.

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EXECUTIVE COMMITTEE.

Ex-Officio—C. C. Nutting, L. H. Pammel, E. Haworth, H. Osborn.
Elective—J. E. Todd, F. M. Witter, R. E. Call.

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Bates, C. O	Coe College, Cedar Rapids
Beal, A. M	Des Moines
Bennett, A. A	Agricultural College, Ames
Beyer, S. W	Agricultural College, Ames
Bruner, H. L	Drake University, Des Moines
Call, R. E	High School, Des Moines
Calvin, S	State University, Iowa City
Chappel, Geo. M	Signal Service, Des Moines
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Gossard, H. A	Experiment Station, Ames
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Pammel, L. H	Agricultural College, Ames
Patrick, G. E	Agricultural College, Ames
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Sage, J. R	State Weather and Crop Service, Des Moines
Shimek, B	State University, Iowa City
Sirrine, F. A	Agricultural College, Ames
Stalker, M	Agricultural College, Ames
Stoner, C. E	Des Moines
Todd, J. E	Tabor College, Tabor
Weld, L. G	State University, Iowa City
Witter, F. M	High School, Muscatine

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Osborne, T. B	
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Barbour, E. H	State University, Lincoln, Nebraska
Bessey, C. E	State University, Lincoln, Nebraska
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Halsted, B. D	Rutgers College, New Brunswick New Jersey
Mally, F. W	Department Agriculture, Washington D. C.
McGee, W. J	United States Geological Survey, Washington, D. C.
Parker, H. W	New York City, New York
Winslow, Arthur	Geological Survey, Jefferson City, Missouri

CONSTITUTION.

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

Sec. II. The object of the Academy shall be the encouragement of scientific work in the State of Iowa.

Sec. 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.

Sec. 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.

Sec. V. (*a*) The officers of the Academy shall be President, two Vice-Presidents and 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.

Sec. 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.

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

SEC. VIII. The secretary-treasurer shall each year publish the proceedings of the Academy in pamphlet (octavo) form giving authors' 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.

SEC. 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.

NOTE ON THE ORIGIN AND OBJECTS OF THE ACADEMY.

It seems desirable in this place when beginning the publication of the proceedings of the Academy under the authority of the State, to give a brief explanation of the origin and object of the Academy.

The present Academy is the lineal descendant of an organization of the same name organized in 1875, but which from failure to hold any meeting after 1884 died by the lapse of its membership, a clause in the constitution providing that members failing to attend a meeting or present a paper during two consecutive years should be dropped from membership.

Under the circumstances it seemed best to the organizers of the new Academy, nearly all of whom had been members of the older organization, to organize under a new constitution, but with special effort to secure the co-operation of such of the members of the old society as were still within the State. This was so far accomplished that at present as will be seen by examining the list of members that nearly every member of the old Academy now in the State is working in the present organization.

The aims and purposes of the two organizations are stated in almost identical terms in their respective constitutions and look to the encouragement of scientific work, especially in the State of Iowa.

The first Academy of Science was organized in 1875 and held its last meeting in 1884. It published proceedings in 1880 in pamphlet form giving abstracts of papers read up to that date and in 1882 a supplementary paper containing a necrology of one of its deceased members, J. Duncan Putnam, of Davenport.

The present organization was effected December 27, 1877, and meetings have been held at least once annually since that date, and in a previous publication, which will be denoted as Part I, of Volume I, the proceedings for the years 1887, '88, '89, were presented to the public.

The funds of the society being insufficient to publish papers as they were presented, and it being felt that their distribution among the people of the State would be of great educational and practical value, it was decided to ask the State assembly to provide for such publication.

This has been generously granted, and the following act, approved by the Governor April 22, 1892, sets forth the conditions and methods of publication:

Be it enacted by the General Assembly of the State of Iowa:

SECTION I. The secretary of the State Horticultural Society is hereby authorized to include in his annual report to the Governor, as an appendix thereto, the proceedings of the Iowa Academy of Sciences, the same to be printed and bound with the reports of the said society.

SEC. II. This act being deemed of immediate importance, shall take effect on and after its publication in the *Iowa State Register* and *Des Moines Leader*, newspapers published in Des Moines, Iowa.

The present part, which will be denoted Part II, of Volume I, will embrace the proceedings of the meetings held during the years 1890-91, and bring the work of the Academy up to date. The next meeting of the Academy will be held in Cedar Rapids, during the week of the State Teachers' Association.

Arrangements have been made for the preservation of the books and papers belonging to the Academy in the rooms of the State Horticultural Society, and it is believed, with this opportunity for the permanent preservation of the Academy exchanges, and the facilities for publication now afforded, that the Academy will enjoy renewed growth and accomplish more fully the objects aimed at by its promoters.

Meetings have been held and papers read during 1890 and 1891 as follows:

MEETING OF SEPTEMBER 5, 1890.

F. M. WITTER—President's Annual Address.

C. P. GILLETTE—"Gall Producing Cynipidæ of Iowa." "Oviposition of Amomalon." "Egg-laying of Apple Curculio." "A New Cecidomid Infesting Box-Elder."

C. R. KEYES—"Evolution of Strophystylus." "Age of the Iowa City Sandstone." "Notes on the Red-rock Sandstone."

R. E. CALL—"Two Quarternary Sections near Des Moines." "Preliminary Notes on Fishes of Polk County and Central Iowa," with Exhibition of Specimens.

R. E. CALL AND C. R. KEYES—"On a Quarternary Section Eight Miles Southeast of Des Moines."

HERBERT OSBORN—"Abnormal Pelage in *Lepus Sylvaticus*." "Additions to Catalogue of Iowa Hemiptera." "Notes on the Life History of Certain Hemiptera."

J. E. TODD—"Further Notes on the Geology of Northwest Iowa." "Exhibition of Volcanic Ashes from Omaha, Nebraska." "The Shore Lines of Ancient Glacial Lakes."

L. H. PAMMEL—"The Woody Plants of Western Wisconsin; A Contribution to the Local Flora of Lacrosse, Wisconsin." "Introduction of Weeds." Some Parasitic Diseases of Iowa Forage Plants." "Plum Scab."

S. E. MEEK—"Fishes of the Cedar River Basin."

MEETING OF JANUARY 1, 1891.

S. E. Meek—"The Occurrence of *Lepus Campestris* in Muscatine County." "Two Cases of Albinism."

J. E. Todd—"Observations on Concretions and Lignilites."

L. W. Andrews—"The Separation of Tin and Tantalum."

L. H. Pammel—"Structure of the Seed Coats of *Crotalaria sagittalis* and *Astragalus mollissimus*."

R. E. Call—"Sketch of the Life and Work of Dr. C. C. Parry."

C. C. Nutting—"Some of the Causes and Results of Polygamy Among the Pinnipedia."

MEETING OF SEPTEMBER 3, 1891.

G. E. Patrick—"Composite Milk Samples in the Laboratory."

G. E. Patrick and D. B. Bisbee—"A New Distilling Flask for Use in the Kjeldahl Process."

R. E. Call—"On the Tertiary Silicified Woods of Eastern Arkansas." "Exhibition of a Hydrographic Map of Iowa."

L. H. Pammel—"Vegetation Along the Mississippi from Templeleau, Wisconsin to Dubuque, Iowa." "Fungi from Various Localities."

Herbert Osborn—"Notes on Some Carboniferous Fossils from Jackson County, Iowa," with Exhibition of Specimens.

MEETING DECEMBER 29 AND 30, 1891.

C. C. Nutting—Address, "Systematic Zoology in Colleges."

J. E. Todd—"Striation of Rocks by River Ice." "Further Notes on the Great Central Plain of the Mississippi."

L. H. Pammel—"Bacteria of Milks, with Exhibitions of Cultures." "Report of Committee on State Flora." "Phænological Notes." "Experiments in the Prevention of Corn Smut."

F. M. Witter—"Notice of an Arrow Point from the Loess in the City of Muscatine." "The Gas Wells near Letts, Iowa."

G. E. Patrick—"Sugar Beets in Iowa."

R. E. Call—"An Abnormal Hyoid Bone in the Human Subject," with exhibition of specimen.

Herbert Osborn—"The Orthopterous Fauna of Iowa." "Notes on Certain Iowa Diptera." (By title.)

Herbert Osborn and H. A. Gossard—"Notes on the Life History of Agallia Sanguineolenta."

W. B. Niles—"The Action of Disinfectants on Nutrient Media."

Charles R. Keyes—"Geological Structure and Relations of the Coal-bearing Strata of Central Iowa." "Brick and Other Clays of Des Moines." "Aluminum in Iowa."

Erasmus Haworth—"Notes on Missouri Minerals. (1) Melanite in a Basic Dike Rock, and (2) Limonite Pseudo Morphs after Calcite." "Prismatic Sandstone from Madison County, Missouri."

H. L. Bruner—"Aboriginal Rock Mortar."

*J. L. Tilton—"Erosion by Middle River for November, 1891." "A Three-legged Snow-bird;" exhibition of specimen.

S. Calvin—"Distinction Between Acervularia Davidsonii and A. Profunda."

S. E. Meek—"Fish Fauna of Arkansas and Iowa compared."

†T. H. McBride—"Slime Moulds."

C. P. Gillette—"How the Female of Cacaecia Semiferana Protects Her Egg Clusters."

Synopsis of the more important items of business transacted at the annual meetings, 1890-91:

A Committee of Iowa Fauna was appointed, which consists of the following Fellows: C. C. Nutting, J. E. Todd, F. M. Witter, Herbert Osborn.

A Committee on Iowa Flora, which consists of L. H. Pammel, J. E. Todd, E. D. W. Holway.

Steps were taken toward the organization and encouragement of local auxiliary societies.

The constitution was amended in such manner as to provide for three classes of members as given in the amended constitution printed herewith, also changing the time of annual meeting so as to take advantage of the gathering of the State Teacher's Association.

The Executive Commiteee was authorized to see to obtaining a place of deposit for the exchanges and other property belonging to the Academy and to prepare articles of incorporation.

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*Prof. J. L. Tilton, of Simpson College, presented by title a paper stating the measurement of the material transported by Middle River, Warren county, during November, 1891, and the consequent erosion by the river. He also presented for examination a three-legged snow-bird (*Junco hyemalis*). The specimen is of special interest, since deformities, though common in domesticated animals, are rarely found in wild animals. The third leg was of the size of the other two legs but apparently useless. It was situated on the dorsal side of the sacrum.

†SLIME-MOULDS.—(Prof. T. H. McBride)—Upon invitation, Prof. McBride addressed the Academy briefly upon the subject of Slime-moulds, discussing their nature, habits, habitat and distribution. About sixty species are now known to occur in the State, although but little attention has been paid so far to their collection or to the investigation of this most interesting group. For the elucidation of the problems set by the Myxomycetes, the co-operation of the largest possible number of careful observers are absolutely essential. The forms they assume are varied, but extremely interesting and beautiful, and it is hoped the number of Iowa observers may continually increase. Prof. McBride promises all possible assistance to any who may wish to engage in the investigation of these remarkable organisms. Whether plants or animals, need not concern us at all. Botanists have so far studied the Slime-moulds and to botanists they will doubtless be relegated for all time to come.

NOTES ON THE GEOLOGY OF NORTHWESTERN IOWA.

BY PROF. J. E. TODD.

I handed in the subject of this paper, intending to throw together various notes which have been accumulating for several years.

I recently took a trip to the region under consideration intending to visit several localities and examine the borings of several wells, which, however. I was prevented from doing for lack of time. Had I been able to procure careful notes from all the wells I should be more decided on several points stated below.

The following is a tabular list of the wells noted with elevations of top and bottom:

LOCALITY.	ALTITUDE OF TOP.	DEPTH.	ALTITUDE OF BOTTOM.
Ponca, Neb.	1175	698	477
Sioux City	1160	2071	-911
Le Mars	1275	1400	-125
Cherokee	1215	960	255
Peterson	1260	145	1015
Emmetsburg	1230	869	231

Of the Ponca well I had access to notes published by Prof. S. Aughey, who visited a well when it was being bored at that place in 1880, and I also had the opportunity to examine the somewhat complete core taken out by the diamond drill in 1888. A summary of the result is as follows:

Eighty feet—More or less, drift clays.

Forty-five feet—Chalkstone capped with siliceous layers. "Inoceramus beds."

Sixty-five feet—Alternate layers of fine, stratified sand and light and drab clay. A pretty compact stratum of sandstone at the top, with a layer of lignite above, sometimes for a little ways, 6-8 inches thick.

Two hundred and thirty feet—Sand and sandstone. (Dakota.)

Thirty-five feet—Sandy shale and fine light green clay with grains like "greensand."

Fifty feet—Rusty gray, porous granular limestone above, blotched blue and cream color below, dolomitic, few casts of shells resembling macrocheilus.

Forty-five feet—Limestone, whitish above and capped with a layer more argillaceous, containing fragments of dolomite; below blue, becoming blue carbonaceous clay.

One hundred feet—Compact gray limestone, with portions below darker, vesicular in several strata. A print of a large trilobite near the top.

Fifty feet—Compact limestone with fragments of greenish flint.

The following condensed statement of the Sioux City well is based upon notes kept by the foreman, furnished me by Mr. J. C. C. Hoskins, and interpreted by samples preserved by Mr. D. A. Magee, and submitted to my examination. The mouth of the well is about thirty-eight feet above the top of the sand rock exposed by the river near by.

Sixty-five feet—Soil and gravel.

Twenty-five feet—Gravel.

Fifty-four feet—Shale. (Benton.)

One hundred and ninety-one feet—Sand and sandstone. (Dakota.)

One hundred feet—" Chalk-rock."

One hundred and ten feet—Gray limestone.

One hundred and fifteen feet—Alternation of sand and gray limestones. Water from near top of this rose to within twelve feet of the surface.

One hundred and fifty feet—White and gray limestones.

Four hundred and forty-five feet—Limestones and shales in thick layers, alternating.

Twenty feet—Red mass, five feet underlaid with sand. Water rises strongly to surface from 1,250 feet.

Forty-five feet—Sand and marl.

One hundred and ninety feet—Hard "micaceous limestone and compressed sandstone."

Fifteen feet—Hard, brown rock; Sioux quartzite?

Five hundred and fifty feet—Hard, gray granite, or gneiss, a five foot layer of white limestone at 1,860.

My knowledge of the Le Mars boring has been derived from communications from Mr. Maurice Vincent, for a time resident of the place, and Mr. M. A. Moore, who was largely interested in the enterprise. I have also examined samples from various depths and visited the locality.

Seven feet—Soil.

Thirteen feet—Yellow clay.

Forty-four feet—Blue clay.

Twenty-seven feet—Sand and gravel, hardened above. (Tertiary?)

Eighty-nine feet—" Soapstone and slate. (Niobrara?)

One hundred and thirty-eight feet—Alternating strata of sandstone and clays, some lignites. (Benton?)

One hundred and forty-seven feet—Sandstone with some shale. (Dakota?)

At 1,060 red rock 2-3 feet, from that to 1,400 gray granite with three thin layers of white limestone in the upper part.

What little I know of the Cherokee well was learned from Prof. G. W. Foster, and specimens kindly saved for me by Mr. A. Z. Wellman.

It was bored in the center of the city of Cherokee and being out of the old channel which had furnished a fine flow from moderate depth, a little north, and nearer the Little Sioux, it failed to strike any artesian water.

After penetrating 400 feet of light blue limestone, at 700 feet it passed into blue clay or soapstone, which continued to the bottom, 960 feet from the surface.

The Peterson boring was for coal. Mr. J. A. Kirchner, who had an interest, gave me a record of the boring and specimens showing plant remains similar to those at Sioux City and Ponca were scattered about the mouth of the shaft.

Fifty-seven feet—Bouldery drift clay.

Eighty-eight feet—Sandstone and shaly clay layers alternating with some layers of lignite. The shaft was abandoned because of water. Veins of lignite 3-4 feet thick are said to have been passed through near the bottom of the shaft.

The well at Emmetsburg I find reported by Prof. N. H. Winchell from notes by the borer Mr. Swan, in the Minnesota report for 1879. From it we derive the following:

Two hundred and twenty feet--Drift and cretaceous clays.

One hundred and nine feet--Sand, dark above, gray below. (Dakota.)

Twenty-two feet--Red marl. Jurasso-Triassic.

Thirty-two feet—Broken and sandy limestone.

Four feet--Black shale.

Thirty feet—Limerock.

Fifteen feet—Gray shale.

Two hundred and twenty-four feet—"Magnesian limestone."

Ninety-five feet—Shales gray and blue.

One hundred and seven feet—White sandstone, "St. Croix."

Six feet—"Granite" (quartzite?).

Besides these wells which reveal the depths, much additional light has been derived from numerous exposures along the Big Sioux and Missouri rivers. There are very few elsewhere. The Drift has buried the older rocks almost every where else.

The following generalizations are offered tentatively:

1. There seems to be a slight development of the later Tertiary just below the drift. This is found in the shape of fine sands found in the Le Mars well and more clearly in the high sand pits which are opened 4-6 miles northwest of Sioux City along the bluffs of the Big Sioux, 160-180 feet above the stream. No fossils have been found in them, but the absence of northern erratics and their horizontal stratification indicate their age to be older than the Ice age. Laminate clays and similar sands are found east of Canton, S. D., on the Iowa side of the Big Sioux.

2. The chalky beds of the Cretaceous are usually uppermost through the region. I have not been able to trace a definite horizon very widely but the following summits of exposures determined by barometer from adjacent railway station, may be helpful: Dakota City, Neb., 1251; St. Onge's, Iowa, 1255; Ponca, Neb., 1245; Hartington, Neb., 1324; Yankton, S. D., 1240; Scotland, S. D., 1275; Volin, S. D., 1300; Medicine Knoll, S. D., 1330; Akron, Iowa, 1175; Canton, S. D., 1290; Brandon, S. D., 1315.

The most complete natural section of the rocks, as was pointed out by Dr. White in his report, Vol. 2, p. 196, is at Cedar Bluffs. The thickness of the chalkstone, or "Inoceramus beds," is 45-50 feet. Instead of repeating, I will refer the reader to the sections well given by Prof. St. John in the report just mentioned. The Cretaceous dips to the north so as to drop below the Big Sioux a little above Akron, but it reappears near Canton and is still higher a little above Brandon, S. D., where it may be seen in place only a few feet above the red quartzite.

The Benton clays, or the upper part of the Woodbury shales of the Iowa geologists, are 80-90 feet thick.

3. The Iowa geologists divide the strata differently from Dr. Hayden. The latter seems to make the top of the sandstone at the foot of the bluff at Sioux City the division between the Benton and Dakota, and this horizon passes below the river on the west side at Ponca. There is much shale below this, 24 feet exposed at Cedar Bluffs and estimating from the relations at Sioux City as shown by the well, we may calculate to extend over 120 feet lower, before it comes to the continuous sandstone which the Iowa geologists have called Nishnabotna sandstone. The divisions of the former seem to correspond better with the lithological characters of the beds.

4. Taking a general view of the formations, there seems to be a slight anticlinal axis, trending in a northeasterly direction. North of this a broad depression in which, as said before, the firmer cretaceous rocks sink below the Big Sioux. In the vicinity of the red quartzite the cretaceous beds rise again to prominence. In this basin considerable thickness of lignite is reported in the vicinity of Centerville, S. D. Water has prevented an opening of the beds which are said to be 4 or 5 feet thick and within 100 feet of the surface.

5. It is an interesting fact that the cretaceous clays and chalkstone are usually attended by *Mentzolia ornata, Shepherdia argentea and Schrankia uncinata.* In fact the last has often disclosed to me the cretaceous character of a slope, which otherwise might have passed unnoticed.

EXHIBITION OF VOLCANIC DUST FROM OMAHA, NEBRASKA.

BY PROF. J. E. TODD.

This material was from a stratum of whitish aspect, about 18 inches in thickness, found in the bluffs facing the Missouri river about 7½ miles north of Omaha. It has the same general characteristics as the volcanic dust which has been found in quantity along the Republican, in southern Nebraska, also in Knox, Cumming and Seward counties in the same State. This statement is made on the authority of J. S. Diller of the United States Geological survey, who has examined samples from all these localities microscopically. This differs in being stained with oxide of iron, and the sharp angular grains are coated with carbonate of lime. Like the rest it contains with the finely pulverized glass, a few rounded grains of quartz and angular grains of feldspar less than .02 of a millimeter in diameter. The dust is such as is carried through the air from volcanoes. The sand grains and occasional diatoms indicate its deposition in still water.

The following is a section of the bluff containing the volcanic dust stratum:

Twenty-five to thirty feet—Loess, exposed as much more on slope above.

Seven feet—Stratified yellow clayey loam, with many calcareous concretions.

One and one-half feet—Volvanic dust, stained with iron oxide.

Five feet—Yellow clayey loam, slightly stratified.

One-half foot—Fine gray sand.

Twenty feet—Coarse sand and pebbles obliquely stratified.

Fifteen feet—Unknown, probably in part blue till. Level of the Missouri river.

This locality is the most eastern exposure of the volcanic dust stratum which is found scattered over most of Nebraska. Dilligent search has as yet failed to discover it on the Iowa side of the Missouri.

THE SHORE-LINES OF ANCIENT GLACIAL LAKES.

BY PROF. J. E. TODD.

As most are aware, there are areas of drift external to any terminal moraines, the origin of which is still in dispute. On general principles, it would be expected that numerous lakes would have frequently occurred during the Ice Age. As the ice advanced, streams would frequently be dammed, and their channels more or less changed, and the weight of the ice, with its chilling effect, in level areas would not infrequently produce a subsidence toward the ice, which would often become filled with the floods escaping from the ice.

Geike, in his "Ice Age," last edition, draws a graphic picture of such lakes in central North America. Inferences derived from the Merjelen Sea, and similar lakes in the Alps, Greenland and the Himalayas, strongly urge the probability of much larger ones of the same kind during ancient times. Such have been found in side moraines upon the more recent drift. Lake Agassiz, and of the Blue Earth region in Minnesota, and Lake Dakota and James Lake in Dakota, readily come to mind in this connection. But can similar lakes be recognized in the much eroded and fragmentary deposits external to the great terminal moraines? Some, as one with whom I was talking a few years ago, when discussing Prof. Wright's hypothesis of Lake Ohio, said, "Glacial lakes are a delusion and a snare," and yet the same person has mapped such a lake in central Wisconsin. Others would refer most of the extra-morainic drift to this cause.

One difficulty, and one which some consider insuperable, is the absence of distinct barriers and shore-lines and old water levels. The beaches of Lake Agassiz have been readily traced, but where are there any such traceable about Lake Ohio or Lake Missouri, or anywhere upon what has been called the older drift? The even, flat topography impresses one with lacustrine character in traversing the Blue Earth region, or that between Scotland and Mitchell, S. D.; but we can readily see that if a lake has been of transitory duration it would fail of producing a plain.

Before dwelling on a few recent observations, which it is the main purpose of this paper to present, let us consider briefly a few reasons for the common obscurity of the shore-lines of old glacial lakes.

1. The surface of such lakes would usually be very inconstant. The ice would have been a very uncertain barrier. The chance of depositing a beach or cutting a cliff would therefore have been small.

2. The accumulation of shore deposits would not only be slight, but being made largely by floating ice would be quite unequally distributed, especially in wide and shallow lakes. Prevalent winds would drive the drift-laden ice to certain shores much more than to others. If the lakes contained islands, the more remote shores might receive no erratics.

3. The difference in the ease of erosion between glacio-natant drift clays and the formations bordering them, may produce marked changes in topography and drainage. The regions of Dakota and Nebraska illustrate this well. Loose sands and easily eroded clays border the western edge of the compact and often boulder clad drift clays. While the latter are little affected by rains and streamlets, the former are rapidly removed. Moreover the former are peculiarly subject to sliding and slushing out at base The amount of erosion which has taken place since the occupation of the earlier glacial lakes may be more perfectly realized, when we learn that the prominent high terrace found along the Missouri, White and Cheyenne rivers is more than 300 feet above their present water level. This terrace dates from the time of the second moraine, or possibly of the first, of the "second glacial epoch." And this terrace is much more recent than the lakes under consideration. An erosion, which has excavated these valleys to such a depth, must certainly have greatly changed the surface along the old lake borders.

4. Yet another influence may have frequently done much to mask lacustrine features, viz., orographic changes. Gilbert has recognized as prominent in the cases of lakes Bonneville and Ontario. Chamberlin finds an elevation of Champlain deposits, of 330 feet in eastern Wisconsin, and of 5-600 feet in northwestern part of the same State. And this has been in a much less time than has elapsed since Lake Missouri was filled with loess.

So much on general principle. As may be remembered the writer has held that the extra-morainic drift of the Missouri valley is probably of sub-aqueous origin, that Lake Missouri which deposited the loess, at an earlier stage was partly filled with sand, gravel and boulder clay; that a similar lake occupied the Red Lake region, from the Bijou Hills to the Big Bend. Also that a similar one covered a wide scope of country from near the mouth of the Moreau northward. Hitherto, I have found rather scanty evidence of an old water level in the distribution of boulders about the Bijou Hills, 590 above the Missouri or 1,900 above the sea, and a patch of bouldery gravel and clay 510 feet above the Missouri, covering an acre or so, south of the mouth of White River.

In 1888 Prof. G. F. Wright reported the finding of something like a moraine along the divide south of the Moreau river. (See Proc. A. A. A. S. 1888.)

It has been my privilege the past season (1890) to traverse the course of Prof. Wright, with the same companion, Rev. T. L. Riggs, and to spend a few days in the examination of this feature.

I found Fox Ridge a high sandy plateau, forming the divide between the Moreau and Big Cheyenne rivers. Upon it, and on its south slope, I found no northern erratics. Its summit twenty miles west of the Missouri is about 2,400 feet above the sea. Along its northern slope is a peculiar flat-topped, butte-like ridge running east and west for 15-20 miles, its top being nearly horizontal and about 50 feet lower than the summit of Fox Ridge.

This was determined not only by several barometric readings, but by distant views from both north and south. The ridge is well covered with granite boulders, and drift 2-5 feet thick, but strange to say no northern drift was found south of the ridge, except where its presence could be accounted for by recent transportation. The land just south of the ridge is frequently 50 feet lower than its top. This ridge is not strictly continuous. There is a wide gap, particularly, where it is crossed by the Virgin creek.

The margin of the drift I had not time to trace fully, but was informed by Mr. Riggs, who knows the region well, that it crosses the Moreau 25-30 miles west of its mouth and runs northward at about the same distance from the Missouri for an indefinite distance. Inside this margin the land nowhere rises higher than the margin, and it is here and there sprinkled with northern boulders, often in patches, especially on the higher levels. The divide between the Moreau and Grand rivers has an altitude of about 2,300 feet. Most of the surface is of Cretaceous clays, and is much eroded, the alternating layers of hard and soft material, producing an interesting topography, studded here and there with high, flat-topped buttes.

The course of the marginal ridge south of the Moreau is in line with some high clay buttes on the east side of the Missouri, just above the mouth of the Little Cheyenne, which are known as Welland Buttes. They are strewn with a thin layer of boulders, and are the west end of a high divide separating the Little Cheyenne and Swan Lake Creek. Crossing this divide is a well preserved ancient channel, more than 400 feet above the Missouri, and there are traces of an old terrace along the Missouri, near the Welland Buttes, at about the same level.

Putting these things together, we come with some confidence to this conclusion: Fox Ridge, with its eastern extension, the Welland Buttes and the high land southwest of Bowdle and west of Faulkton, once formed the divide between the Cheyenne and Moreau rivers, when they flowed through to the James river valley. When the great ice sheet came down the latter valley during the glacial period, and occupied the outermost terminal moraine, there was for a time a great lake formed north of this Fox ridge divide. It was deep enough to float ice-floes and probably bergs from the edge of the ice sheet further north. These formed a bouldery beach along the margin, particularly along the southern side. Of the two outlets indicated, the western one cut down more rapidly, and formed part of the course of the Missouri. As erosion proceeded the bouldery margin became a ridge, because it yielded less rapidly to degradation than the soft clays and loose sands adjacent.

For this glacial lake we propse the name Lake Arikaree, after the Indian tribe whose home formerly occupied a considerable portion of its area.

STRIATION OF ROCKS BY RIVER ICE.

BY J. E. TODD.

Though it is commonly admitted by geologists, that both land-ice and floating-ice are capable of striating rocks, when armed with erratics; careful discriminations seem to be largely neglected. The question, whether river-ice was ever the active agent in scratching rocks, had been raised in the writer's mind several years since by a few observations in Dakota. Diligent search at several seemingly favorable localities had given only negative evidence, until this past season, when two or three observations seem to demonstrate the fact that such is not very infrequently the case.

In this abstract there is room but for the clearest example.

Three miles above Grand Tower, Illinois, there is a hard even-topped stratum of dark lime-stone, jutting out from the eastern bank for several yards, and dipping at a slight angle toward the bank. The steep face resting upon it and extending further up stream is covered with large sandstone boulders. The dip of the rocks is 4-6 degrees E. N. E. The principal seams of the rock are N. 10°-12° E. The surface, which was quite generally planed and striated, was 10 feet wide, on an average, and 60-75 feet long. The direction of most of the striæ was S. 10°-11° W., and of a few, S. 18° W. The striated surface reached from the water level up to two or three feet above. A small patch toward the southern end of the area was scratched in a direction, S. 56° E. The striæ were, if anything, more strictly parallel than in most glacial striæ. They were short, being rarely more than three inches long. This was mainly due, it would seem, to the much-cracked and nodular character of the rock. One other peculiarity of the stone affected the form of the markings. Scattered through it were numerous black grains like iron oxide. These usually headed the narrow ridges between the striæ. The striæ were mostly fine, rarely more than an eighth of an inch across. As if to leave no doubt concerning the cause, a long, deep, horizontal scratch, about four feet long and as high above the ledge just described, was found on the nearly vertical face of a large sandstone boulder. This was in the same general direction as the striæ below.

The reasons for referring these phenomena to river-ice are briefly, as follows:

1. Their recency, as indicated by their appearance and their location where water and weather would obliterate them in a short time.

2. Their parallelism with the present channel of the river.

3. Their occurrence outside of the recognized limit of glacial action.

Other localities where similar phenomena have been found which are reasonably referred to the same origin, are as follows:

Running Water, S. D., a little above landing, S. 73 E., "Chalkstone," few feet above low-water.

Sioux Falls, S. D., a few rods east of Cascade Mills, N. 57 W., Red Quartzite, few feet above low-water.

Wellington, Mo., a few rods N. W. of depot, S. 45, 61 and 73 E., Limestone, few feet above low-water.

Grand Tower, Ill., 3 miles up R. R. from depot, S. 10 and 18 W., Limestone, few feet above low-water.

Cape Girardeau, Mo., at landing, S. 10 to 35 E., Limestone, few feet above low-water.

All these directions are magnetic.

Besides these, we would provisionally refer to the same cause striæ reported by Dr. C. A. White as found near low water at Omaha, Neb. [Geol. Iowa, Vol. I. p. 95]; some reported by Prof. S. T. Trowbridge, from the vicinity of Glasgow, Mo., and some reported by Prof. J. W. Spencer, as occurring at St. Louis, at low water mark.

It seems not unreasonable to suppose that this same influence was even more efficient when the rivers were flowing at higher levels, with stronger currents and when erratics were more abundant and ice cakes larger and more abundant, as must have often been the case during the Glacial epoch.

It is no doubt true that ledges are often exposed long to the ice action of rivers without being striated. The conditions producing the effect may not yet be fully understood, but the following seem to be some of them.

1. The localities most favorable, seem to be on the outside of a bend, or near a strong current, near low water mark, and below a point where silicious erratics are abundant at the water level.

2. The dynamical conditions necessary are probably a sudden breaking up of the ice before it is rotted by thawing, while it still adheres firmly to the shore, and when there is a flood to wield it.

EASTERN EXTENSION OF THE CRETACEOUS IN IOWA.

BY CHARLES R. KEYES.

In connection with a casual reference to the cenological features of Central Iowa mention may be made to the recent discovery in the drift at Des Moines of a mass of rather soft ferruginous sandstone charged with fossils of unmistakable cretaceous type, the greater part being in a good state of preservation. When first discovered the mass was perhaps two feet in diameter and contained upwards of a dozen species of fossils. A few of the best preserved specimens were taken at the time; and the place revisited a few days later for the purpose of securing the entire piece, but unfortunately, workmen had removed it. The species obtained were: *Otodus appendiculatus* Agassiz, *Lamna texana* Rœmer, *Fasciolaria culbertsoni* Meek & Hayden, *Lunata concinnia*, Meek & Hayden.

Announcements have already been made of the occurrence in the drift of Iowa beyond the limits of known Mesozoic strata *in situ* of Cretaceous fossils and fossiliferous sandstone. Dr. White has reported an ammonite from Waterloo, Iowa, a fragment of baculite from Iowa City,* and six specifically determinable forms from Hardin county,† and has shown that the facies of the fossils in question has a close affinity with the fauna of the Fox Hills group, or the upper-most portion of the marine Cretaceous in the continental interior. The recently discovered Des Moines specimens afford additional evidence in support of this supposition. The good preservation of the molluscan remains, though so fragile, together with the fact of the comparative softness of the ferruginous sandstone, suggests, as in the other cases mentioned, that the fragments of Cretaceous strata are not far removed from the locality of original deposition. The satisfactory determination of the eastern extension of the Cretaceous in Iowa is attended with much difficulty, chiefly on account of the great depth of the drift, covering the northwestern part of the State. But doubtless outliers will be discovered considerably to the eastward of the present ascribed limits.

*Geol. Iowa, vol. I, p. 98.

†Am. Geologist, vol. I, p. 223

CONTRIBUTION TO THE FAUNA OF THE LOWER COAL MEASURES OF CENTRAL IOWA.

BY CHARLES R. KEYES.

(ABSTRACT.)

Among a large number of species recently discovered in the lower coal measures near Des Moines are some hitherto unrecognized forms. The following are the descriptions of three of the most important shells.*

CHONETES LÆVIS.

Shell small; much wider than long; transversely semi-elliptical; the cardinal line as long as the greatest width of the shell, or often slightly extended beyond the lateral margins. Ventral valve convex, with no indication of a mesial sinus; beak not prominent; cardinal area rather narrow but well defined centrally, becoming linear toward the extremities; foramen moderately wide; cardinal margin bearing from four to seven oblique spines on each side of the beak. Dorsal valve flat or very slightly concave; with no mesial fold. Surface of both valves apparently perfectly smooth; but under a magnifier it is seen to be marked by numerous fine concentric striæ, and more prominent, often somewhat imbricated, lines of growth; these are sometimes crossed by fine nearly obsolete radiating striæ.

Length 7 mm.; breadth 12 mm.

This species is found in the superimposing black shales of coal No. 3 at Des Moines; and is associated with *Chonetes mesoloba*, *Productus muricatus*, and the minute gasterpods mentioned elsewhere. The glabrate character, and the absence of a mesial fold and sinus, as is constant in all eight of the specimens found, forms a marked contrast with the associated congeneric forms, in which the radiating striæ are unusually sharp and well defined; and also with the other carboniferous forms of the same genus. This species is closely allied to, and perhaps identical with, the form described by Geinitz [1] as *Chonetes glabra;* but this name, however, was preoccupied by Hall in 1857, for a species from the Upper Helderberg.

PLEUROTOMARIA MODESTA.

Shell small, sublenticular, spire greatly depressed, volutions six, obliquely flattened above; body whorl very large, rapidly increasing in size, sharply angular on

* Described and figured along with other forms in the Proceedings of the Academy of Natural Sciences of Philadelphia, for 1888, pp. 222-246.

1 Carbonformation und Dyas in Nebraska, 1866, p. 60.

the periphery, flattened or very slightly concave above, prominently rounded below, suture line linear; spiral band very narrow almost linear, very slightly impressed and occupying a position just above the peripheral angle; on the spire the band is obscured by a single series of conspicuous nodes; aperture subquadrate, or subrhombic; umbilical region slightly impressed, but not perforated; surface glabrate; under a glass exhibiting fine lines of growth; the last whorl with a series of small transverse folds, or wrinkles, toward the tuberculated margin; each fold apparently originating at a node and extending about one-half or two-thirds the distance to the periphery.

Twenty or more specimens of this beautiful little species have been obtained from the black superimposed shales of coal, No. 3, at the Giant Mine, No. 1. It approaches more closely than any other the form described by Cox as *P. depressa* and may eventually prove identical with it. *P. depressa*, however, was preoccupied by Phillips in 1836; and this name was also used by de Koninck and by Passy.

SOLENISCUS HUMILIS.

Shell very small, short, subfusiform, or elongate-subovate; spire prominent, forming one-third or more of the entire length of the shell; volutions about six, increasing moderately in size, slightly convex. Test rather thin. Columellar fold distinctly visible within the aperture, which is subelliptical; callosity clearly defined but not conspicuous; outer lip thin, sharp. Suture well-defined but not deeply impressed. Surface smooth, but under a glass exhibiting lines of growth. Length 6 mm.; width 3.5 mm.

This little species is from the superimposed black shales of coal No. 3, at the Giant mine; and is found associated with the numerous other small gasteropods mentioned in another place.

A NEW CONOCARDIUM FROM THE IOWA DEVONIAN.

BY CHARLES R. KEYES.

CONOCARDIUM ALTUM.*

Shell of medium size, subtrigonal, anterior view broadly cordate. Anterior end truncate, with a forward slope from the umbones to the lower anterior sharply rounded extremity. Dorsal margin behind the beaks slightly curved, with the edges of the valves incurved, while in front of the beaks it is produced forward into a more or less prominent alate extension; basal margin crenate within; posterior extremity at the hinge line decidedly angular. Beaks rather prominent, gibbous, incurved. Hiatus lanceolate; occupying about two-thirds of the lower posterior margin. Surface marked by simple, regular, radiating costae, about forty in number, twenty-five of which occupy that portion of the shell behind the umbonal slope; the umbonal slope is broad, bordered on each side by a prominent costa

* Described and figured with other forms in the Proceedings Academy Natural Science of Philadelphia. 1888. pp. 247-248.

which gives it a decided biangular appearance; the costæ are crossed by numerous fine, crowded concentric lines; and a few larger somewhat imbricated lines of growth.

Length 24 mm.; breadth 21 mm.; height 20 mm.

Horizon and locality. Limestones of the Hamilton at Iowa City, Iowa.

This species somewhat resembles certain forms of *C. trigonale* of Hall, but the very broad. strongly biangular umbonal slope readily distinguishes it from that species. It also approaches some congeneric forms from the Devonian of Europe, especially certain species from the western part of France, recently described by M. Œhlert[1]

1 Etude sur quelques Fossiles Devoniens de l'ouest de la France.

PRELIMINARY NOTE ON THE SEDENTARY HABITS OF PLATYCERAS.*

BY CHARLES R. KEYES.

Platyceras is a generic term which has been proposed for a Paleozoic group of mollusks whose shells are "sub-oval or sub-globose, with a small spire, the whorls of which are sometimes free and sometimes contiguous; the mouth generally campanulated or expanded." These fossil shells had been frequently referred to the genus of modern mollusca known as Capulus. In the case of Platyceras as in many other Paleozoic genera, numerous species have been based, not on any apparent distinctive character, but seemingly simply on their occurrence at different geological horizons; and this has given rise to the establishment of many species which are unquestionably invalid. For specific distinction considerable importance has been attached to the configuration of the peristome, but even this feature now appears to have little classificatory value in the majority of species of the genus. A careful comparison of a large series of different species of Platyceras reveals the fact that the apertural margin in various specimens of the same species often presents considerable variation; a phenomenon not to be entirely unexpected in a group so closely allied to the modern Capulus.

Notwithstanding the comparative abundance of Platyceras in some of the Paleozoic strata of both this country and Europe direct paleontological evidence of the sedentary habits of the members of this group is not often met with; yet the instances presented, independent of their bearing upon Platyceras, are of unusual significance as furnishing a solution to certain important morphological problems relative to the Paleozoic crinoids.

From time to time Paleontologists have mentioned the occurrence of Platyceras attached to crinoids and numerous explanations have been advanced, but it was not until about the year 1873 the correct solution was given. In a large number of instances lately examined the gasteropod covered completely the anal opening of the crinoid, the sinuosities in the lip of the Calyptraean shell corresponding exactly to the irregularities of the surface to which the shell was attached. The conclusion, therefore, is that the intimate association of the two organisms was not the result of accidental pressure but that the molluscan shell was actually attached during life. The inference is, then, that the Platyceras was not truly parasitic in its habits, as has been urged by many writers.

*This and the three preceeding papers were read at the meeting of September 5, 1888, but through an oversight were omitted from the Academy's proceedings of that year.

EVOLUTION OF STROPHOSTYLUS.

BY CHARLES R. KEYES.

(ABSTRACT.*)

Recently a large series of of the most important species of Platystoma and Strophostylus was examined and the matrix carefully removed from the apertural portions of many of the shells. The structural features disclosed in the various forms show a relationship between the two established genera that was long suspected. The two types are now regarded as identical.

The genetic relationship, as at present understood, of the leading species of Strophostylus are graphically represented in the accompanying scheme. The earliest known forms of this group are from the Niagara rocks; but the extended vertical range of such species as *S. ventricosus* would indicate that the specific type had a higher antiquity than present information would suggest. Three principal series developed from this primitive form: (1) one preserved more or less distinctly the original characters; (2) another degenerated more or less, giving rise to loosely coiled shells and those approaching the Copulus group; and (3) a third acquired intensified features, which are particularly noticeable in the region of the columella.

At the base is the species upon which Conrad founded his genus Platystoma, and was called *P. ventricosum*. It chances to be the most generalized as well as one of the oldest forms of the group. The (3) third series shows a continued progression in the development of the axial parts, and finally ended in a form having a conspicuously twisted columella, as was acquired by *S. andrewsi*. This exaggerated character in the species last alluded to was the basis of Hall's genus Strophostylus. But it will be seen at once that the species selected was actually an extreme development of a variant series, and is connected by a complete gradation of forms with the earlier and less specialized one. Later in the history of the most primitive form now known an exceedingly variable series was given off, which assumed in the several species diverse characters. Some vary towards the *S. andrewsi* type, while others tend towards the *S. niagarensis* section. In the variable forms of *S. turbinatus* some significant phases are represented, which suggest the relationship of these shells to certain other genera. In the extreme form appears an elevation of the spine, that is unknown elsewhere in the group. Some examples show scarcely any thickening of the inner lip or columella, while others have these features well developed.

It must be borne in mind that the scheme as here represented is intended to indicate merely the lines along which the several developments took place, rather

* Published in full with one plate in the American Naturalist. Vol. XXIV, pp. 1111-1117, pl. xxxiii. December, 1890.

than the phylogenetic history of the group. The correct determinations of the phylogeny of animals from paleontological evidence is attended with many difficulties. For, as repeatedly shown by Darwin and others, new variations tend to be transfered backward in the ontogenetic history of a species, and may dispose older characters. This taken in connection with the fact that variant changes may occur in one part of an organism without materially affecting other parts, calls for extreme conservatism in passing judgment on phyogenetic problems from evidence afforded by fossils.

AGE OF CERTAIN SANDSTONES NEAR IOWA CITY.

BY CHARLES R. KEYES.

The sandstones under consideration lie in old gorges in Devonian limestone a short distance north of Iowa City. On account of the presence of plant remains, which, however, were too fragmentary for identification, Hall regarded the arenaceous deposits as belonging to the upper coal measures. Others visiting the places, since the announcement of the discovery in 1858, have adopted the same view as to the age of the rock, without attempting to question the correctness of the assumption, or to obtain further evidence.

Lately some molluscan remains have been found in the sandstones. Comparisons show that they are very closely related to Kinderhook species occurring abundantly in the yellow sandstone at Burlington. More perfect specimens however are necessary before final judgment can be passed. Careful research will, no doubt, reveal soon large numbers of good fossils in the beds in question.

The Kinderhook is well exposed south of Iowa City at Burlington, and northwestward at Le Grand, in Marshall county. It is probable that exposures are accessible at numerous intermediate places. The Burlington limestone—the stratum superimposed immediately upon the Kinderhook in Iowa, is said to be well exposed northward from the city of Burlington to within 9 miles of Iowa City. Hitherto the shore deposits of the Kinderhook have not been recognized in Iowa except near Burlington. The Iowa City locality fills up the gap. However, some additional information is required before the question can be regarded as definitely settled. And the present note is merely suggestive.

NOTES ON THE REDROCK SANDSTONE.

BY CHARLES R. KEYES.

The sandstone of Redrock, in Marion county, Iowa, has long attracted popular attention. The bright vermillion cliffs rise to a height of one hundred to one hundred and fifty feet above the water surface of the Des Moines river. The red coloration of the rock, however, is ocal. The formation has a known geographic extent of at least twenty miles; and probably stretches out much farther. At Redrock Cliff the stone is massive for the most part, but rather soft and thin-bedded above. At this place it is a very fine grained and homogeneous sand rock, some portions even affording excellent material for grindstones. But southeastward, and at Elk Bluff, two miles below, the sandstone passes into a fine-grained, ferruginous conglomerate. The dip is everywhere to the south and west; and at a short distance above the quarry, a short distance above the village, the inclination is very considerable. A mile beyond, the sandstone has disappeared completely and the section shows only shales and clays. The space between the latter exposure and the last known outcrop of the sandstone is perhaps half a mile, the interval being hidden by quaternary deposits down to the water level. The abrupt change in the lithological characters of the rocks in so short a distance has been mentioned by Owen and by Worthen; but the true explanation is entirely different from the suppositions of those writers.

Recent observations have cleared up many of the hitherto doubtful points concerning the geological history of the Redrock sandstone. It is not the basal member of the coal measures, as was regarded by Worthen; nor is it a shore extension of the Kaskaskia limestone; neither is its geographic extent as limited as has been supposed. Twenty miles to the southeast of Redrock a sandstone of great thickness, having identical lithologic characters and with a similar stratigraphical position is believed to be its extension southward. And it may also rise a few feet above low water in the northwestern corner of Marion county. The most interesting consideration in regard to this Redrock sandstone is the fact of its considerable elevation above the surface of the sea and its subjection to subaerial erosive agencies for a long period of time before submergence again took place. During that interval the great thickness of sandstone was probably almost entirely removed in places.

GEOLOGICAL STRUCTURE AND RELATIONS OF THE COAL-BEARING STRATA OF CENTRAL IOWA.

BY CHARLES R. KEYES.

(ABSTRACT*).

The exposed stratified rocks of central Iowa are made up chiefly of Lower Coal Measure clays, shales and sandstones. In the southeastern portion of the area the upper member (for Iowa) of the Sub-Carboniferous—the St. Louis limestone—is exposed along the Des Moines river. To the westward the so-called Middle Coal Measures and the Upper Coal Measures are represented. Hitherto it has been supposed that the three recognized divisions of the upper Carboniferous rocks in the State have each a maximum thickness of about two hundred feet. Lately, however, the Upper Coal Measures alone have been discovered to have at

* Published in full in the Bulletin of the Geological Society of America, Vol. II. pp. 277-292. pls. ix, x. (1891.)

least double this estimate; and at a still later date the vertical extent of the other two formations has been found to differ very much from the limit usually assigned: the Middle Coal Measures being considerably thinner than was supposed, and the Lower Coal Measures very much thicker.

From an economic standpoint, the coal of the region forms by far the most important deposit. The seams vary from a few inches to seven or even eight feet in thickness; the average of the veins at present worked being between four and five feet. These are disposed, not in two or three continuous layers over the entire area, but in numerous lenticular masses from a few hundred yards to several miles in diameter. A single horizon may thus contain several of these lens-shaped beds of greater or less extent. Along the line of the general section the coal-bearing horizons have been found to number more than a score; and the extension of the investigations beyond the limits of the particular area here considered has very greatly increased this figure. Recognizing this fact, the aggregate amount of coal is far in excess of what has been supposed hitherto. The peculiarities of its disposition and the consequent popular misunderstanding concerning the actual extent and distribution of the coal beds has led to a large but useless expenditure of capital. This phase of the question will receive further expansion in another place.

Summing up the more salient features in the present preliminary consideration of the Coal Measures of central Iowa, it may be said that:

1. The Lower Coal Measures are very much thicker than has been hitherto supposed.

2. The so-called Middle Coal Measures are are not so extensive, vertically, as was once supposed; and the designation as a formation name is of very doubtful utility, at least in so far as Iowa is concerned.

3. The recognition of the very subordinate importance of the "Middle" member suggests that the Coal Measures in Iowa may more properly be regarded as forming two, instead of three, divisions.*

4. The unconformity of the Lower Coal Measures of Iowa upon limestones of the Lower Carboniferous is much more pronounced than heretofore suspected. The confirmation of this statement is found in excavations recently made at Elk Cliff, at Harvey, at Fairfield, in Jefferson county, and elsewhere.

5. The striking unconformities in the Lower Coal Measures have never been so apparent as at present. The most remarkable instance of this sort is the case of the Redrock sandstone. The vast sand bed had manifestly been consolidated and elevated above the surface of the sea for a considerable distance; then it was subjected to long-continued denundation, as is shown in the deep gorges and ravines which are still preserved in the hard sandstone. So widespread and intense was the action of the erosive agencies that the great sandstone, more than one hundred and fifty feet in thickness, was largely removed; and at the present day only a few isolated outliers tell of its former great extent. When regional submergence again set in, the old gorges and shore depressions were occupied by coal swamps.

6. The earliest formed coal seams are far more extensive, both geographically and vertically, than the later ones. On the whole, the coal of Iowa may be regarded as distributed in innumerable lenticular basins, sometimes several miles in diameter and six or seven feet in thickness centrally, sometimes only a few hundred yards in extent. These occur at many different horizons and interlock with one another, so that a boring may pass through a score or more coal horizons without meeting more than one or two veins of sufficient thickness for profitable working.

BRICK AND OTHER CLAYS OF DES MOINES.

BY CHARLES R. KEYES.

(ABSTRACT.)

In the absence of extensive exposures of good building stone, in the immediate vicinity of many of the larger cities of the State, architectural materials must be derived in large part always from other sources. Fortunately. in and about these towns there are exhaustless supplies of good clays from which may be manufactured easily the ordinary structural and ornamental materials. These clays, however, as is well known, have diverse properties, certain ones being better adapted for particular purposes than others. while some may be used more advantageously in different ways. Hence the indiscriminate working of the deposits is not attended by the highest economic results, and often ends disastrously. This does not appl to one locality, but to the entire State. Clay is constantly being put to a multitude of uses which were undreamed of a decade ago. Everywhere this material is becoming more and more important, economically, in draining farm lands, in sewering, in paving, in all kinds of building. And there are still countless other ways in which it might be used with great profit. Manufactured clay is daily replacing other building material, such as granite and similar rocks, on account of its cheapness, its practically equal durability, and its great range of artistic effect with a requirement of much less labor than is possible in the case of the natural rock.

ALUMINUM IN IOWA.

BY CHARLES R. KEYES.

(ABSTRACT.)

Attention is called to the birth of an industry in Iowa that promises to be one of the greatest industries of the State in the near future. It is the establishment of a plant for the production of aluminum. As is well known, this metal is soon to be *the* metal of the world—replacing largely iron, steel and other metallic substances used in the arts. The properties of aluminum need not be dwelt upon here. The cost of producing the metal has hitherto been the great drawback to its general usage. A few years ago the price was $15.00 or more a pound. Now

it is about 50 cents. And improved methods have just been announced by which it may be extracted at a cost of less than 20 cents per pound.

A few months ago a plant was established at Hampton, Iowa. which is working a clay yielding three ounces more of aluminum to the bushel than in any other known locality in the west, and, perhaps, in the United States. The suggestion is important. Iowa has within her borders inexhaustible supplies of good clays admirably adapted for this purpose. But they require careful investigation that they may not be worked indiscriminately and thereby lead to complete failure in many cases. When the industry shall have become thoroughly established the gold fields of California, of Australia, of indeed the whole world will sink into insignificance as compared with the wealth coming from this source.

ON A QUATERNARY SECTION EIGHT MILES SOUTH-EAST OF DES MOINES, IOWA.

BY CHARLES R. KEYES AND R. ELLSWORTH CALL.

The section is located on the line of the Wabash railway about two miles below the little station of Hastie. It forms a continuous exposure of nearly three-fourths of a mile in length; and in some places has almost a vertical face of from 125 to 150 feet. It is capped by twenty feet of loess, carrying characteristic fossils such as *Succinea avara* Say; *Succinea obliqua* Say; *Helicina occulta* Say; *Pupa muscorum* Linne; *Vallonia pulchella* Muller; *Zonites arboreus*, Say; *Patula strigosa*, Gould; and a large Helix, probably *Mesodon thyroides*, Say. Below the loess to the track level the section is made up of blue clays and straticulate sands and gravels with occasional large boulders. In the gravel several large fragments of carboniferous limestone with fossils were found. The lower sands rest directly upon the coal measure shales probably since these are well shown in the river bed 10 feet below the track.

The section is of special interest, inasmuch as it is near the terminal moraine of the Des Moines lobe of the great glacier usually referred to the second epoch of the North American Ice Age.

NOTE ON THE DIFFERENCES BETWEEN ACERVULARIA PROFUNDA HALL, AND ACERVULARIA DAVIDSONI EDWARDS AND HAINE.

BY S. CALVIN.

The original description of *Acervularia profunda* Hall, is found in Hall's Report on the Geological Survey of Iowa, published in 1858. The specimens on which the species was founded came from near Independence, in Buchanan county, Iowa. In the same report Professor Hall, not without some hesitation identifies another form found abundantly throughout the Devonian area in Iowa, with *Acervularia davidsoni* Edwards and Haine. This, so far as I have been able to ascertain, was the first time the name had been employed in a work published in America; for although Edwards and Haine's specimens came from near Jeffersonville, Indiana, the description of *Acervularia davidsoni* appeared in the great Monograph of the authors, published in France. It should be noted that near Jeffersonville, Indiana, there occurs another form which authors, following the example of Edwards and Haines, usually refer to *Cyathophyllum rugosum* Hall.

The three species mentioned above, as recognized by everyone who has ever handled them, are somewhat closely related. Dr. Rominger in Geology of Michigan, Vol. III, page 107, is disposed to regard them all as but varieties of one species. The *Acervularia davidsoni*, as it occurs in Iowa, is certainly very sharply defined from either of the other two, while *A. profunda* exhibits a very intimate correspondence as to structure with *Cyathophyllum rugosum* from the Falls of the Ohio.

Comparing *A. profunda* with *A. davidsoni* we may note that it differs in the appearance and mode of growth of the corallum, in the greater tendency to independent growth of corallites, in the size of its corallites, the shape of its calyx, the thicker non-corrugated wall by which the individual corallites are bounded, the almost entire absence of an inner pseudo-wall bounding a central area, and the thinner septa with more numerous and conspicuously developed carinæ.

The *A. profunda* is a much coarser looking species than *A. davidsoni*. Its lower surface is never as smooth and flat as is that of most coralla of the other species from Iowa. This surface is transversed radially by the outer corallites which stand out in strong, transversely wrinkled ridges, sometimes almost entirely free from union with contiguous corallites. All the corallites show a remarkable tendency to independent growth, so that in some specimens a large proportion of the whole number of corallites stand apart from those adjacent on the upper surface of its corallum and are individually covered externally with an independent epitheca. In certain modes of preservation the corallites are even separable into wrinkled, polygonal prisms that exactly imitate a very common condition in *Cyathophyllum rugosum*.

In the region from which Hall's type comes the corallites of *A. profunda* are on the average somewhat larger than those of *A. davidsoni*. It is true that the corallites of both species vary within very wide limits, and it is therefore quite possible that the superiority in size of *A. profunda* may not be maintained in all localities. In the Paleontology of Ohio, Vol. II, page 240, Dr. Nicholson describes a form under the name of *Acervularia profunda*, Hall, that is distinguished among other things by having the corallities smaller than *A. davidsoni*.

The shape of the calyx is markedly different in average specimens of the two species. In *A. profunda* the calyces are separated by relatively thin partitions owing to the manner in which the sides of the cup slope abruptly downward and inward from the margin; the septa are thin and have conspicuous, crowded carinæ which are as fully developed near the margin of the calyx as around the central area, particularly in respect to which they are in marked contrast with the septa of *A. davidsoni*. The septa differ still further from those of *A. davidsoni* in having more of their edges free and in having their edges beautifully denticulated. There is but little thickening of the septa to form a pseudo-wall around a central area; indeed this feature is in a large proportion of cases wholly wanting. The secondary septa are nearly as long as the primaries inside the central area.

Acervularia davidsoni, Ed. and H., has a much wider geographical range in Iowa than *A. profunda*, Hall. The area in which *A. profunda* occurs is nearly all included in part of Buchanan and Black Hawk counties, while the area over which the other species is distributed is many times greater. As pointed out in the *American Geologist* for September, 1891, *A. profunda* is not associated in the same beds with *A. davidsoni*, but occurs uniformly at a horizon a few feet lower. Outside the area occupied by *A. profunda* its place seems to have been taken by *Phillipsastrea gigas* Owen. At least this last species, while never very common, occupies the same relative position a few feet below the horizon at which *A. davidsoni* is found, and so far as known it is not present in the region in which *A. profunda* attains its maximum development.

With respect to the particulars in which *A. profunda* differs from *A. davidsoni* it agrees essentially in structure with *Cyathophyllum rugosum* of authors, and it may therefore be regarded as the western representative of the last named species. If carinated septa have any generic significance, then *Cyathophyllum rugosum* is not a *Cyathophyllum* at all. Whatever the decision may be *C. rugosum* and *A. profunda* must ultimately stand side by side in the same genus.

A. davidsoni stands somewhat apart from both of the foregoing species in a number of particulars. The calyces have a sharply defined central pit with explanate margins. In typical specimens the floor of the calyx, except in the central pit, is almost on a level with the margin; the septa are thick, scarcely denticulated, with but a small portion of their edges free, the carinæ are few and clumsy and chiefly developed in the region immediately surrounding the central area. Both primary and secondary septa are conspicuously thickened around the edge of the central area, the carinæ are also developed there better than elsewhere, the effect being to produce in polished sections the appearance of a bi-areal coral with a central area bounded by a definite inner wall. Under the magnifier this wall is never complete. The thickened septa and strongly developed carinæ never quite coalesce, so that the outer area is never, as in true bi-areal corals, perfectly shut off from the central space. At the margin of this central space the secondary septa all end more or less abruptly, and only the primary septa are continued as thin non-carinated lamellæ into the central area.

Acervularia davidsoni is certainly congeneric with some of the species referred to Acervularia by Edwards and Haime and other authors. Whether or not it is generically related to the type species of the genus may be left an open question. So long as genera are mere artificial creations without sharply defined natural boundaries it will do no violence to the facts, but will be a matter of convenience and at the same time will give effect to a recognizable structural difference, if we keep *A. davidsoni* apart from the typical forms of the genus *Cyathophyllum*,* and for the present at least retain it in the genus *Acervularia*. Along with *A. davidsoni* must go *Acervularia inequalis*, Hall and Whitfield. As a mere matter of convenience, but with less confidence as to the justness of the arrangement, we may for the present add to the recognized species of *Acervularia* the *A. profunda*, Hall, and the *Cyathophyllum rugosum* of authors. The last two species may yet, with perfect justice, be separated generically from *A. davidsoni*.

*Dr. Rominger and Mr. W. J. Davis place this and related species under the genus *Cyathophyllum*. See Geology of Michigan, Vol. III., and *Kentucky Fossil Corals*.

NOTES ON MISSOURI MINERALS.

BY ERASMUS HAWORTH.

I. Melanite in a Basic Dike Rock.
II. Limonite Pesudomorphous after Calcite.

(Published with consent of the State Geologist of Missouri.)

I.

At various places in the Archaean areas of Missouri the granites and porphyries are cut by dikes of basic rocks which usually trend N. E. and S. W. but occasionally in other directions. The dike rocks are comparatively constant in composition. When holo-crystalline they are a diabase, or an olivine diabase, and when less perfectly crystallized they generally correspond to diabase porphyrite.

Usually there are no marked indications of contact metamorphism, either in the wall rock or the dyke rock. In Sec. 16, T. 33, N. R. 2, E., on the East Fork of Black River, in Reynolds county, is an important exception to the above statement. On the left bank of the stream, at a point where it makes a short turn from east to south, just above a small cataract, locally called The Falls, is a large dike trending N. W. and S. E. which forms the bank of the stream for a few yards. At this place the dike rock rises in the form of a bluff ten metres high or more, filled with vertical fissures, and presenting in every respect the appearance of an eruptive rock.

In some places along the base of this bluff the contact between the dike rock and the quartz porpyhry through which the eruption occurred is quite plainly shown. It seems that the lava has overflowed the walls of the fissure and is here resting on top of the quartz porphyry. This dike rock is a good example of what was formerly called a "green stone." Its specific gravity is 2.7434. A determination of its acidity by the St. Louis Sampling and Testing Works for the Missouri Geological Survey showed that it had 45.40 per cent $Si\,O_2$. Macroscopically it seems to be perfectly compact excepting an occasional gas cavity now filled with calcite and epidote. The freshest specimens obtainable were somewhat altered by weathering, so that the hammer marks on them were ashy white.

Microscopically it is seen that there is a considerable amount of glass present, with small triclinic feldspar crystals and much green fibrous hornblende, probably secondary in origin. No pyroxene or olivine was seen in the thin sections examined, although it is quite possible one or both of these minerals was originally present, and has been altered into the fibrous hornblende.

In a few places along the contact line between the dike rock and quartz porphyry the dike rock has been corroded apparently by water or gas, probably by a fumerole action at the time of eruption. The corrosion is not very extensive, perhaps never exceeding a metere vertically. The action was sufficiently vigorous to give to the rock an irregular, porous appearance. The cavities thus produced are filled with small crystals varying in size from almost microscopic dimensions to a centimetre or more in length. They are brown in color, varying on the one hand to greenish brown, and on the other to nearly black, especially those which are weathered. Their crystallographic properties are interesting on account of the different kinds of symmetry they have approached by the excessive development of planes in certain zones. They are all rhombic-dodecahedrons, the edges of which are occasionally truncated by minute icoistetrahedrons never large enough to alter the general appearance of the crystal. In addition to the regularly formed dodecahedrons four different types have been noticed.

First—The four planes normal to the plane of the lateral axis are elongated, as in Fig. 1, giving the crystal an apparent tetragonal symmetry, and resembling a combination of the unit. prism, ∞P, with the pyramid of the second order $P. \infty$. But as all the angles are either 90° or 120° there is no doubt but that t is a modification of the rhombic dodecahedon.

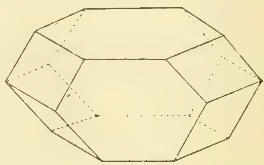

Fig. 1.

Second—In this case six planes are elongated, as in Fig. 2, so that the crystal assumes the symmetry of the hexagonal system, and appears to be a combination of the hexagonal prisim as ∞P. and the rhombohedron R. The angles are here also 120°, just what they should be for the hexagonal prism, making the resemblance all the more striking. These two figures are similar to two of those given for garnets in Dana's System of Mineralogy, p. 266.

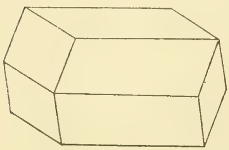

Fig. 2.

Third—This case differs from the first given in the excessive development of two of the faces resembling the pyramid of the second order, as is shown in Fig. 3. In this way it seems to have a monoclinic symmetry, and to be formed by a combination of the two lateral pinacoid faces, $\infty P \bar{\infty}$ and $\infty P \bar{\infty}$ with the positive and negative pyramids $\pm P$.

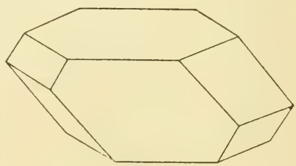

Fig. 3.

Fourth—In this case the six faces are elongated as in Fig. 2, and also two of the, faces resembling the rhombohedrons, while the third is very small, as in Fig. 4, giving the crystal apparently the monoclinic symmetry, and seeming to be composed of the clinopinacoid, $\infty P \bar{\infty}$, the unit prism ∞P, the clino dome, $P \bar{\infty}$, and the plus orthodome $+ P \bar{\infty}$, a combination which is not contrary to the monoclinic symmetry. Fig. 4 is drawn in this position in order to illustrate the pseudo symmetry, and should be rotated 45° to the left if $\dot{c}$ is placed vertically.

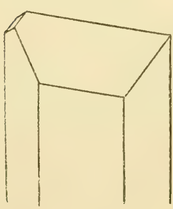

Fig. 4.

Small fragments of the mineral examined in polarized light, with the nicols crossed, transmit some light, showing that the optica anomalies so common in garnets occur here as well.

Correction.

By a mistake in printing some of the figures used to illustrate "Notes on Missouri Minerals" by Erasmus Haworth, were inserted in a horizontal position. They should be as follows:

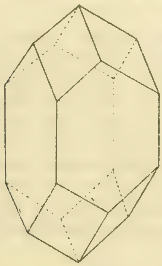

Fig. 1.

Pseudo--tetragonal symmetry, apparently with unites prism ∞P, and pyramid of second order, P∞.

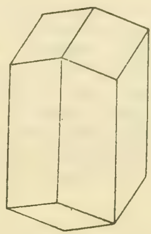

Fig. 2.

Pseudo—hexagonal symmetry, apparently with prismatic, ∞P, and rhombohedral, R, faces.

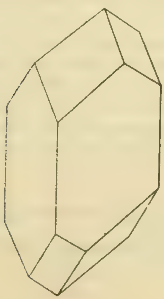

Fig. 3.

Pseudo—monoclinic symmetry, apparently with the two lateral pinacoidal faces, $\infty P \infty$, and $\infty P \grave{\infty}$, and both plus and minus pyramids, +P, -P.

Fig. 5.

Scalenohedron of calcite with alternate polar edges beveled and modified, as in text.

The specific gravity of fresh looking, well formed crystals was found to be 3.6002. A chemical analysis kindly furnished by the Missouri State Geological Survey, made by the St. Louis Sampling & Testing Works, gave the following results, which leaves no doubt but that the mineral in question is a lime-iron garnet, of the variety melanite, although it is more of a brown in color than that variety usually is:

$Si\,O_2$	=	33.88 per cent.
MnO	=	0.20 per cent.
$Fe_2\,O_3$	=	29.35 per cent.
$Al_2\,O_3$	=	5.53 per cent.
$Ca\,O$	=	30.71 per cent.
$Mg\,O$	=	0.63 per cent.
		100.30 per cent.

The occurence of this mineral is of interest because it seems to be the first time it has been found in the State, and because garnets of all kinds are so rare. In fact, with the exception of one instance reported to the writer in a private communication, by Prof. G. C. Broadhead, and which has not yet been published, this is the only locality known in the State of Missouri where garnets of any kind are found. In Bulletin No. 5, of the Geological Survey of Missouri, p. 42, it is stated that garnets have not been found anywhere within the area of the crystalline rocks of the State. It should be noted that, occuring as they do here within a dyke rock, they in no way have a bearing on the question there discussed, viz., the origin of the granites and porphyries.

II

At different places in Southeast Missouri some of the many fine specimens of calcite are coated with a thin film which is a beautiful, rich amber in color. An examination of this coating showed it to be a compound of ferric oxide the exact chemical nature of which was not determined. One of the specimens from Potosi, in Washington county, which has been in the Penn College Museum for a few years, so well illustrates, not only the controlling force a crystal has over the molecules of a pseudomorph deposited on it, but also the law of symmetry in crystallization, that it is thought worthy of mention. It is a collection of modified left handed scalenohedrons from one to two centimetres, for a half length, for the most of which the formula—2 R^2 was estimated. Usually each scalenohedron is terminated by rhombohedral faces. In addition to this each acute polar edge is beveled by a second scalenohedron producing another set of six faces from one to three millimetres wide. The coating on these crystals is comparatively light and the molecular control exerted by the calcite has caused it to be deposited on these narrow-scalenohedral faces only, leaving the remainder of the crystal entirely unaffected. Fig. 5 illustrates this.

Fig. 5.

By comparing this specimen with others it is found that as the coating became thicker it was next deposited on the rhombohedral faces, and covered the whole crystal only after it became so abundant that the molecular force of the calcite could no longer control it. This is the finest example the writer has ever seen of a crystal controlling a pseudomorph deposited on it, and especially illustrating so well at the same time the law of symmetry in crystallization.

PRISMATIC SANDSTONE FROM MISSOURI.

BY ERASMUS HAWORTH.

(Published by consent of the State Geologist of the Geological Survey of Missouri.)

On the right bank of the St. Francois River, in S. 31; T. 33, N.; R. 6. E., about 200 yards southwest of the St. Louis Granite Company's quarry, near Knob Lick, Madison county, Mo., is a little sandstone ridge, trending northwest and southeast, nearly 200 yards long, 10 yards wide, and not more than 8 to 10 feet high above the nearly level ground on either side. The country rock here is the Cambrian sandstone, which overlies the granite, as is beautifully illustrated at the quarry near by. This little ridge is interesting on account of the peculiar form of the sandstone composing it. In places where the soil has been somewhat worn away, instead of revealing flat layers of sandstone, as can be found near by in any direction, the surface is covered with fragments of sandstone of a prismatic form, resembling in shape the basaltic columns so well known in different parts of the world. In size the prisms range from about three-fourths of an inch to one and a half inches in diameter, and from three to eight inches in length. They are not uniform in geometrical outline, some having four sides, some five, and a few six. Quite often two and occasionally three prisms adhere together, side by side, but generally so loosely that they can easily be broken apart. In such cases the boundary between them is usually a single plane, but sometimes two new planes are exposed by the breaking, forming a re-entrant angle on one prism. Fig. 1 fairly represents a combination of two of these prisms.

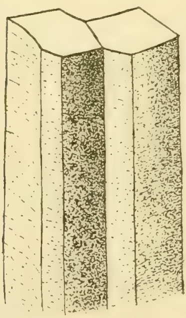
Fig. 1.

The nature of the rock was studied quite carefully, both macroscopically and microscopically, and it was found to be nothing but an ordinary, somewhat irregularly indurated, fine-grained sandstone. The grains of quartz are waterworn, as is usual. The induration is produced by the interstitial spaces being more or less filled with silica, but the thin sections examined showed no instance of secondary growth of the quartz crystals.

The existence of the ridge is probably due to the induration of the sandstone. Why this limited area should be thus indurated, and the surrounding country should not be, there seemed to be no obtainable evidence. However, this of itself is of little importance. But the prismatic form of the sandstone is much more interesting. The specimens gathered were on or near the surface, and were not seen *in situ*; but from their great abundance it must be argued that they extend downwards for a considerable distance. It was first thought that possibly a dike rock had once existed here, which had assumed the prismatic character, and that in some way by surface decay it had left moulds into which the sand had been carried. But a careful examination revealed no indication whatever of there ever having been a dike here, although they are quite common in the surrounding country. The granite close by is older [1] than the sandstone, and could not therefore have played any part in the matter by metamorphosing the sandstone in any way.

[1] See Bull. No. 5. Mo, Geol. Sur. p. 12, et seq.

THE TERTIARY SILICIFIED WOODS OF EASTERN ARKANSAS.

BY R. ELLSWORTH CALL.
Read September 1891.

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The occurrence of silicified wood in the sands and gravels of the Tertiary of the Lower Mississippi Valley has long been known. Aside, however, from the numerous localities mentioned by Hilgard,* nearly all of which are in the State of Mississippi, little attention has been given it. Numerous geologists have spoken of it or incidentally studied it in connection with other investigations, but hitherto no attempt has been made to recognize the species and fix their taxonomic value, if, indeed, they possess any such value. Among those who have investigated the Orange Sands and other Tertiary deposits of the Mississippi Valley and who have added to our information as to the occurrence of these fossils are Hilgard,† Penrose,‡ and Knowlton.§

The last named has made the only microscopic study of these fossils which is on record. Since his investigations are based upon material which, for the most part, was collected by the writer, it is thought that it will be useful to place on record in this form, a more detailed statement of the conditions of the occurrence of the silicified woods, their peculiarities, their structural relations and their stratigraphical position, in the hope that it may eventually prove to be of use in correlating the deposits in which they are found.

These fossil woods occur throughout the area covered by Tertiary sands and gravels in the State of Arkansas. When in large masses they are apparently rarely far removed from beds of Tertiary lignite, if in small masses or in small

* Agriculture and Geology of Mississippi, 1860. pp. 20, 21, *et seq.*

† Agriculture and Geology of Mississippi, 1860. pp. 20, 21, *et seq.*

‡ First Annual Report of the Geological Survey of Texas. 1889; "A Preliminary Report on the Geology of the Gulf Tertiary of Texas from Red River to the Rio Grande." By. R. A. F. Penrose. Jr., pp. 1-101.

§ See Annual Report of the Arkansas Geological Survey for 1889. Vol. II. pp. 249-267. Plates IX-XI.

fragments they occur in the gravels of nearly all the region and in the beds of the streams and brooks of the area covered by the Tertiary. Occasionally whole trunks of trees are found, often partially buried in the sands or deeply imbedded in the gravels which cover the flood plains of the creeks and ravines within the Tertiary area and especially along Crowley's Ridge, from Helena to the Missouri line. Specimens have been obtained from logs or stumps *in situ* and in undisturbed Tertiary beds at the following points: Hope, Hempstead county; Camden, Ouachita county; near Red Land, Cleveland county; at Red Bluff, Jefferson county; at Helena, Forrest City, Wittsburg, Wynne, Harrisburg, Jonesboro, Gainesville, Boydsville, and St. Francis in the country traversed by Crowley's Ridge in the eastern part of the State. All of these localities have furnished examples of silicified wood from large logs or stumps in place and always imbedded in Tertiary sands or gravels. It is a remarkable fact that hitherto, in Arkansas, silicified woods have been seen but very rarely in the Tertiary clays. At all the localities mentioned above, except one, the wood is found only in gravels or sands *in situ*, or in redeposited gravels and sands in the low valleys.

The geological section of the Crowley's Ridge region, to which area this paper especially refers, shows the following sequence, seen in the generalized section in St. Francis county, which is characteristic for the southern portion.

GENERALIZED SOUTHERN SECTION ON LITTLE CROW CREEK.

1. A loess soil, with enough sand to render it decidedly siliceous. This is the surface member and is usually of but little depth.
2. Typical loess, varying in depth from thirty to ninety feet, eroding rapidly, and presenting a characteristic loess topography. This member caps the ridge even at its highest points.
3. A clayey, pebble-bearing, bluish or otherwise dark colored loess clay which forms the base of the typical loess deposits and probably marks the first stage in the loess deposition. This member varies somewhat in different localities, being often quite thin and is even sometimes wanting. The pebbles are most abundant in the lowermost portion.
4. Orange-colored gravels, irregular in thickness, rudely stratified, sometimes well assorted so that only coarse gravels, or *vice versa*, are seen; there are occasional pockets or lenses of sand derived from the underlying member. In rare instances this bed lies directly under the clays. Silicified coniferous wood often occurs in this member.
5. Party-colored sands, of variable fineness, often quite irregularly stratified, sometimes overlying the pebble bed, but usually occurring underneath it. The sand grains are well rounded. There are occasional masses or pockets of red, drab, white, or yellow pipe clay.
6. Blue, black or drab clays, horizontally stratified, with small, sometimes larger, pieces of coniferous lignite. This member constitutes the greater portion of the body of the ridge. Along its margin it is to be seen only in the deepest ravines, or along the St. Francis and such of its small tributaries as flow from the ridge. It is often penetrated in deep wells, as at Forrest City, and underlies the whole region. The lower exposed portion is fossiliferous, the fossils are marine, and Claibornian in age. The clays are, therefore, Eocene Tertiary.

Slight differences in the section appear in various portions of the ridge, but are not worthy of remark in this connection. The generalized section for the northern portion of the ridge, made at a point seventy-five miles north of St. Francis county, shows the following sequence:

GENERALIZED NORTHERN SECTION NEAR GAINESVILLE, GREENE COUNTY.

1. A humus, largely siliceous, or a soil mainly sand. At the highest hilltops this soil contains gravel or may be entirely replaced by waterworn gravel.
2. Gravel bed, commonly removed by erosion.

3. Sands of Tertiary age, false bedded, party-colored, coarse or fine, banded often with drab, red or white pipe clay, or the last may be in pockets or lenses. These sands are generally loose, but in certain localities they have metamorphosed into a very hard, glassy quartzite. The areas of metamorphism are linearly distributed over many square miles, but are confined chiefly to the west side of the ridge. Silicified woods are found in this member at many localities, but none has yet been discovered in the metamorphosed portions.

4. Drab, blue and black clays of Eocene Tertiary age, horizontally stratified, occasionally fossiliferous, the fossils being chiefly the leaves of deciduous trees. These clays contain rare beds of lignite of small extent and erratic vertical distribution. Moreover, the clays are commonly gypsiferous and are further characterized by abundant small plates of muscovite in the cleavage planes. Silicified wood was seen at a single locality, on Cache River.

The absence of fossils in nearly all the members of the Arkansas Tertiary renders necessary their distinction upon lithological and structural data. The large masses of silicified wood in the upper members of the series are the only organic forms known above the Eocene clays. If in any way these silicified woods may be genetically connected with the lignite beds a means of correlation will not certainly be had, but the fact may sometime possess taxonomic value. Studies made in Eastern Arkansas seem to show that all or nearly all of the silicified woods of the Tertiary sands and gravel beds are derived in some manner from the underlying beds of lignite. In many places whole tree trunks, stumps standing in place, or large fragments of silicified wood occur so related to lignite deposits as to show that they are derived therefrom. In the northwestern portion of Greene county, on the west side of Crowley's Ridge, are masses of wood partly in the form of lignite and partly silicified. The lignitized part is buried in Eocene clays; the silicified ends are buried in Eocene Tertiary sands. It would appear that in this case, before the sands were eroded away, the portion of the trunk which had been buried therein was subjected to the action of waters containing silica in solution and the lignitic matter was replaced by silica.

The silica is, of course, all present as secondary quartz, is often massive but, also, frequently crystallized. Especially is holocrystalline quartz abundant in specimens of wood that were partially decayed when the older lignification process began. In the drusy cavities of such lignite are found large numbers of perfect and rather large quartz crystals. These are often, in some specimens always, characterized by a uniform dark or brownish color which is due to inclusions of limonite.*

Prof. F. H. Knowlton, of the United States Geological Survey, has studied microscopically both the lignite and silicified woods found in Eastern Arkansas. The results of his work may be found in Vol. II. of the Arkansas Geological Survey Reports for 1889. His studies have developed the interesting fact that the woods belong to both dicotyledonous and coniferous types. This occurrence is the first known dicotyledonous wood found in this country in rocks older than Pleistocene and is the first dicotyledonous form determined by internal structure. If, therefore, examinations of both lignites and silicified woods are made and it results that the same form or forms are represented in both, a strong reason exists for genetically connecting the silicified woods with the lignites.

Unfortunately for taxonomic purposes all the forms described by Prof. Knowlton are new, but some otherwise valuable results have been reached. In the first place

* An especially fine example of this nature was taken from a section in Tertiary sands thirteen miles southeast of the town of Camden on the line of the Camden & Alexandria Railroad. Of the many thousands of quartz crystals which this specimen exhibits not one has been seen which is free from inclusions of limonite.

he finds, among the four new species studied, two forms which are clearly dicotyledonous, and two other distinctly coniferous in relationship. The species are:

Coniferous.	Dicotyledonous.
Cupressinoxylon arkansanum,	*Laurinoxylon branneri,*
Cupressinoxylon calli.	*Laurinoxylon lesquereuxiana.*

There was also a single additional specimen whose affinities appeared to be dicotyledonous and to belong to *Laurinoxylon*; the condition of the material would not admit of a closer determination. The specimens found indicate comparatively few species, but these few must have existed in great numbers. One of the most valuable and pertinent facts in this connection is the finding of the dicotyledonous *Laurinoxylon branneri* in the lignite bed of Bolivar Creek, as lignite, deeply buried in Eocene clays in massive form.

Thus far sufficient distributional facts to give a taxonomic value to the fossil woods have not been discovered. Until extensive collections throughout the whole region of the southern Tertiary have been made it will not be possible to use these forms for purposes of differentiation or of correlation. It is believed, however, that since in the Tertiary sands of Arkansas, Louisana, Texas and Mississippi the same relations of silicified woods to lignites have been observed, it may be possible to co-ordinate the divisions recognized in those States by geologists and devise a system of nomenclature that will explain the relationships of the various beds to each other, though it cannot be done at present.

During the progress of the study of the region by the writer it became more and more clear that the silicified wood had some intimate relation to the pockets or beds of lignite which are scattered throughout the ridge. It was early noticed that no lignite occurs in the sands or gravels above the clays, and that no detached masses of silicified wood occur entirely in the clays. As the investigation proceeded it became a favorite hypothesis that the silicified wood was transformed lignite, and that careful microscopic study would probably prove the hypothesis to be correct. Professor Knowlton's investigations appear to verify the hypothesis.

The opinion that the silicified wood was, in some way, to be connected with the lignites of the bed underlying the sands was suggested by Hilgard* many years ago. Speaking of the occurence of fossils in the Orange sands he says: ". . . . The closest scrutiny I have bestowed on hundreds of extensive exposures, has failed to detect any fossil apparently peculiar to the formation as such. This might seem paradoxical enough to anyone acquainted with the frequent occurrence of silicified wood in these strata, but it soon becomes quite obvious to an attentive observer that the regions of the frequent occurrence of this fossil in the Orange sand are coextensive with those in which fossil wood, either silicified—when imbedded in siliceous sands—or lignitized, occurs in the underlying lignitiferous Cretaceous or Tertiary strata. It is not unusual to find trunks of silicified wood imbedded partly in the unchanged lignitic strata, partly in the Orange sand; the portion contained in the latter being nearly or wholly deprived of carbon, while the part imbedded in the lignitic material is, if at all silicified, of an ebony tint and often contains pyrites." Again, "I am convinced that the greater part, if not all of this fossil wood, is derived from the underlying strata and will be represented in their flora."

There can be little question, therefore, that the process of silification has occurred, in some cases at least, since these masses were torn from the underlying beds

* American Journal of Science, II, Vol. XLI, p. 313, 1866.

by the waters which deposited the sands above the clays.* As ordinarily understood the process is purely a chemical one and perhaps very slow. It consists in the replacement, particle by particle, of the carbon of the lignite by silicic acid, or silicon dioxide. It is by no means essential that the organic matter be unchanged when the process begins. If the belief that this wood represents what was once lignite be a correct one, then the process of silicification can occur in the case of organic matter which has already undergone a partial change.

Where found in clays in a silicified condition, it has probably resulted from the same processes that are seen to obtain in the highly siliceous sands or gravels which overlie them. Though the impervious nature of most clays renders the percolation of silica-charged waters a matter of great difficulty such percolation certainly occurs in them. The silicified masses of wood are often far too large to have been removed from the clays and deposited in the overlying gravels by an ordinary wave or current action, for they sometimes weigh tons. In the form of lignite the same masses could have been transported by currents, but since very large pieces have been rarely, if ever, found far from lignite deposits, even that proposition has very little weight.

The vertical distribution of the silicified woods of the Arkansas Tertiary is limited by the line of contact between the sands and clays which constitute the Arkansas series. Below this line the silicified wood never occurs, with the single exception above,† so far as observations have yet extended. Above it no lignites have ever been found. The vertical range is therefore limited by the thickness of the sand and gravel bed which is commonly, in Arkansas, between fifty and eighty feet.

There is a marked difference in the vertical range of this fossil in the Tertiary of Arkansas and the Tertiary of California. In the latter State the vertical range is often many hundreds, even several thousands, of feet. Whitney says:‡ "It will be proper to add some of the most important facts gathered during the investigation of the gravel deposits in regard to the mode of occurrence of the fossil plants of the Pliocene epoch. The vertical range of these has been alluded to, and it may

* Dr. R. A. F. Penrose, Jr. (*op cit.*, pp. 24, 26, 50, *et seq.*). has placed on record the numerous occurrences of silicified wood in the Tertiary of Texas: he finds it in both sands and clays. In his description of the Sabine River beds he says: "Silicified wood is of very frequent occurrence in these strata; sometimes occurring as small fragments: and at other times as large trunks of trees. On the Brazos River, in the northern part of Milam county, was seen a trunk one and a half feet in diameter, protruding from a clay bed. Ten feet of it were exposed, while the rest was imbedded in the clay. In many places such fragments are collected in great quantities, but it is especially plentiful in the lower part of the Fayette beds. It is generally dark brown or black inside, and weathers gray or buff color on the outside. Sometimes it occurs partly lignitized and partly silicified. It frequently shows shrinkage cracks which are filled with quartz or chalcedony, and are often lined with quartz crystals."

In this case stratification was but partial or was still in progress, and since there is exposed in the face of the bluff a log which was partially lignitized and partly silicified it proves all but conclusively that, even in the Texan Tertiaries, the lignitic precedes the siliceous condition of these woods.

† In this case the stumps are still standing, the roots, also silicified, ramifying in all directions in Eocene blue clays. Less than one hundred feet east, however, the line of contact between the sand beds and the clays was disclosed in a vertical cut in a hillside. This line was at or near the elevation of the stumps. It was clear that, if the stumps did not actually project into the overlying sands, they were but a short distance below and under conditions to favor silicification from waters percolating through the clay to them.

‡ Auriferous Gravels of the Sierra Nevada, pp. 235, 236. See also American Journal of Science, II, Vol. XLI, p. 359, 1866.

be more distinctly stated that either fossil wood or leaves have been found at every elevation, from the lowest to the highest, where gravels occur. Even as high as Silver Mountain City, at 7,000 feet of elevation, large masses of fossil wood are found in the volcanic deposits; and in Plumas county the same occurrence has been noted on several of the highest mountains in the region, as Penman's Peak and Clermont, peaks from 7,000 to 8,000 feet high . . . . . Fragments and often large masses of wood are found, both in the gravels and the associated clayey and tufaceous beds. In the gravel they frequently bear the marks of transportation from a distance, as would be expected."

In the California Tertiary the most completely silicified and best preserved specimens of wood occur in connection with deposits of a volcanic character, sometimes a rhyolitic ash.* It is suggested by Whitney that these relationships have something to do with the process of silicification. For that region Whitney believes that not only were the woods silicified after their imbedding in white pulverulent volcanic ash but "the lava itself exhibits signs of having been acted on by silicifying agents after its deposition." That the greater part of the series of beds included in the gravel formation has been thoroughly permeated with waters holding silica in solution and that chemical changes induced thereby are sufficient to explain the phenomena appears quite probable. The relations which the phenomena sustain to the facts of volcanism so abundant in that region are set forth and the conclusion is drawn that that relation explains silicification in these woods. In California it becomes a subordinate problem under volcanism.

The chemical processes which obtained in the case of the Arkansas gravels were not co-ordinate with those in California, for there is no evidence of volcanism or any similar phenomena associated with their silicification. The silica in the eastern locality must be sought in the accompanying sand beds and was probably brought into solution by the action upon it of organic acids.

The study of the Arkansas Tertiary silicified woods appears to justify the following conclusions:

1. The silicified woods of Eastern Arkansas are all of Tertiary age.

2. They are derived from the beds of Eocene clays that underlie the sands and gravels in which they commonly occur.

3. They are silicified lignite; the process of silicification has occurred either while they were still in the clays or most often after they were removed and buried in the sands and gravels.

4. They possess as yet no taxonomic value in determining the relative ages of the members of the Tertiary series.

ADDITIONAL NOTE ON SILICIFIED WOOD IN IOWA.

Nearly all who have had occasion to make any extended study of the Pleistocene strata or deposits in Iowa have found, somewhat rarely it is true, specimens of silicified wood which occur under varying conditions. Most of those which the writer has seen have been found in rearranged Pleistocene strata and bear evidence of having been rather roughly handled since silicification. The generic position of most of these examples is uncertain since there have been no careful microscopical examinations, save in a single instance, of any of these specimens. Professor F. H. Knowlton, of the United States Geological Survey, has studied very carefully† a single example of these woods, basing his investigation upon a

* Op. cit., pp. 327-329.

† Proceedings United States National Museum, Volume II, 1888, p. 5-6.

specimen taken in Emmet county. He found the material to represent a species new to science and gave it the name of *Cupressinoxylon glasgowi*, after its discoverer. He concludes that it represents a horizon which is Cretaceous in age. In the absence of any information to the contrary it is fair to assume that the specimen came from the rocks *in situ* but, if so, it is the only case on record of the occurrence of silicified wood so situated in the limits of the State. It would be interesting to institute studies of these woods in connection with the great masses of silicified woods found so abundantly along the upper Missouri; such study might serve to indicate the real origin of these straggled specimens.

In the Pleistocene of this State occasional large examples of silicified wood have been found; the ones examined by Professor Knowlton were small. The writer has noted two or three, in and about the city of Des Moines, that would weigh an hundred pounds or more; the largest of these was little water-worn.

Throughout the central and east-central portions of the State, and occasionally, in other parts of the commonwealth, large trunks of coniferous trees are reached in well and coal borings. These belong, without question, to that earlier, Pleistocene stratum which many geologists denominate "the forest bed." In the debris which was thrown out of the famous Belle Plaine artesian well, when water was found, there came from this stratum large masses of coniferous woods, sometimes quite large logs, mingled with sands and gravel. They constituted one of the features which made the well famous.

Similar woods have occured in deep wells within the city of Des Moines, even when the highest lands within the city were penetrated. The writer has now in his possession fine examples of such wood taken from a well thirty-six feet in depth in the heart of the city. They are much crushed and twisted, one end of one piece being broken or crushed into fibers by some heavy grinding weight, and give clear evidence of the harsh treatment which they have received. In no case have these fossil woods been compared with those which are silicified: so that identity in generic relation cannot be postulated. It is fair to remark, however, that no member of the forest bed proper has yet furnished a single example of silicified wood; that is no specimen of wood which became silicified since burial in that particular stratum. It would appear, therefore, that the real origin of the silicified woods found in the Pleistocene of this state must be sought outside of its imits.

THE FISHES OF THE DES MOINES BASIN.

BY R. ELLSWORTH CALL.

To one familiar with so much of the literature of science as pertains to the natural history of the State of Iowa it is surprising that so little has been done in relation to its fishes. A list designed to stand for the icthyic fauna of the State has yet to be compiled. There have appeared but three papers devcted to Iowa fishes. Of these three one was published under the auspices of the United States

National Museum,* the others were both published in Iowa§ °, under Iowa auspices and by an Iowa man. The first of these papers lists thirty species from the Des Moines river, at Ottumwa, of which list two were new to science. The two forms were *Notropis gilberti* and *Ammocrypta clara*. From the Chariton river, at Chariton, there were listed in the same paper thirteen species. From the Hundred and Two river, near Bedford, there were taken nineteen forms. The latter stream furnished no new species while one, *Etheostoma iowæ*, was found in the Chariton.

The second of these papers was preliminary to a complete account of Iowa fishes and is not yet finished. It aims to present the main facts, regarding species and their identification, thus far gathered through personal observation and collated from other sources. In it may be found certain notes on the geographic distribution of the more common forms, but recent investigations have already rendered this feature of little value. But little may be found in it concerning the forms that occur within our limit.

The third paper deals only with the larger forms of Iowa fishes and mainly with those that have food value. It also contains notes on geographical distribution, but this feature here likewise does not represent the facts as now understood.

With this brief list the bibliography of Iowa fishes practically ends. Such work as has been done and as has been published indicates that very much yet remains to be accomplished before the list of Iowa fishes can be completed. To facilitate this work and to secure as a basis for comparison in respect to richness in species, abundance, and geographical distribution a list that would be fairly representative of the strictly defined Iowa fish fauna the writer has collected and studied a great many fishes from the basin of the Des Moines. The main facts which this study has made known are made the basis of this preliminary paper.

As yet the investigations of the area limited by the hydographic basin of the Des Moines are unfinished. Practically only the streams of the central portion of the area have been studied. These streams all present, as would be expected, a great sameness of fauna, but at the same time they present a characteristic one. Without exception they are all typical prairie streams with physical features common to all alike. Minor differences, such as greater clearness, less depth, more rapid current, rockier bottoms and a greater number of cold springs characterize all as their source is neared. Correlated with this are certain forms found only at or near the rivers' sources that have, therefore, a somewhat limited distribution.

Several small streams, chiefly located within a few miles of the city of Des Moines, have been examined with the greatest thoroughness and they have little or nothing more to yield to continued exploration. These streams may therefore stand as typical for all similar streams in Central Iowa. One of these, Beaver Creek, will be further described in connection with the list collected therein and this list, it is believed, will stand as a type of all similar ones based on so small an area as a single creek.

The physical features of the Des Moines river demand but a passing mention. Its bed is ever varying from soft ooze to hard rock, grading in all ways from mud through sand and gravel to coarse boulders. With these varying conditions there is also a various fauna. Certain forms as the *Siluridae*, the *Acipenseridae* and

* Proceedings of the United States National Museum, 1885, Vol. VIII.

§ Bulletin from the Laboratories of Natural History of the State University of Iowa Vol. I, No. 2, 1889.

° Proceedings of the Iowa Academy of Sciences, for 1889-90.

the *Catostomidae* delight in muddy waters and muddy bottom. The *Centrarchidae*, the *Percidae* and the *Cyprinodontidae* delight most in clear cold streams. Especially abundant are they if to clearness and coldness be added a bottom studded with boulders and smaller rocks affording thus means for hiding. In such situations especially may the beautiful genus *Etheostoma* be found, both in great numbers and variety.

The subjoined list of species collected and studied by the writer in this area is made after the system adopted by Doctors Jordan and Gilbert, in their masterly "Synopsis of the Fishes of North America"*.

PETROMYZONTIDÆ.

(The Lampreys.)

Petromyzon concolor Kirtland.—This form has occurred only in the Des Moines river, at Des Moines. Two specimens have been secured, and both of these were taken from large catfish caught in the river within the city limits. Both were captured in March, one in 1887, the other in 1889. It is the habit of this species to ascend the river to spawn but it does so with the aid of other and larger fish. It is fairly common, according to report of fishermen, on large catfish in early spring, though but these two have been secured by us.

LEPIDOSTEIDÆ.

(The Gars.)

Lepidosteus osseus Linnaeus.—Des Moines river; Raccoon river, Des Moines and Adel.

The common or long-nosed gar is not taken except by fishermen and they obtain it rarely. Two forms of this genus are commonly recognized but only one of these has been seen by us within our limits.

SILURIDÆ.

(The Catfishes.)

Ictalurus punctatus Rafinesque.—Raccoon river at Adel, Perry and Des Moines: Middle river; North river, Walnut creek; Beaver creek; Des Moines river at Des Moines and Ft. Dodge.

This is a very abundant fish throughout the area studied. A peculiar feature in relation to its habitat consists in the fact that it commonly is confined to the more rapid portions of the streams and is not often taken in still waters. Its use for food commends it to popular attention.

Ameiurus melas Rafinesque.—North River; Raccoon river at Des Moines, Perry and Adel; Walnut creek, Beaver creek.

The chief characters of this fish are sufficiently well indicated by its generic and specific names. The very short and broad, or curtailed, caudal fin and its deep blue-black color serves to readily distinguish it from its congeners. Its habits are peculiar in that it is rarely taken in swiftly flowing or clear water but appears to thrive best in deep and muddy streams, with slowly moving current, or in the bayous formed by the abandonment of former river channels. In such situations it is both abundant and large. Near the city of Des Moines is an old river channel in which this form is so abundant that a single haul of the seine brought to land several thousands of them. Among the lot thus obtained many were the maximum length for this species, or about twelve inches. The larger specimens

* Bulletin United States National Museum, No. XVI, 1883.

are common in the city markets in the winter, being seined by fishermen through holes cut in the ice. At their best they are fish of slow movement and are easily captured.

Noturus exilis Nelson.—Raccoon river, Perry.

This form has occurred but once and is represented by but a single specimen. It presents no facts worthy of especial mention.

Noturus gyrinus Mitchell.—Raccoon river, Des Moines; Des Moines river at Des Moines. Rare.

The stone cats delight in muddy bottoms, are fish of slow movement, easily captured and of little or no use for food purposes. Neither of the species of *Noturus* has been taken save rarely, but of the two forms found the last named is by far the most abundant. There are several other well defined members of the genus which should be found within our area and may yet be discovered on more complete investigation.

CATOSTOMIDÆ.

(The Suckers.)

Ictiobus velifer Rafinesque.—Walnut creek; Beaver creek; Raccoon river at Perry, Adel, and Des Moines; Des Moines river at Des Moines and Ft. Dodge; Lizard creek; Middle river; North river.

This is beyond doubt the most abundant of the Buffalo fishes in Iowa. Throughout our area it is most common, the seine often landing several hundred pounds of this fish. Like most of the suckers it is to be found abundantly in rather deep but muddy water. It often attains a considerable size but does not grow to so great a size as the common Buffalo of commerce, the *Ictiobus cyprinella*. The form presents variations of note in the matter of scale formulæ, length of spine on back, depth, number of rays to the fins, and other features that would seem to render very promising the careful study of a large number. There is no other Iowa fish presenting so great variation.

Ictiobus difformis (?) Cope.—Middle river, Warren county.

This identification is somewhat doubtful but the specimens, four in all, seem to belong under this form. The species has not before been recorded from Iowa outside of the Missouri drainage. The determination is based upon comparison of specimens received from Dr. Chas. H. Gilbert, taken at New Harmony, Indiana.

Catostomus teres Mitchell.—Raccoon river at Des Moines, Adel and Perry; Middle river; North river; Des Moines river at Des Moines and Ft. Dodge; Beaver creek; Walnut creek.

This is one of the most common suckers in the smaller streams. The young are much spotted with blackish or brownish spots which almost or entirely disappear in the aged specimens. It is almost useless for food because of the great number of small bones, scattered apparently without order throughout the myocommas.

Catostomus nigricans La Sueur.—Beaver creek; Raccoon river at Des Moines, Adel and Perry; Des Moines river at Ft. Dodge and Des Moines; Middle river.

This is an abundant form occurring all over Iowa. It has a peculiarly long snout, hog-like and distensible, and is much blotched with blackish or brown pigment. It is often found in the swiftest streams, lying usually on the bottom and loves best clear water. Its value as a food fish is small indeed.

Moxostoma duquesnei Le Sueur.—Beaver creek; Des Moines river at Ft. Dodge and Des Moines; Raccoon river at Des Moines, Perry and Adel; Middle river.

This is a well marked variety of *Moxostoma macrolepidotum* and is quite common in our area. The large sized, red fins, coarse scales, and peculiarly compressed pharyngeal teeth render it very easy of distinction. It is found in streams of either rapid or slow current, appearing indifferent to either condition. In the deeper holes in the larger streams it may always be found.

Moxostoma aureolum Le Sueur.—Lizard creek, Ft. Dodge.

This species occurred to us but once within the limit assigned to this paper. The locality abounds with the common *Moxostoma duquesnei* and among them were found a dozen or more of this species. It is common in the great lakes of the north and may not stand as a good species on further study.

Placopharynx carinatus Cope.—Raccoon river, Adel and Perry.

This form will yet, no doubt, be found throughout our area. It is essentially western, having been described from the upper Missouri. It is difficult of separation from the common red-horse which it greatly resembles superficially except on careful examination of the pharyngeal teeth. It is "a large coarse sucker, externally similar to the species of *Moxostoma*, from which genus it differs only in the remarkable development of the lower pharyngeals and their teeth; the bones are very strong, and six to ten of the lower teeth are enlarged, little compressed, with a broad rounded or flattened grinding surface; the mouth is larger and more oblique than in *Moxostoma macrolepidotum* and the lips are thicker."—Jordan. Large numbers of this form were taken the present year in Northwestern Iowa, but the localities are all outside the limits imposed by this paper.

CYPRINIDÆ.
(The Minnows.)

Campostoma anomalum Rafinesque.—Beaver creek; Four Mile creek; Raccoon river at Adel, Des Moines; North river; Middle river; Walnut creek; Beaver creek, and Four Mile creek, Polk county.

This usually abundant form has not occurred to us in the great numbers which characterize its presence generally. It is one of the most easily recognized of the *Cyprinidae* because of the great peculiarity of certain anatomical features, the intestines alone being several times the length of the body. Moreover this organ is coiled in a characteristic manner about the air-bladder, a fact which no other minnow, the world over, presents. A vegetarian in food habit, the great length of the intestines is readily understood. When taken the abdomen, or ventral region, is usually distended and greenish in color, due to the nature of the contained food. The scales are irregularly mottled, giving to the fish a peculiarly dirty appearance. In common with the other *Cyprinidae* it never attains but small size.

Chrosomus erythrogaster Rafinesque.—Walnut creek.

This most beautiful minnow has occurred but once in our area. Three specimens represent the results of most assiduous collecting. The small but clearly defined scales, closely crowded, the graceful outline, the brilliant spring colors of males and females all conspire to render this form of easy determination; the infrequency of its occurrence in aquaria, therefore, seems to point to its rarity in this section of Iowa, though it is reported abundant in other localities. While widely distributed throughout the great Mississippi Valley, it attains its maximum abundance and beauty in the Ozark region of Missouri and Arkansas. It is, in nuptial coloration, probably the most gaudy fish in our waters.

Hybognathus nuchalis Agassiz.—Walnut creek; Raccoon river at Adel, Perry and Des Moines; Beaver creek; Squaw creek, Ames.

A minnow not easy, always, of separation because of great variability. Rather common in our collections, that is, occurs in nearly all our streams, but not in great abundance.

Pimephales notatus Rafinesque.—Middle river; North river; Raccoon river at Adel, Des Moines and Perry; Des Moines river at Des Moines and Ft. Dodge; Beaver creek; Walnut creek: and in a small stream without name in the city of Des Moines, but connected with no other stream.

Without exception this form is the most common and most abundant Cyprinoid in Iowa. Throughout our area it occurs in nearly every collection made and in the greatest abundance. All collections made in the spring presented males with a black head, much enlarged, apparently, due to the great number of large epidermal tubercles. These number, usually, fourteen and are generally arranged in constant order. The somewhat large light, colored scales render it of easy separation from its only congener, the following species. It is the one fish to be always found in the bait-pail of the sportsman.

Pimephales promelas Rafinesque—Four Mile creek: North river; Raccoon river at Perry, Adel and Des Moines; Walnut creek, Beaver creek.

P. promelas is easily distinguished from its congener by the dark coloration of the anterior portion of the body, the smaller scales crowded before, the dusky color line along the side of the body, the short blunt head, and the incomplete lateral line. It does not attain the size of *P. notatus*, specimens rarely or never exceeding three inches in length. It is commonly abundant in all our collections.

Cliola vigilax Baird and Girard.—Middle river; Raccoon river at Des Moines Perry and Adel; Des Moines river at Des Moines.

This species is readily known by the black spot at the end of the lateral line at the base of the caudal, its light coloration and the short, blunt, decurved snout. From *Phenacobius mirabilis*, which it superficially resembles, it is readily distinguished by the peculiar mouth of the latter. This form occurred in our collections in warm waters, with muddy bottoms, being rarely taken in streams with rapid currents. It occurred to us in great abundance at Adel in a shallow bayou representing a former river channel.

Notropis ardens Cope.—Des Moines river, Des Moines; Beaver creek.

This form is rare in our collections, one locality, the first, presenting but a single specimen. Among the difficult forms belonging to this genus this takes rank among the most difficult, has a synonymy which is increasing as more is known of the genus, and is the smallest species of *Notropis* in Iowa. Doctor Jordan justly remarks of the genus that it presents the most puzzling fishes in the world. Its Iowa representatives are especially difficult owing to the great similarity of habitat and the absence of those marked station peculiarities which may be assumed justly as a cause of the more marked differences in the *Notropides* of other States. Only the closest scrutiny succeeds in establishing specific characters and then the result is often not satisfactory. That this form is more widely distributed than our personal collections indicate is probable.

Notropis cayuga Meek.--Squaw creek; Beaver creek; Raccoon river, Adel.

This is a rare form in Iowa. Occasionally occurring in fair numbers it is yet true that a day's collecting in a most favorable locality will discover but a half dozen in number. The chief characters presented are the very close or large scales, few in number before the dorsal fin and the well defined black line passing from the tip of the snout to the base of the caudal fin. This line, moreover, is continuous to and around the front of the face, on the upper lip only, which fact serves as a clear diagnostic character. In forms looking much like it the color band descends to and includes the upper portion of the lower lip; this form constantly never has the line on the lower lip. In habit *Notropis cayuga* is somewhat peculiar. It has never occurred to us except in water that was warm, with muddy bottom, and never yet in water flowing swiftly or cold water. It would seem, therefore, that it may be sought for in bayous and similar situations with hopes of success. It is one of the most beautiful fishes in the genus.

Notropis deliciosus Girard.—Des Moines river, Des Moines and Ft. Dodge; Raccoon river at Des Moines, Adel and Perry; Beaver creek; Walnut creek; Squaw creek; Middle river.

It will be noted that this species is of wide distribution in our area and it is likewise abundant, being exceeded in point of numbers only by *Pimephales notatus*. It is difficult of distinction from certain of its congeners, notably *Notropis gilberti*, the last named, however, having a much larger eye and larger mouth, with a greater number of scales before the dorsal, the scales being, also, somewhat larger. In *deliciosus* the mouth is very small, on which character the specific name is based.

Notropis dilectus Girard.—Beaver creek; Walnut creek; North river; Raccoon river at Des Moines, Adel and Perry; Des Moines river at Des Moines.

A form of common occurrence, but few in numbers. It is believed that the form called *rubrifrons*, listed below, is to be properly considered a synonym of this species.

Notropis gilberti Jordan and Meek.—Raccoon river at Des Moines, Adel and Perry; Four Mile creek; Walnut creek; Beaver creek; North river; Middle river.

This species' name is based upon certain forms discovered by Messrs. Jordan and Meek in the Des Moines river, at Ottumwa. Allied to *Notropis boops* Gilbert, it is readily distinguished from that form by the smaller eye. It is very abundant in all of our collections, hardly less so than is *Notropis deliciosus* with which it presents some features in common.

Notropis megalops Rafinesque.—Beaver creek; Four Mile creek; Raccoon river at Des Moines, Adel and Perry; Des Moines river at Des Moines and Ft. Dodge; Walnut creek; North river; Middle river.

This species is the largest and most variable *Notropis* in Iowa if not in North America. The old forms, especially the males, present features so entirely different from those of the young that the wonder is not that so great a synonymy is found under this species but that the list of names is not greater. The old males are very deep, the lateral line much decurved, the scales larger and proportionately broader, the eye smaller and the whole facies of the fish, as seen in the smaller forms, entirely different. Its synonymy will embrace more names than any other species in the genus. Throughout our limit it is a very abundant and ever present form in the small and large streams alike. Like *Pimephales notatus* it is rarely absent from the fisherman's bait-pail. It is a common form in the aquaria in Des Moines.

Notropis rubrifrons Cope.—Squaw creek.

A form which is properly to be placed in the synonymy of *Notropis ardens* Cope.

Notropis umbratilis Girard.—North river; Raccoon river at Adel, Des Moines and Perry; Des Moines river at Des Moines; Middle river; Walnut creek; Beaver creek.

This small but well defined form is common in occurrence but somewhat rare in point of numbers, three or four specimens alone rewarding patient and continued search in each of the above localities.

Notropis whipplei Girard.—Raccoon at Des Moines, Adel and Perry: Walnut creek; Middle river; North river; Des Moines river at Des Moines and Ft Dodge; Squaw creek; Yader creek.

This specimen is one of the prettiest of the genus. The closely set scales, bluish or steel blue in color, the graceful outline, the brilliant yellow or red fins of the nuptial dress in spring all make this species as conspicuous in the seine as the beautiful *Chrosomus erythrogaster*. It is very abundant in all parts of our area. The males are armed in spring with a great number of small tubercles which extend backwards over the head and nape even to the dorsal fin. Compared to its length its depth exceeds that of any other *Notropis* except *Notropis lutrensis*, a species not found in our limit but abundant in Northwestern Iowa. The form was originally described from Arkansas, thus showing the wide geographical distribution of this species. As a usual thing great range of distribution is correlated with great variation in certain characters, but in this case there is a marked departure from the law, the variations being slight. Little or no differences are noticeable on careful comparison.

Phenacobius mirabilis Girard.—Middle river; North river; Beaver creek; Raccoon river; Des Moines; Squaw creek; Four Mile creek.

Large, fine examples of this species are found in the smaller streams and in the bayous along the larger ones all over our area. The marked black spots at the base of the caudal is a conspicuous character which, joined to the peculiar mouth, renders the form of easy identification. The only fish with which it is likely to be confused is *Notropis cayuga* but from this it is readily distinguished by color and size and by the mouth. The species is fairly common.

Rhynicthys atronasus Mitchell.—Walnut creek; Beaver creek.

A single example of this form occurred in each of these streams, indicating its rarity in our area. The genus, which comprises two species only in the United States, is one confined mainly to clear mountain streams and the State of Iowa does not offer suitable habitats for the forms. It is to be classed among the rarest of our Cyprinoids.

Hybopsis kentuckiensis Rafinesque.—Raccoon river at Des Moines, Adel and Perry; North river; Beaver creek; Des Moines river at Des Moines and at Ft. Dodge; Walnut creek.

This chub is one of the most abundant of the larger Cyprinoids and is rather constant in its characters. In some localities, especially in the smaller streams named above, it is very abundant and large. Those streams which are clear the major part of the summer or which are fed by cold and perennial springs are most favorable to its development. In Walnut creek occurred many specimens which were affected with a crustacean parasite fastened to the soft flesh at the angle formed by the junction of the pectoral fins with the body. While many of these fishes were so affected it was noticeable chiefly on those fishes which were taken in muddy water or in water with deep muddy bottom. The parasite is as yet unstudied.

Hybopsis storerianus Kirtland.—Raccoon river, Perry, Des Moines and Adel; Walnut creek; Middle river.

This easily recognized and highly characteristic species is very abundant in the larger of the streams named. The largest and finest specimens came from the Raccoon river at Adel and from the Middle river, the form being especially abundant in the last named stream. The decurved mouth, giving it a sucker-like appearance at first view is characteristic and is a feature presented by no other form in our area. Specimens nearly eight inches in length were collected in the Middle river.

Semotilus atromaculatus Mitchell.—Walnut creek; Beaver creek; Raccoon and Des Moines rivers, Des Moines; North river.

A species of very wide distribution in all streams, both large and small, but preferring clear creeks or brooks. This dace often attains a length of quite one foot, though none that would exceed seven inches have been taken by us. The locality producing this form in greatest numbers is Walnut creek, in which many and large examples were taken.

Notemigonus chrysoleucus Mitchell.—Raccoon river, Des Moines; Beaver creek.

This beautiful fish has occurred in only the two localities named though it is said to be common in sluggish or weedy waters. The form is rare with us, only six or seven specimens having been taken. Its bright golden hue, great depth of body, characters of the opercular covering, and the sharp ridged dorsum will enable it to be readily distinguished. It occurred in our collections in a deep hole, removed from the Raccoon river, and seems to do best in streams of muddy bottom. It possibly occurs in plenty in favorable localities.

CYPRINODONTIDÆ.

(The Top-Minnows.)

Zygonectes notatus Rafinesque.—Squaw creek; Raccoon river, Des Moines.

This form is rare at Des Moines, only one specimen having been taken, but it is abundant in Squaw creek at Ames. None of the specimens seen attained the maximum size which is stated to be three inches. It thrives best in still waters.

ESOCIDÆ.

(The Pikes.)

Esox vermiculatus Le Sueur.—Beaver creek; Yader creek.

Three examples were taken in Beaver creek and one seen in an aquarium, said to have been seined in Yader creek, a small stream in South Des Moines, tributary to the Des Moines river but dry the most of the year. The peculiar character of the markings on the side of the body distinguish the least pickerel from its remaining congeners. In the following species, the pike—*Esox lucius*—these markings are a deeper yellow, are disconnected commonly, and are oval in shape. The general yellow cast of the pike enables ready distinction, though by fishermen the species are not separated. The least pickerel rarely ever exceeds twelve inches in length though specimens have been seen from the northern portion of the State fully fifteen inches in length.

Esox lucius Linnæus.—Raccoon river, Des Moines and Adel; Des Moines river, Des Moines and Ft. Dodge.

This is the common pike and is now commonly taken by sportsmen in our region. It takes the hook far more freely than the preceding form. It is common or even abundant in the lakes and streams of the northern and northwestern portions of the State. Prof. S. E. Meek and the writer have taken or seen specimens of eight and ten pounds weight in number in Storm Lake and in the Cherokee river. It is found in deep and still water and most abundantly in deep streams that have many weedy patches. A seine pulled over or through such a locality is certain to capture a specimen, the fish lurking in the shadow of the weeds escaping thus the observation of the unsuspecting minnow. They are very ravenous and are exceeded in this particular by no fish in our waters. The writer has frequently placed a minnow in the mouth of a pike just or recently landed and watched "the thing swallow", which is done in great haste. Even on land, thus, is shown the inordinate appetite of this veritable shark of the fresh water streams.

Esox masquinogy Mitchell.—Skunk river, near Ames.

While not found within our area so far as known this species is likely to be found though not commonly. It is known from the Mississippi river but from the locality mentioned above this is the only representative. The head of this magnificent specimen is now preserved in the Iowa Agricultural College museum. It is reported from the Squaw creek but no authentic specimen is known therefrom. This form is the *Esox nobilior* or "Muskalunge" of the northern waters.

ANGUILLADÆ.
(The Eels.)

Anguilla anguilla var. **rostrata** Le Sueur.—Raccoon river, Adel; Des Moines river, Des Moines.

This species is common in the larger streams throughout our limit though most common in the Des Moines. The form is anadromous, that is, it is a marine fish which ascends the fresh-water streams to spawn. Very little is known of its life history though its food habits have been well made out. It is extremely voracious foraging most freely at night; it is commonly taken on trot lines set at night in this region though the writer has several very fine specimens, including one very large one, taken in the Des Moines with hook and line in the day time.

ATHERINIDÆ.
(The Silversides.)

Labidesthes sicculus Cope.—Raccoon river, Des Moines and Adel; Des Moines river, at Ft. Dodge.

The specific name of this little fish is by no means always indicative of its habitat. Though common in "half dry pools," in allusion to which the name is bestowed, it is very common in the Raccoon at Adel in the rapidly flowing stream where the bottom is sandy. A number of specimens were there captured and had their presence been suspected many more might have been taken. The snout reminds one of the "pipe-fishes" of the Atlantic coast but is far less produced; of course the resemblance is superficial. The fish is quite transparent, so much so that the gross anatomy may be fairly made out without dissection—a feature presented by at least one other fresh-water fish in our area. It is in many respects our most interesting fish.

CENTRARCHIDÆ.
(The Basses.)

Pomoxys annularis Rafinesque.—Raccoon river, Des Moines; Middle river.

These two localities have together furnished but four or five specimens. Very valuable as a food fish, its flesh being both white and sweet, it is the delight of the youthful angler. It has occurred to us only in an abandoned channel of the Raccoon, in deep water, and in a deep hole in Middle river; from the circumstances of its habitat, in these localities, it would seem to prefer quiet and deep muddy waters. It is a powerful swimmer, takes the hook with great eagerness and is quite gamey making it a good fish for sport. The localities named are among the most northern known, the fish being a southern form. The related "crappie", *Pomoxys sparoides*, has not yet been found in our limit though an abundant form in the Mississippi on the eastern border of the State.

Ambloplites rupestris Rafinesque.—Raccoon river at Adel, Des Moines and Perry; Des Moines river, at Des Moines, Ft. Dodge and Estherville.

This abundant fish is to be found wherever there is a clear rocky bottom affording means of concealment. In clear streams with bottoms thus characterized, and affording abundant weeds, grass or river-moss it is always to be found loitering in the shadow of the rocks alike alert for food or enemies. It does not take the hook readily and is very suspicious of danger when one is temptingly dangled in its very face. The numerous black blotches on the side, extending from the dorsum to nearly the base of the anal and pectoral fins sufficiently well indicate the color markings by which it may be distinguished from related forms.

Lepomis humilis Girard.—Beaver creek; Walnut creek; Middle river; North river; Raccoon river at Des Moines, Adel and Perry; Des Moines river at Des Moines and Ft. Dodge; Squaw creek.

Always abundant this species is nevertheless to be found in excessive numbers in nearly all streams in which it occurs in the State of Iowa. There is a well marked difference between the females and the males in respect to color markings. The females have little of the deep yellow or red color on the belly while they have a number of the coppery colored markings on the sides scattered without order or apparent arrangement. The males are characterized by the presence of a great many orange colored spots, also without definite order, on the sides, while the lower fins are deep red or bright yellow. The more somber hues assumed by the females render it sometimes a matter of question as to specific identity. The organs of reproduction are then the last resort. The species is very abundant throughout the entire northwestern portion of the State occurring in every stream; in some of the smaller muddy creeks which empty into the Missouri it is almost the only fish we found. This and the next form are the most common ones of the genus in our area.

Lepomis cyanellus Rafinesque.—North river; Walnut creek; Beaver creek; Raccoon river, at Adel, Des Moines and Perry; Squaw creek; Des Moines river, at Des Moines, Ft. Dodge and Estherville.

The "green sun-fish" is nearly or quite as common as the preceding form. Its deeper coloration, inclining more to blue than to green enables ready separation. Then, too, it is a deeper and thicker fish, attains a greater size, and the sexes are not so easily discerned. Indeed, so far as our observations have extended the sexes cannot be readily separated. The habitat is the same as that of *Lepomis humilis* and where one is found the other usually comes to light also.

Lepomis pallidus Mitchell.—Raccoon river, Adel and Des Moines.

This form is rare in our area, but three specimens having been discovered.

Lepomis megalotis Rafinesque.—Beaver creek.

A single specimen of this species has thus far alone rewarded our search. In common with all the members of the genus little is known of its breeding habits though all have a similar habitat. All are used more or less for food but their small size renders them of little value for that purpose. They are tenacious of life and make acceptable aquaria stock. As justly remarked by Doctor Jordan the genus is among the most difficult of our fish fauna.

Micropterus dolomieu Lacepede.—Raccoon river, at Adel and Des Moines; Middle river; Beaver creek; Des Moines river at Des Moines and Ft. Dodge.

The small mouthed black bass is very common in the larger streams in our limit. In the deeper portions of the clear rivers it best thrives though it is not uncommon in the muddy streams like the Raccoon. It is a darker fish than its congener and far more abundant but less commonly taken by the hook. It is the stream bass while the following is found in still waters like bayous and lakes. It is considered a very good game fish ranking all others for sport. Its habits, food, chief characters, distribution, relationships, all are quite well understood and form the subject of numerous memoirs both scientific and popular. It is, probably, the most widely known fresh-water fish.

Micropterus salmoides Lacepede.—Beaver creek; Raccoon river at Adel and Des Moines; Des Moines river at Des Moines.

This form is far less common than the preceding but is often taken on the hook. It is a lighter colored fish, much larger, and esteemed more highly than any other of our native game fishes. The largest specimens seen came from the Des Moines. It is rather more slender than *Micropterus dolomeiu* and is readily distinguished by the less number of rows of scales on the cheeks, this form having but ten, the preceding possessing seventeen rows.

PERCIDÆ.
(The Perches.)

Of this family only the genus *Etheostoma* is represented in our area so far as specimens establish the fact. Known commonly to the professional naturalist and rarely seen by the sportsman or amateur, this interesting group has lately been carefully studied with the result that rich avenues for investigation have been opened. The forms are among the smallest that are known to us and at the same time comprise many that are of surpassing beauty and grace. Among them are to be found the gaudiest of our fishes. Common alike in large and small streams they escape observation because they do not take the hook, being too small, and their habits also render them less liable to be noticed. In muddy streams certain protectively colored forms live in great numbers, while, again, in streams with grassy or weedy bottoms other forms abound. Among rocks or weeds, on gravel and shallow sand bars, in pond, lake, creek, river, even rill, the "johnnies" are to be found, and always found in situations seemingly conducive to personal safety. About fifty species are recognized with the probability that the field is not yet exhausted. Of these seven have thus far been found in our area.

Etheostoma aspro Cope and Jordan.—Beaver creek; North river; Raccoon river, at Adel; Des Moines river, at Des Moines and Ft. Dodge.

This is one of the largest species of the genus and is found in considerable abundance, locally, throughout our limit. The large black blotches on the sides distinguish it from associated forms. It loves streams the bottoms of which are paved with rocks.

Etheostoma caprodes Rafinesque.—Des Moines river, at Des Moines and Estherville.

A single specimen only has come to light in the collections we have made at Des Moines. It is the largest darter known. Our specimens are not of the maximum size.

Etheostoma flabellare Rafinesque.—Beaver creek; Raccoon river, Des Moines.

But few specimens have been found by us. It is said to be abundant in clear streams. Among other peculiarities this form has the lateral line developed about half way.

Etheostoma jessiæ Jordan and Brayton.—Beaver creek; Squaw creek.

This form, a southern one, is very rare in our collections, but a single specimen having been found in Polk county. It is among the smaller of the darters.

Etheostoma nigrum Rafinesque.--Beaver creek; Squaw creek; Raccoon river, at Des Moines, Perry and Adel; Walnut creek; North river; Des Moines river, at Ft. Dodge.

This is the most abundant etheostomoid fish in Iowa. In nearly every stream it is abundant, often, in favored localities exceeding in numbers all other members of the genus together. The general light straw colored back ground, on which are arranged the characteristic "W" markings will enable its ready separation. In all streams examined by us from Ft. Dodge to the Missouri it is a most constant member of their fauna. It appears to delight equally in muddy and clear waters, with bottoms of all natures. It loves to lie in concealment under leaves, stones, twigs, or even lies half buried in the sand.

Etheostoma pellucidum Baird.—Raccoon river, at Des Moines and Adel; Des Moines river, at Ft. Dodge.

The pellucid darter is well named. Like *Labidesthes sicculus* it is quite transparent and the gross anatomy may be made out, measurably well, without dissection. It is nearly white in color, with a few double but small dark spots along the dorsum from the nape to the base of the caudal. A similar row is to be seen, often but faintly, on the sides just above the lateral line. The lateral line itself is in the midst of a series of from five to six rows of scales which widen out to a fan-like shape at the base of the caudal fin. Otherwise the fish is without color. Its choice habitat is in shallow water, on sandbars, its coloration being admirably adapted to protection. It is possibly the best illustration of protective coloration that the genus affords. It is very abundant at all the localities named on sandbars in swiftly flowing water. From its habit of concealment by plunging beneath the sand with only the eyes out of "sand" it has been made the type of the subgenus *Ammocrypta*. A related species, possibly but a synonym, has been described from the Des Moines under the name of *Ammocrypta clara*. The locality for the new species is Ottumwa.

Etheostoma phoxocephalum Nelson.—Raccoon river, at Adel.

But two specimens have been found by us at this locality. They were taken in rather rapidly flowing water and in a portion of the stream abounding in large drift boulders. The species is easily recognized by the color markings and peculiar tapering head, which latter character it shares in common with no other etheostomoid fish.

While the present paper is designed only to record the results of personal collection and the study of the fishes of Central Iowa it will be helpful, perhaps, to list in addition all forms recorded by others from our area. The first bibliographic reference given above lists from the Des Moines, at Ottumwa, the following:

Noturus flavus Rafinesque.
Notropis boops Gilbert.
Hybopsis dissimilis Kirtland.
Ameiurus nebulosus Le Sueur.
Hybopsis hyostomus Gilbert.
Hybopsis biguttatus Kirt.
Hadropterus evides Jordan and Copeland.
Boleosoma olmstedi maculatum Agassiz.
Ammocrypta clara Jordan and Meek.

The total number of species now known from this limited area is, therefore, sixty-three. A few more than one hundred species are known in the State. Our area then shows, thus far, a fauna numbering over 60 per cent of the species known to Iowa. That this list will be largely increased is most probable.

The nature of the fish fauna of Central Iowa, so far as known, may be best exhibited in the following tabular view:

FAMILY.	GENERA.	SPECIES.
Petromyzontidae	One	One
Lepidosteidae	One	One
Siluridae	Three	Six
Catostomidae	Four	Six
Cyprinidae	Twelve	Twenty-five
Cyprinidontidae	One	One
Esocidae	One	Three
Anguillidae	One	One
Atherinidae	One	One
Centrarchidae	Four	Eight
Percidae	Six	Ten
Eleven.	Thirty-five.	Sixty-three.

ON AN ABNORMAL HYOID BONE IN THE HUMAN SUBJECT.

BY R. ELLSWORTH CALL.

(ABSTRACT.)

The hyoid bone lies at the base of the tongue just above the upper border of the thyroid cartilage. It is not articulated with any other bone in the body.

It is usually studied as consisting of five parts, all of which may readily be distinguished in the normal specimen, especially in the young subject. There is the body of the bone, or the basi-hyal; there are also two cerato-hyals, or lesser cornua, and two thyro-hyals, or greater cornua. The whole forms a horse-shoe shaped bone to which the name hyoid has been given in allusion to the shape of the Greek letter *upsilon*, which the bone greatly resembles.

In the normal bone the body is commonly compressed antero-posteriorly, curved and extended transversely. On the anterior lower border is a rather prominent but blunt tubercle. Owen describes the cerato-hyals as "mere pisiform nodules of bone projecting from the line of union of the basi-hyal and thyro-hyal portions," that is to say, they arise from the area of junction. Strong, somewhat rounded ligaments extend from the cerato-hyals, or lesser cornua, to the styloid processes of the temporal bones, or rather to their petrosal portions.

Also, normally, both the thyro-hyals and the cerato-hyals are separated from the basi-hyal or body to a late period in life. A slight expansion of the posterior end of the thyro-hyals is usually seen and these often bear—indeed I have never seen any other condition—epiphyses. From these processes extend ligaments which reach to the thyroid cartilage and this occasions the name bestowed upon them. All these five bones become completely ossified and ankylosed at from thirty-five to forty years of age.

It may be further remarked that the cerato-hyals are described by Holden as being "of the size of barley-corns."

In the specimen before us the process of ossification and ankylosis is complete and the subject was probably past the middle of life. The vertical ridge on the anterior surface of the basi-hyal is scarcely to be noticed; equally poorly indicated are the lateral ridges which depart horizontally from the median line. There is but one cerato-hyal and it is completely ankylosed to the basi- and thyro-hyals on its side. This one is excessively long and styliform and is also slightly curved. It is in no sense a mere projection nor is it "the size of a barley-corn." It is nearly six times longer than the normal structure in the normal bone.

With respect to the missing cerato-hyal careful examination reveals no articulating surface for it; it probably did not exist in this subject.

Referring now to the points of attachment of the various muscles it will be seen that an exceedingly rough surface is presented to notice. It is highly probable, though of this I have no personal knowledge since the specimen came into my hands after complete dissection, that much of this roughness results from the necessary rearrangement of the muscles and ligaments in respect to their points of attachment. The area of surface for attaching them was certainly below the normal.

ARTESIAN WELLS IN IOWA.

BY R. ELLSWORTH CALL.

(ABSTRACT.)

The demand for artesian waters in the State of Iowa is not to be connected with unfavorable climatal conditions. The State is well watered; a considerable number of rather large streams and innumerable smaller ones combine to make it, from a hydrographic standpoint, unique among prairie states. The annual rainfall is a little more than thirty-five inches and chiefly comes at a time of year when every crop necessity is fully supplied. The main grounds upon which artesian waters are sought, therefore, are first, the convenience of such flows for farm and urban use, and second, the supposed purity of such waters. These are the prime reasons which have induced exploratory drilling, the chief results of which it is the purpose of this notice to record.

About four-fifths of the area of Iowa has now been demonstrated to possess artesian conditions. Most of this area lies northwards of a line which may be drawn across the State, in a northwestwardly direction, from near Keokuk to Sioux City, except in the igneous area indicated below. South of this somewhat arbitrary line but one or two artesian flows are known; these appear to be connected with the Nebraska artesian area and are in the immediate neighborhood of the city of Omaha and Council Bluffs. By reference to the sketch map accompanying it will be seen that the greater number of the wells lie along the Des Moines river or its tributaries; this distribution, which is well marked, is to be correlated with the distribution of the great terminal moraine within which most of these wells are situated. This peculiarly interesting feature is further discussed beyond. The very deep and permanent artesian wells lie mainly east and north of the line above

mentioned; or better still, east of a line drawn north and south through the city of Ottumwa, number 109 of the map. With but a single exception, that at Washington, number 54 of the map, these deeper borings furnish abundant flows of water. But there are also, east of this north and south line, two smaller areas of shallow wells whose characters are essentially identical with those exhibited by the wells within the terminal moraine. One of these lies along the Iowa river, see map, numbers 60-66, etc.; the other, and by far the smallest single artesian area in the State, is in the valley of the Wapsipinnicon river, in Bremer county, see map, numbers 11-12, 42. The shallow wells, therefore, constitute well defined groups; the deep wells are widely scattered.

It has been found convenient to classify the Iowa artesian wells in terms of the geological structure which they exhibit. To the shallow wells, those that form groups and which present similar geological sections, the term, "glacial wells," or wells of the first class, has been applied. To all others, no matter what may be the geological age of the strata into which they may pass or in which they end, the term "deep wells" or wells of the second class, may be appropriated. There is no distinguishing mnemonic on the map by which these wells may be differentiated.

A few important deep borings have been made, in various parts of the State, but more particularly in the northwestern and southwestern portions, in which artesian waters were not found. But, in the greater number of these borings, the waters rose to constant heights, always, however, some distance below the top of the boring. These are called on the map "deep wells not artesian" and are indicated by a specific mnemonic, as in the well at Glenwood, in Southwestern Iowa, see map number 120.

In depth the glacial wells range from forty feet to two hundred and fifty feet in a few cases; this feature is dependent on the relation of the borings to preglacial drainage, on the one hand, and to the thickness of the morainic materials, which is a variable, on the other. A generalized section may be given as follows, being based upon the sequence of strata as exhibited in Hancock and Wright counties:

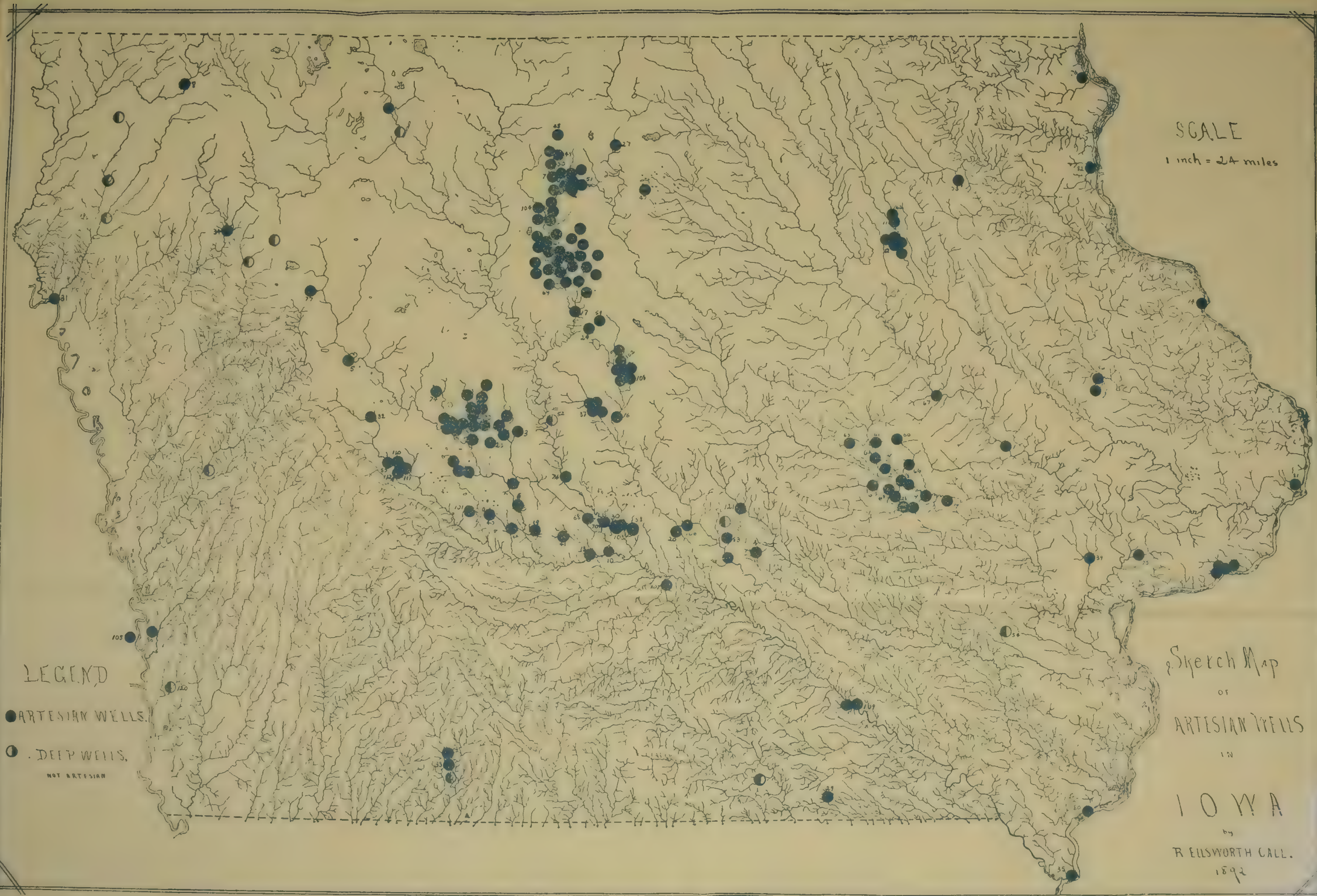
Soil	1 to 5 feet
Bouldery clay, with water	10 to 50 feet
Sand and gravel	8 to 20 feet
Bluish, bouldery glacial clays	30 to 120 feet
Sand and gravel, with water	15 to 25 feet

These materials are irregulary distributed over the surface of the State and exhibit a variable relation. However, whenever the gravels and sands of the lower series are reached, especially in the valleys of the larger streams within the terminal moraine, flowing wells are likely to be obtained.

The deeper artesian wells, or those which present the characteristic feature of penetrating the country rock are typified by the following section which is that of the deep artesian well at Cedar Rapids:

No.		Feet.
1.	Dark gray limestone	50
2.	Light gray limestone	85
3.	Gray limestone	40
*4.	Coarse grained, reddish-brown limestone	65
*5.	Coarse, brown and very porous limestone	60

*Contains water.


SCALE
1 inch = 24 miles
LEGEND
ARTESIAN WELLS.
. DEEP WELLS.
NOT ARTESIAN
Sketch Map
OF
ARTESIAN WELLS
IN
IOWA
by
R. ELLSWORTH CALL.
1892

No.		Feet.
6.	Coarse, light brown limestone, mixed with shale	30
7.	Shale	20
8.	Coarse, dark gray limestone	25
9.	Coarse, light gray limestone	45
10.	Tough blue clay	200
11.	Reddish brown sandstone	295
12.	Shale	5
13.	Dark bluish-grey sandstone	65
14.	Shale	1
15.	St. Peter's sandstone	50
16.	Gray sandstone	74
*17.	Brownish sandstone	40
*18.	Coarse grained porous brown sandstone	270
19.	Light sandstone	88
20.	Dark colored and hard sandstone	42
21.	Brown, very close grained and hard sandstone	140
22.	Blue clay	100
23.	Soft, reddish-brown sandstone	160
24.	Potsdam sandstone	200
25.	Red sandstone	75

Over the eastern third or more of Iowa, east and north of the line drawn from Keokuk to the vicinity of Sioux City, as above mentioned, thence northeastwardly to Worth or Mitchell counties, the St. Peter's sandstone may be reached in deep wells and flowing water found. North of that part of the line which extends northeastwardly from Sioux City flowing water will not be found, if the indications of the strata penetrated in the Hull, Sioux county, well are reliable. From that place igneous rocks, presenting a volcanic facies, have been submitted to us.

The southwestern part of the State, that is all that part of Iowa which lies south of the first arbitrary line above indicated, will not furnish artesian waters. The section, which is given elsewhere, of the Glenwood deep boring furnishes the most complete vertical section of the Carboniferous rocks which is exhibited in Iowa. It further affords no hope that artesian waters will be reached at reasonably profitable depths in that portion of the State.

The south central parts of Iowa will likewise not, probably, repay drilling for artesian waters. There will, however, doubtless be found very many wells that will furnish abundant water by pumping. These wells will need to go down until the St. Peter's sandstone is reached. If they should stop in the Carboniferous rocks which form the country rock of the region there is little hope that good water will be had.

*Contains water.

SECTION OF THE GLENWOOD DEEP WELL.

All members of this section, except the first seven, belong to the Carboniferous series. The first seven are Pleistocene.

STRATA.	Number.	Depth to top of strata, feet.	Thickness, feet.
Alluvial soil	1		2
Yellow bluff deposit. Loess	2	2	113
Yellow with marly concretions. Loess	3	115	25
Same as above, with clay stones. Loess	4	140	14
Gravel bed (water). Drift	5	154	6
Quicksand. Drift	6	160	3
Blue clay with gravel. Drift	7	163	1
Fire clay	8	164	3
Blue marl	9	167	8
Compact blue limestone	10	175	3
Bluish marly clay	11	178	4
Silicious light-colored limestone	12	182	5
Black carbonaceous shale	13	187	1½
Blue shaly clay	14	188½	6½
Shaly clay or muck	15	195	8
Silicious limestone	16	203	1
Compact limestone	17	204	4
Slate	18	208	10
Light grey limestone	19	218	4
Blue limestone	20	222	5
Blue shaly fossiliferous limestone	21	227	5
Shelly limestone	22	232	5
Hard blue limestone	23	237	3
Shale	24	240	4
Compact limestone	25	244	10
Blue clay with shaly limestone	26	254	3
Blue shale	27	257	6
Hard silicious limestone	28	263	16
Red ochre	29	279	10
Mottled red and blue clay	30	288	28
Sandstone [Fissure]	31	317	6
BASE OF UPPER COAL MEASURES.			
Blue shaly limestone	32	323	17
Blue shale	33	340	2
Compact limestone	34	342	5
Mottled red and blue shale	35	347	3
Hard grey limestone	36	350	13
Clay	37	363	3
Fossiliferous limestone	38	366	6
Soapstone	39	372	1
Hard gray limestone	40	373	7
Sandstone	41	380	5
Silicious limestone	42	385	11
Black slate	43	396	½
Sandstone, and sandy limestone	44	396½	8½
White marl	45	405	2
Hard grey limestone	46	407	8
Blue fossiliferous limestone	47	415	4
Red and blue shale	48	419	19
Grey limestone	49	438	18
Blue shale	50	456	1
Sandy limestone	51	457	10
Limestone	52	467	1
Slate	53	468	2
Sandstone	54	470	6
Hard grey limestone	55	476	15
Black slate	56	491	5
Grey limestone	57	496	8
Sandstone	58	504	4

STRATA.	Number.	Depth to top of strata, feet.	Thickness, feet.
Blue shale	59	508	8
Sandy limestone	60	519	10
Sandy slate	61	529	21
Sandy limestone	62	550	20
Marly limestone	63	570	4
Limestone	64	574	5
Slate with trace of coal	65	579	2
Blue shale	66	581	14
Grey limestone	67	595	17
Coal (?)	68	612	1
Silicious limestone	69	613	4
Hard grey limestone	70	617	6
Blue shale	71	623	2
Sandstone	72	625	10
Varigated shale	73	635	3
Varigated clay and soapstone	74	638	17
Varigated red and blue clay	75	655	30
Varigated sandstone	76	685	35
Slate with trace of coal*	77	720	1
Blue shale	78	721	4
Blue limestone	79	725	5
Blue shale	80	730	2
Sandstone	81	732	8
Slate	82	740	12
Fine sandstone	83	752	3
Blue shale	84	755	3
Black limestone	85	758	2
Gravelly sandstone	86	760	8
Fossiliferous shale	87	768	19
Blue limestone	88	787	4
Slate	89	791	2
Blue shale	90	793	22
Blue shale with sandstone band	91	815	10
Sandstone†	92	825	20
Varigated shale	93	845	29
Slate	94	868	3
Blue shale	95	875	7
Sandstone	96	884	2
Soft blue shale	97	886	24
Limestone	98	910	1
Slate	99	911	1
Blue shale	100	912	8
Green soapstone	101	920	2
Slate	102	922	3
Sandy shale	103	925	5
Sandy limestone	104	930	10
Slate and shale	105	940	2
Limestone	106	942	3
Black slate, 3 feet; coal, 3 feet	107	945	6
Fire clay	108	951	5
Limestone	109	956	3
Slate	110	959	3
Limestone	111	962	2
Sandy limestone	112	965	5
Sandy limestone	113	970	15
Brown sandstone	114	985	4
Limestone	115	989	9
Sandy shale	116	999	10
Soft sandstone	117	1,008	20
Brown sandstone	118	1,028	12
Sandy shale	119	1,040	38
Sandstone	120	1,078	3
Black slate	121	1,081	2
Blue shale	122	1,083	5
Fire clay	123	1,088	6
Blue shale	124	1,094	8
Limestone	125	1,102	18
White shaly clay	126	1,120	5
Ash colored s apstone	127	1,125	3
Sandstone	128	1,128	22

*716 struck salt water. Rising to 176 feet of surface.
†Second vein of salt water rising to within fifteen feet of surface.

STRATA.	Number.	Depth to top of strata, feet.	Thickness, feet.
Hard blue limestone	129	1,150	10
Sandstone	130	1,160	20
Sandy limestone	131	1,180	5
Limestone	132	1,185	10
Black limestone	133	1,195	5
Fossiliferous limestone with iron pyrites	134	1,200	5
White sandstone	135	1,205	30
Brown limestone*	136	1,235	15
Grey limestone	137	1,250	25
White limestone	138	1,275	5
Fine brown sandy limestone	139	1,280	20
Hard grey limestone	140	1,300	45
Brown sandy limestone	141	1,345	5
Hard grey limestone	142	1,350	5
Brown sandstone	143	1,355	11
Limestone	144	1,366	4
Magnesian limestone	145	1,370	10
Grey limestone	146	1,380	3
Magnesian limestone	147	1,383	13
Grey limestone	148	1,396	9
Brown sandy limestone	149	1,405	45
Brown sandy limestone	150	1,450	20
Fine sandstone	151	1,470	5
Grey limestone	152	1,475	15
Sandstone	153	1,490	20
Magnesian limestone	154	1,510	50
Magnesian limestone	155	1,560	5
Mottled shale	156	1,565	35
Blue slate	157	1,600	34
Sandy shale	158	1,634	10
Limestone	159	1,644	6
Grey limestone	160	1,650	18
Grey sandstone	161	1,668	7
Grey sandstone	162	1,675	5
Grey sandstone	163	1,680	1
Slate	164	1,681	10
Sandy limestone	165	1,691	6
Black sand	166	1,697	12
White sand, shells and slate	167	1,709	6
Sandy limestone	168	1,715	5
White sand, shells, and slate	169	1,720	5
Soapstone	170	1,725	2
Brown sandstone	171	1,727	6
White sand, shells and slate	172	1,733	5
Brown sandstone	173	1,738	7
Light brown sandstone	174	1,744	10
White sandstone	175	1,755	10
Grey sandstone	176	1,765	5
Dark brown sandstone	177	1,770	5
Brown sandstone [flinty]	178	1,775	9
Dark brown sandstone	179	1,784	10
White sandstone [water 40 feet from surface]	180	1,794	1
White sandstone	181	1,795	5
Brown sandstone	182	1,800	14
Light brown sandstone	183	1,814	14
Brown sandstone [quartzite?]	184	1,828	2
White sandstone	185	1,830	2
Light brown sandstone	186	1,832	3
Brown sandstone [quartz crystals]	187	1,835	1
Grey sandstone	188	1,836	1
Grey sandstone	189	1,837	3
Dark grey sandstone	190	1,840	8
Coarse, hard, reddish sandstone	191	1,848	2
Brown sandstone	192	1,850	7
Blue limestone [1853 bottom of water-bearing rock]	193	1,857	18
Grey sandstone	194	1,875	5
White sandstone	195	1,880	5
Light brown sandstone	196	1,885	3
Fine white sandstone	197	1,888	7
Light brown sandstone	198	1,895	15
White sandstone	199	1,910	5

*1,210 ft. struck fresh water, rising to 126 ft. from surface.

STRATA.	Number.	Depth to top of strata, feet.	Thickness, feet.
Light grey sandstone	200	1,915	5
Dark grey sandstone	201	1,920	10
Magnesian sands one*	202	1,930	5
Magnesian limestone	203	1,935	3
Magnesian rock [gypsum?]	204	1,938	3
Light colored sandstone	205	1,941	7
Dark grey sandstone	206	1,948	12
Light grey sandstone	207	1,960	30
White sandstone	208	1,990	5
Grey sandstone	209	1,995	5
Blue sandy limestone	210	2,000	?

*Struck water, rising to 171 feet from surface.

It is interesting to note that no water was found in this deep well until at a depth of 716 feet when salt water was reached in the Carboniferous strata through which the boring was then progressing. Another hundred feet and a second vein of salt water, rising to withing fifteen feet of the surface, was found. Fresh water was not reached in appreciable volume until the drill had penetrated to a depth of 1,235 feet and then the pressure was sufficient only to bring the water to within 126 feet of the top. Water, whether salt or fresh is not stated, was found again at 1,794 feet and at 1,836 feet, but neither vein sent water to the surface. At a depth of 1,930 feet the last water-bearing stratum was passed, the drilling ending at 2,000 feet.

From this section it is clear that the differentiation of strata has been earried far beyond the point to which the geologist would go*. However, it is valuable since it shows clearly the heterogeneous character of the lowermost coal measure strata in Southwestern Iowa.

This section appears to give corroborative evidence of the general conclusion above indicated, that artesian water would not be found in that portion of the State.

The accompanying map, which appears through the kindness of Hon. J. R. Sage, Director of the Iowa Weather and Crop Service, for whom the facts contained in this paper were originally gathered, does not locate all the wells known to us in Iowa. Very many of the wells, especially those which are classed as glacial, occur in groups and are so close together that it is impossible to indicate them on a map of this scale. In a large number of cases, as in Story, Hancock, Hamilton and Iowa counties, each character represents a dozen or more wells. At a future time it is hoped to present all this evidence in the form of a larger map with appropriate mnemonics.

* I am indebted to the kindness of Mr. Seth Dean, of Glenwood, for the details of the Section.

SOME EXPERIMENTS FOR THE PURPOSE OF DETERMINING THE ACTIVE PRINCIPLES OF BREAD MAKING.

MINNIE HOWE.

(ABSTRACT.)

This paper described a series of experiments made by the author at the Iowa State University during the winter and spring of 1891, together with their results.

The problem was to seperate the bacteriam, *Bacillus subtilis*, and the yeast plant, *Saccharomyces cerevisiæ*, found together in ordinary soft yeast, to obtain pure cultures of each, and to determine the part each played in bread making.

It was found that bread made of sterilized flour and raised with the pure Bacillus culture was light, but not as spongy as ordin ary bread, sweet, close-grained, rather dark colored, smelling and tasting much like "salt-risen" bread.

Bread raised with the pure yeast culture under exactly the same conditions as the first was somewhat light, sweet, not so fine grained nor as light as either ordinary bread or that made with bacteria. It had a peculiar, insipid odor unlike either of the other kinds, and was tasteless, as if made out of sawdust.

The results of these experiments seem to show that neither the yeast plant nor the Bacillus alone will make as good bread as both together; that either without the other will produce alcoholic fermentation and cause the bread to rise; that the Bacillus is rather more efficient alone than the yeast. No one set of experiments, however, can be regarded as conclusive.

ABORIGINAL ROCK-MORTARS.

BY H. L. BRUNER.

A few notes by the writer, under the above title, were published in the *American Anthropologist* for October, 1891.

These "mortars", excavated in rock *in situ*, are located on the east slope of the Franklin Mountains, about eleven miles north of El Paso, Texas, and near the mouth of the "House Canon."

In the canon, about three-fourths of a mile above the excavations, is a spring of excellent water. To the eastward is a gradual slope toward the mesa, which is perhaps three hundred feet lower. Within a few steps of the excavations is a trail leading northward to another spring, and thence westward over the range.

The mountains in the immediate vicinity are composed of intrusive granite, which also underlies the detritus below the mouth of the canon and crops out here and there in low knolls and ridges. In two such granite knobs, about one hundred yards apart and one-fourth of a mile from the mouth of the canon, the excavations are found. One of these, which is quite bare, contains a small number. The other is partly over-laid and partly fringed with large granite rocks, all more or less tilted or moved from place. On this knoll, some in detached rocks, some in undisturbed granite, are upwards of sixty excavations. All stand nearly or quite perpendicular, the detached rocks having undergone little change of position since the excavations were made.

A description of this group will serve the purpose of this paper.

The excavations themselves are of two kinds, which differ both in size and shape. The larger, thirty-two in number, are uniformily semi-fusiform, the diameter and depth being about in the proportion of three to five. The largest of these measures fourteen inches in diameter at the mouth, and nineteen inches in depth. A small one is ten and one-half by fourteen inches; a wide one, fifteen by sixteen inches; a narrow one, twelve by eighteen inches.

The wide excavations are, naturally most weather-worn, other things being equal. A few in sound granite and particulary narrow or shaded holes, are in a perfect state of preservation. Fourteen are well preserved. Five, made near an edge of a rock, have been partly worn away on the outer side; one similarly situated has been split open lengthwise and others, crowded in a smalll area, are more or less fractured.

Twelve excavations, in seperate groups of five and seven, are found a few steps apart from the rest and are more exposed. The remainder lie in or near the shadow of a large, tilted block of granite. These excavations also appear oldest, and in the shade are much crowded.

Scattered among or near these shaded excavations are found more than thirty smaller basin-shaped ones, which, moreover, occur nowhere else. These vary in size from six inches wide by three inches deep, to two inches wide by one-half inch deep. Seven only are of the former size, the majority being much smaller.

Some plainsmen say that the excavations are Indian grain-mortars; others assert that they are cooking-holes in which food was boiled by throwing heated stones into the water covering it. It has been suggested, also, that they were used for crushing ores, but the absence of any workable ore in the vicinity would seem to render this improbable. The writer would add that they may have served, also, for the storage of water from the spring which is somewhat difficult of access. They were, however, doubtless used for a variety of purposes as occasion required. The basin-like excavations probably served to hold round-bottomed vessels, such as are still used by the Indians of the Southwest, or the largest of them may be mortars.

The knoll was, presumably, a camping place for hunting parties or roving bands. The site commanded an extensive view of the mesa and of the approaches to the spring, and the loose rocks afforded shade and an ambush to the hunter and concealment from enemies.

No excavations are known to exist in the canon near the spring, though suitable rocks are abundant. Such a site would be distant from the trail and further from the mesa. Preference for this rock-covered knoll was quite natural.

Numerous small fragments of pottery were found, both plain and decorated, and resembling very much in quality and style of adornment some of the modern ware. A few of these fragments were on the surface; others were buried a few inches. Some at least were very old.

A few flakes were dug up between the loose rocks and a rude ax was found on the surface. The place, frequented at present by hunters and stockmen and formerly by prospectors, is not likely to yield many relics of a portable kind at this day. However one very interesting implement was obtained and has been pronounced unique by the Bureau of Ethnology. This was found on the surface about one-third of a mile below the excavations, having been transported presumably by water. It is an oval-lenticular tool of quartzite, its greatest length, breadth and thickness being respectively four and one-half, three and one-third and one and three-eighth inches. One surface is somewhat rough and has been worked into its present form, which nicely fits the hollow of the hand when the fingers are slightly curved. The other surface is smoothly worn and shows distinct longitudinal scratches; these, moreover, make a small angle with the line of greatest length, which fact, together with its shape, curvature and markings, suggests that the stone held in the concave palm, was used as a sort of pestle, by a vertical motion against the sides of the larger excavations or "mortars." How much reduction the pestle has suffered cannot be known.

Other pestles may also have been used, but the large excavations were uniformily pointed at bottom and would not permit the use of the ordinary sort.

NOTICE OF ARROW POINTS FROM THE LOESS IN THE CITY OF MUSCATINE.

READ DECEMBER 29TH, 1891, BY F. M. WITTER.

No other question has ever engaged the attention of man more than that which relates to the origin and destiny of his race.

Many theories have been advanced to account for man's origin and there is likewise great diversity of opinion as to his destiny.

Evolution, it seems to one, is competent to explain the natural order of things from the crystal to man. Except we build on the sure foundation of the past and present all speculation concerning man's destiny must be conjecture.

The geologic history of the earth is determined from its rocks and what they contain.

The beautiful and multifarious forms of nature's mineral flowers, the legions of plants and animals whose impress are stamped in its rocky beds form chapters in the history of our globe.

So, too, the imperishable remains of primeval man, such as the cave-dwellings, shell-heaps, earth-mounds and works of stone are the sources from which the early history of this paleolithic man or man-like animal is derived.

Man began his career as master of the world when he commenced the use of fire and stone.

The various forms of quartz, such as chert, flint, agate and obsidian, bore to him the same relation that iron bears to us.

Out of these he fashioned his spear and arrow points, knives and drills.

In the beds of those ancient lakes, the geologist has described, the archæologist looks for the tools and weapons of prehistoric man. Near the close of the great Ice Age in this latitude, especially in Iowa, numerous lakes were formed along the courses of the rivers by occasional barriers of ice across the valleys of the streams.

The city of Muscatine stands on the bed of one of these lakes. At that time the surface of this lake stood nearly at the top of our highest hills, perhaps one hundred and fifty feet above high water in the great river at our feet.

The fine grained yellowish brown material, so conspicuous at our brickyards and in all streets where cuts have been made, was deposited in this lake. It covers the Drift, or at any rate the coarser materials of the Drift, and lies over our hills like a great mantle. In places it is from forty to fifty feet thick.

The geologist calls it Loess. It is the last in the series of marked physiographical changes that have occurred in this region. The border or shoreline of this Loess lake is quite easily found, From this Loess have been taken several species of land and fresh-water shells, the remains of two American reindeer, fragments of wood, the antler of some species of deer, etc. Long ago I was led to believe we ought to obtain evidence that men were here before this lake had disappeared. On Eighth street, near St. Matthias church, Mr. Chas. Freeman was for many years engaged in changing a fine hill of this Loess into brick. I have before me a rather rudely formed spear point of pinkish chert. This, Mr. Freeman says, he took from the Loess at this place at a point about twelve feet from the surface. In answer to my questions he said it could not have possibly dropped from the top, for he was digging under the bank for the purpose of caving it down when the spear point was struck, and he was specially interested in the impress or matrix where it lay. Several of the deeper depressions on this implement are still filled with the characteristic Loess. About the same time in the same bank as the Loess was caved off, Mr. Freeman noticed a stone, as he supposed, projecting from the vertical wall. As such things were rare in this compact homogeneous Loess, he examined it and found it to be an arrow point projecting from the undisturbed earth, at least twenty-five feet below the surface. At a brickyard about two blocks to the north of this, as Mr. Freeman was moulding brick, he took from the clay a well-formed arrow point. This was covered with a blue clay quite different from the usual Loess. Inasmuch as this arrow point had passed through the bed where the clay is mixed it seemed as if the story it told was not very clear. At a point in this bank a bed of fine blue clay was uncovered. The top of this blue clay was over eight feet from the surface. On examination of the bank and inquiry into the circumstances I believe, with Mr. Freeman, that the arrow point must have come from the blue clay. About one mile from where it empties into the Mississippi river, Mad Creek has cut away the point of a hill, the top of which is Loess. This cut forms a bank almost perpendicular, probably forty feet high. About ten feet from the top is a bed of gravel perhaps one foot thick. In this gravel bed Mr. Joe Freeman, a third year student in our High school, found a considerable fragment of the tooth of an elephant. I examined this gravel bed and found in it numerous flint chips, such as are supposed to have been struck from arrow and spear points, knives, etc.

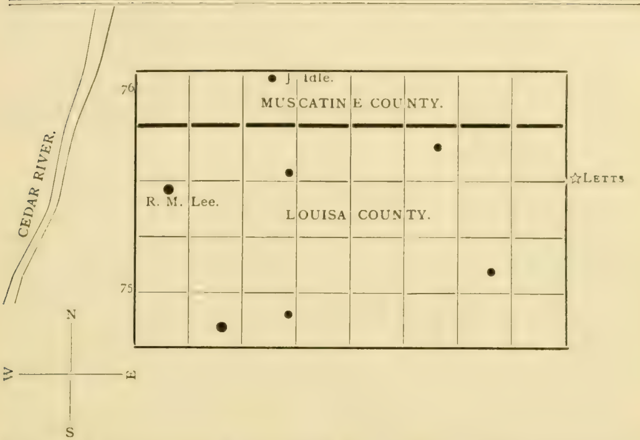
On both sides of our great river in this region, on the most commanding sites, are mounds of earth, the works of men. These mounds do not seem to be built on Loess. They are considered to be very ancient. Might it not be possible that the men who built these mounds were of the same race as those who pursued their game and lost their weapons by the shore of our ancient Loess lake?

THE GAS WELLS NEAR LETTS, IOWA.

READ BY F. M. WITTER AT THE SIXTH ANNUAL SESSION OF THE IOWA ACADEMY OF SCIENCE, IN DES MOINES.

In the early part of December, 1890, Mr. T. L. Estle, living in section 3, township 75, north, range 4, west 5th p. m., sunk a well on his farm for water. In drift at a depth of about one hundred feet he struck gas, which burned readily but in two or three days the gas ceased to flow. Between forty and eighty rods west of this place, about the same time Mr. R. M. Lee bored for water. At about one hundred feet he failed to get water and stopped boring. In the evening he commenced to pull out his casing, and succeeded in raising it perhaps eight or ten feet. During the night a great roaring was heard and on approaching the well with a lantern the gas took fire and a great flame shot several feet in the air with a frightful noise. In a few days the flame was extinguished and the gas piped into Mr. Lee's house a few rods away, where for over a year it has furnished him light and fuel. This well now furnishes Messrs. R. M. Lee, T. J. Estle, J. E. Lee and Robt. Lee with all their fuel and light. Robt. Lee is a little over one mile from the well.

It is carried in common gas pipe laid on top of the ground. This is two inches, one and one-half inches and the last half mile one inch in diameter.



GAS WELLS NEAR LETTS, IN MUSCATINE AND LOUISA COUNTIES, TOWNSHIPS 75 AND 76, N. R. 4 W, 5 P. M.

This well supplies twelve fires and sixteen lights. No estimate has been made as to how many more it might supply, but the number would certainly be quite large.

Mr. J. E. Lee stated that the opening admitting the gas from the casing of the well to the main was considerably less than the size of an ordinary lead pencil and that it flowed a half mile in the main in fourteen seconds. How this rate was satisfactorily ascertained we did not learn. The same gentlemen said the pressure at first was about five and one-half pounds, which has steadily risen till it is now twelve pounds. From a large stream issuing in our faces we could detect a faint odor of ether or chloroform. It gives a fine light and a most intense heat in the stoves and artistic grates. It seems in all respects to be equal or superior to the best artificial illuminating gas. The gas is used just as it is when it issues from the well.

Within a circle of about three miles in diameter in the townships named above from at least seven wells sunk for water, gas issued. The depth to the gas ranges from about ninety feet to one hundred and twenty-five feet. At a depth from six feet to twenty-five feet below the gas a good, constant supply of water is obtained.

It seemed to be very easy to shut off the gas by the rapid sinking of the casing in a soft blue clay with some sand in which the gas is thought to be stored. The clay seems to form a tube as the drill and casing descend and thus prevents the gas from getting into the well unless it is given a little time at the right place.

The country for miles around is full of wells which are all believed to reach the water below the gas without discovering the gas for reasons given above.

I made the following tests on the water from below the gas: With Potassium Ferrocyanide I observed no re-action. On evaporating perhaps fifty c. c. a considerable amount of solid matter was obtained. This was somewhat of a yellowish brown color and effervesced with Hydric Chloride.

This solution when tested with Potassium Ferrocyanide gave a deep blue. I was led to believe from these tests that the water contained a carbonate and some compound containing iron in solution. My stock of water would not admit of further tests.

At a depth of eighteen or twenty feet water has generally been found in this locality, but the supply is variable. Mr. Robt. Lee has a well which he dug several years ago, the water of which was excellent and in good quantity. This well is about eighteen feet deep and carefully walled. Last summer he bored for water about one hundred feet from this well. At a depth of a little over one hundred feet he found a little gas issuing at irregular intervals. Immediately after the appearance of the gas the water in the shallow well became muddy and unfit for use and has remained so, though the water seemed to be much worse at times, not periodic. It seems to me the gas rises outside of the casing to the porous bed holding the water of the shallow well and injures the water.

The country in which these wells are located is comparatively level. Indications are at hand everywhere of a boggy or peaty nature. There are but few low hills, and no ravines of any note. The soil is a rich, black loam and the whole region is said to be destitute of boulders, so common in many parts of Iowa and especially of Muscatine county.

Mr. J. E. Lee stated that wells in this region had been sunk two hundred and eighty feet and no rock had been reached. The well in Muscatine county from which gas is used is on the farm of Mr. John Idle, in section 35, township 76, range 4 west. The farmers in the neighborhood of these gas wells are about to complete an arrangement to put down a well two thousand to two thousand five hundred feet deep. This is to determine whether there is oil below the gas.

It is my own opinion that the gas comes from considerable beds of vegetable matter buried in this unusually heavy drift deposit in this region. The area, it seems to me, which is thus underlaid is six or eight miles long and three or four miles wide. I should expect to find the rocks here directly below the drift to be of Devonian age.

This locality is on the east side of the Cedar river. The nearest well to the Cedar river is about two miles distant. No gas has yet been found on the west of the Cedar. This region is directly on the edge of what I have considered the sub-carboniferous.

Some eight or ten miles to the south of these wells rock are exposed along the creeks and deep ravines. I have not seen these rocks, but I think Mr. Frank Springer reported several years ago that certain beds of these rocks were well filled with the remains of fish, especially their teeth.

A NEW DISTILLING FLASK FOR USE IN THE KJELDAHL PROCESS.

BY G. E. PATRICK AND D. B. BISBEE.

The only serious drawback to the Kjeldahl method of nitrogen determination is the breakage of distilling flasks, and in laboratories where many determinations of albuminoid nitrogen are made by the Stutzer process this breakage is often a matter of much annoyance and considerable expense, since only the best quality of flasks will long stand the requirements of the process.

Some months ago the breakage in a certain lot of flasks purchased for this laboratory having become unendurable, the writers hit upon the idea of distilling from copper flasks; and upon trial, the results have been so satisfactory that we can with confidence recommend the plan to other chemists. The copper flasks used were the ordinary one pint oxygen retorts, minus caps, delivery tubes and clamps.

At first, trials were made by distilling ammonia from a solution of pure ammonium chloride and NaOH, to assure ourselves that no ammonia was retained by the copper. These results were made comparative by distilling from both glass and copper flasks. Exactly 10 c.c. of an ammonium chloride solution of known strength were used in all following tests. The results, after deducting for error found by blank experiment, were as follows:

	IN GLASS FLASKS.	IN COPPER FLASKS.
No. of C.C. of decinormal acid neutralized	14.4	14.25
" " " "	14.23	14.23
" " " "	14.2	14.30
" " " "	14.28	14.25
" " " "	14.3	14.25
" " " "	14.15	14.30
Mean of six	14.26	14.26

Next a salt of mercury was added to the ammonium salt in the flask, and K_2S sufficient to precipitate the mercury was added before liberating the ammonia and distilling. The following were the results after deducting for the error in the blank:

	IN COPPER FLASKS.
No. of C.C. decinormal acid neutralized	14.13
" " " "	14.25
" " " "	14.25
" " " "	14.2
" " " "	14.25
" " " "	14.25
Mean of six	14.22

These results compare favorably with those from glass just reported.

Next, to imitate the condition of Stutzer's process, copper hydrate, as well as a mercuric salt and K_2S, was added. Results after deducting the blank were as follows:

	IN COPPER FLASKS.
No. of C.C. of decinormal acid neutralized	14.2
" " " "	14.2
" " " "	14.3
" " " "	14.25
" " " "	14.25
Mean of five	14.24

Here again, the results were practically identical with those obtained by distilling from glass.

The plan was then tried upon the product of the Kjeldahl digestion in fodder analysis, both in total and albuminoid nitrogen determination, the results in all cases being in substantial agreement with those obtained by distilling from glass; and now we use the metallic flasks in the regular analytical work of the laboratory. A few results will suffice to illustrate:

SUBSTANCE TAKEN.	RESULTS—IN COPPER.	IN GLASS.
Shorts, total Nitrogen	2.81 per cent.	2.81 per cent.
Shorts, Albuminoid Nitrogen	2.26 "	2.26 "
Cream Gluten Meal, total Nitrogen	6.28 "	6.27 "
Cream Gluten Meal, Albuminoid Nitrogen	6.18 " 6.21 "	6.24 " 6.22 "
Sugar Meal, total Nitrogen	3.33 "	3.19 "

(Determinations made two months apart.)

We employ 200 c.c. of water in transferring the contents of the digestion flask into the distilling flask, using about half of it in diluting and cooling the acid licquid before actually transferring. We are also in the habit of introducing 30 c.c. of the K_2S solution, instead of 25 c.c. as is usually directed. This may not be necessary, but the fact that the residual liquid after distillation is always free from (binary) sulphur, the excess being removed by the flask itself, seems to render a little extra sulphide advisable. This action between the sulphide and the copper will doubtless in time destroy the flasks; but long before that time arrives, they will have saved in glassware many times their cost.

The flasks are heated by rather small, naked flames; a large flame under the one pint flask will boil the charge over. The receiving flasks are marked at the 200 c.c. level to show when the operation is finished. No zinc or pumice is required to prevent "bumping;" otherwise, the arrangements are as usual.

The distillation is completed *within thirty minutes;* so the saving of time is very great.

IOWA AGRICULTURAL EXPERIMENT STATION, *Ames, Iowa.*

COMPOSITE MILK-SAMPLES IN THE LABORATORY.

BY G. E. PARTICK.

Composite milk-samples for use at creameries, as a means of saving labor in the valuing of milk by any of the "oil tests," I first proposed (in detail) in Bulletin No. 9, of the Iowa Experiment Station, May 1890. The preserving agent there recommended for preserving the samples was corrosive sublimate, $HgCl_2$, numerous experiments having shown that it preserves the *mechanical*, as well as the chemical, condition of milk better than any other common antiseptic. For use in creameries I insisted that the sublimate have mixed with it some suitable aniline color, as a guard against accidental poisoning; and to hasten solution in the milk, admixture of common salt, NaCl, was recommended.

For six months past I have employed the same principle in the laboratory, in analyzing the milk of experimental cows, not only for fat (by one of the "oil tests") but also for solids, gravimetrically. (See Iowa Station Bulletin No. 13, page 29, May, 1891.)

For this purpose the preservative is of course used without admixture of aniline color in common salt, as these would bring error in the results on solids.

The corrosive sublimate is powdered finely and passed through a very fine gauze sieve. Only a very small amount is needed to preserve milk-samples five or six days without material change; and five days is as long as such keeping is desirable in most experiments on milk production. For keeping five days, .125 gm. of the $HgCl_2$ is sufficient in cool weather, and .200 gm. in summer weather, provided the daily samples are 50 c.c. each, making the complete composite sample 250 c c. The theoretical error thus introduced in the result of solids is only .05 per cent with the smaller amount, and .08 per cent with the larger; the former figure is within the "limits of error" in ordinary routine work, and the latter nearly so if not quite. Many comparative trials have, however, convinced me that there is a *very slight* loss in the solids of milk preserved for five or six days, but that it rarely exceeds .05 per cent; therefore it is my custom to neglect correction for the $HgCl_2$ when it amounts to only .05 per cent; and when it amounts to .08 per cent to correct by deducting .03 per cent. These corrections are accurate enough for use in routine work, by the method of drying in air on fine asbestos in open watch-glasses—the method which I have thus far employed; doubtless finer work could have been done, and perhaps more accurate corrections found, by the method of drying in hydrogen, had time permitted the employment of this method.

The following test determinations were made by Mr. E. N. Eaton, assistant chemist in this station.

1.—Experiments in which the entire sample of milk was preserved for the time named, no daily additions of fresh milk having been made.

(*a.*) With .05 per cent of $HgCl_2$; added no correction is made for this in final results.

SAMPLE.	Solids in Fresh Milk.	Number of days Preserved.	Solids in Preserved Milk.
No. 1	10.34	5	10.34
No. 2	12.35	5	12.45
No. 3	10.95	5	10.92
No. 4	11.13	5	11.13

(*b.*) With 10 per cent of $HgCl^2$ added: results corrected by deducting .05 per cent:

SAMPLE.	FRESH.	NUMBER OF DAYS.	PRESERVED.
No. 5	11.27	8	11.27—.05=11.22 per cent.
No. 5	11.27	8	11.33—.05=11.28 per cent.

(*c.*) With .65 per cent $HgCl_2$ added, by mistake; results corrected by deducting .60 per cent.

SAMPLE.	FRESH.	NUMBER OF DAYS.	PRESERVED.
No. 6	13.47	8	13.94—.60=13.34 per cent.
No. 6	13.47	9	14.06—.60=13.46 per cent.

This last trial (*c*) indicates that the usual amount of $HgCl_2$, viz. .05 per cent, is as efficient as a much larger quantity.

(II.) Composite samples; fresh milk added each day; $HgCl_2$ added .05 per cent on entire composite sample. Results not corrected.

COWS.	Mean of results on daily samples analyzed separately.	Number of da. s.	On composite samples.
No. 114	10.53	5	10.45
No. 115	10.80	5	10.78
No. 37	14.30	5	14.36
No. 38	14.60	5	14.58

In warm weather I prefer the use of .08 per cent or .10 per cent of $HgCl_2$, with a correction of .03 or .05 per cent.

Lightning or Mason jars are convenient receptacles for the composite samples. The mercuric chloride is weighed out and placed in the jar at the time of adding the first daily sample, or before. Upon the addition of each daily sample to the composite, the latter should be well mixed by a rotary motion—not by shaking—in order to redistribute the cream throughout the whole; and this mixing should be done every day, whether the samples be added every day or not.

Sometimes, especially in warm weather, the composite sample will have floating upon its surface flecks of milk-solids; these can be broken up, and the sample brought into almost perfect mechanical condition, by means of a stiff test-tube brush used as a pestle inside the jar, rubbing the flecks to pieces against the walls of the latter.

One must guard against error from the rising of minute flecks of milk-solids to the surface while weighing out the charge; this is easily done by inverting the weighing pipette once or twice just before running out the charge upon the asbestos.

It hardly needs saying that in summer the composite samples should be kept in as cool a place as possible; ice or cold water would of course be useful.

EXPERIMENT STATION, *Ames, Iowa, Aug. 10, 1891.*

ON A NEW ASTATIC GALVANOMETER WITH A SINGLE SPIRAL NEEDLE.

[ABSTRACT OF PAPER READ DEC. 27, 1887.]

LAUNCELOT W. ANDREWS.

Two types of astatic galvanometer are in common use. In one, two needles with poles reversed are united to form a rigid system, in the other, a single suspended needle is emploped, the directive force of the earth's magnetism being compensated by an inmovable magnet suitably placed north or south of the needle. (Hauy's method.)

In both these forms the sensitiveness is very variable because a slight change in the magnetic movement of either needle of the astatic combination, or of the fixed compensating magnet, exerts a disproportionately great influence upon the sensitiveness of the instrument.

It is, however, possible to construct a galvanometer not subject to this disadvantage, having only one needle and no compensating magnet.

A magnetic needle hung in such a way that a straight line passing through its poles shall be parallel to its axis of suspension will experience no horizontal directive force if placed in a uniform magnetic field. It will be in a word astatic.

The author has utilized this principle in the construction of a galvanometer of constant senstiveness, as follows:

The needle is made in the form of a helix of one turn and is supended by a cocoon fibre in such a way that the axis of the helix nearly coincides with the axis of suspension.

The extremities of this needle play freely within the cores of two coils of insulated wire closely surrounding them. Its oscillations may be very efficiently damped by winding the coils upon solid copper bobbins.

The coils are advantageously so arranged, as in the instrument exhibited before the Association, that they may be connected either in series or in parallel circuit.

WOODY PLANTS OF WESTERN WISCONSIN.

BY L. H. PAMMEL.

This paper simply embodies the results of some observations made about La Crosse, Wisconsin, from twenty to twenty-five miles northeast and south, and the southwestern part of Minnesota in Houston and Fillmore counties. The region is entirely in the driftless area.[1] This part of the State is lower than the area lying to the northeast. Its most marked feature is the absence of drift. This area (driftless) occupies about 12,000 square miles. So far as the soil is concerned, it is not unlike that found in many other parts of the State. Sandy soils abound as elsewhere in the State. In some cases the topography is nearly flat, but generally it is hilly and in some cases slightly rolling. The alluvial bottoms along the streams and creeks abound in as rich a soil as is found anywhere in the State. Prairies are limited and of small size, in some cases sandy with black, sandy depressions of better soil. La Crosse Prairie, on which La Crosse is built, may be given as an illustration. Few trees abound except along its margins near the rivers. This prairie is bounded by La Crosse river on the north, Mississippi river on the west, and Mormon Cooley creek on the south. The region is abundantly supplied with water, there being numerous small streams and springs, which occur in almost every valley, besides there are streams of considerable size like Black, Root, Kickapoo and La Crosse rivers.

The geological formation belongs to the lower Silurian which shows abundant out-crops of potsdam sandstone everywhere. According to Moses Strong,[2] the maximum elevation of the hills at La Crosse is 470 feet above the river. The hills are only 350 feet at Fountain City, 200 feet at Maiden Rock and eighty feet at Bay City. The higher hills facing the Mississippi river are covered with lower magnesium limestone, varying considerable in thickness. The fact that the soils on the ridges, as well as the valleys, were once thickly covered with timber, and is returning to that condition, when allowed to do so, is largely due to the decomposition of the limestone rock and the physical condition of the soil. This soil is not only fertile, but retentive of moisture, which is an important feature in forest growth. The alluvial soils, which are derived from the washing of the hills, have a somewhat different growth than is found on the ridges and valleys, since

[1]Geology of Wisconsin, Vol. I, p. 260-608.

[2]Geology of Wisconsin, Vol. IV, p. 39.

a portion of this land is often covered with water. Peat-bogs and wet swamps also abound. The vegetation here is quite uniform. A marked feature is the absence of trees and woody plants as a rule. *Salix, Nemopanthes fascicularis, Larix, Carex, Cyperus, Scirpus, Eleocharis, Sarracenia*, a few grasses, especially *Spartina cynosuroides* in the drier places, *Habenaria psycodes, Lilium Canadense*, etc., abound.

The woody plants of this region are represented by the following orders: 1. *Menispermaceæ;* 2. *Tiliaceæ;* 3. *Rutaceæ;* 4. *Celastraceæ;* 5. *Rhamnaceæ;* 6. *Vitaceæ;* 7. *Sapindaceæ;* 8. *Anacardiaceæ;* 9. *Leguminosæ;* 10. *Rosaceæ;* 11. *Saxifragaceæ;* 12. *Hamamelideæ;* 13. *Cornaceæ;* 14. *Caprifoliaceæ;* 15. *Rubiaceæ;* 16. *Oleaceæ;* 17. *Urticaceæ;* 18. *Juglandaceæ;* 19. *Cupuliferæ;* 20. *Salicaceæ*; 21. *Coniferæ;* 22. *Liliaceæ.*

In the arrangement of the genera Gray's Manual, 6th edition, has been followed.

MENISPERMACEÆ.

1.	*Menispermum canadense*, L.	Moonseed.

TILIACEÆ.

2.	*Tilia americana*, L.	Basswood.

ILICINEÆ.

3.	*Nemopanthes fascicularis*. Raf.	

CELASTRACEÆ.

4.	*Celastrus scandens*. L.	Climbing Bitter-sweet.
5.	*Euonymus atropurpurens*, Jacq.	Burning-bush, Wahoo.

RHAMNACEÆ.

6.	*Ceanothus americanus*, L.	New Jersey Tea. Red-root.
7.	*C. ovatus*, Desf.	

VITACEÆ.

8.	*Vitis bicolor*. Le Conte	Summer Grape.
9.	*V. riparia*. Michx.	Wild Grape.
10.	*Ampelopsis quinquefolia*. Michx.	Virginia Creeper.

SAPINDACEÆ.

11.	*Acer spicatum*, Lam.	Mountain Maple.
12.	*A. barbatum*. Michx.	Sugar or Hard Maple.
13.	*A. saccharinum*, L.	White or Silver Maple.
14.	*A. rubrum*, L.	Red or Swamp Maple.
15.	*A. negundo*. L.	Box Elder or Ash-leaved Maple.
16.	*Staphylea trifolia*, L.	Bladder Nut.

ANACARDIACEÆ.

17.	*Rhus typhina*, L.	Stag-horn Sumac.
18.	*R. glabra*, L.	Smooth Sumac.
19.	*R. venenata*, D. C.	Dogwood.
20.	*R. radicans*, L.	Poison Ivy.

LEGUMINOSÆ.

21.	*Amorpha canescens*, Nutt.	Lead Plant.
22.	*A. fruticoso*. L.	False Indigo.
23.	*Robinia pseudacacia*, L.	Black Locust or False Acacia. Frequent escape.
24.	*Gymnocladus dioicus*. L., Koch.	Kentucky Coffee-tree.

ROSACEÆ.

25.	*Prunus americana*, Marshall.	Wild Plum.
26.	*P. pumila*, L.	Sand Cherry.
27.	*P. pennsylvanica*, L.	Wild Red Cherry.
28.	*P virginiana*, L.	Choke Cherry.
29.	*P. serotina*. L.	Wild Black Cherry.
30.	*Spiræa salicifolia*, L.	Common Meadow Sweet.
31.	*S. tomentosa*, L.	Hardhack.
32.	*Rubus triflorus*, Richardson.	Dwarf Raspberry.
33.	*R. strigosus*, Michx.	Wild Red Raspberry.
34.	*R. occidentalis*, L.	Black Raspberry.
35.	*R. villosus*, Ait.	High Blackberry.
36.	*R. canadensis*, L.	Dewberry.
37.	*Potentilla fruticosa*, L.	Shrubby Cinque-foil.
38.	*Rosa blanda*, Ait.	Rose.
39.	*R. rubiginosa*, L.	Sweetbrier. In woods naturalized.
40.	*Pyrus coronaria*, L.	Wild Crab. The species as recognized in Gray's Manual.
41.	*Pyrus arbutifolia*, L.	Choke Berry.
42.	*Crataegus coccinea*, L. ?	White Thorn.
43.	*Crataegus sp.*	
44.	*Amelanchier canadensis*, Torr. & Gray.	June-berry.

SAXIFRAGACEÆ.

45.	*Ribes cynosbati*, L.	Gooseberry.
46.	*R. gracile*, Michx.	Missouri Gooseberry.
47.	*R. rubrum*, L. var. *subglandulosum*, Maxim.	Red Currant.
48.	*R. aureum*, Pursh.	Missouri Currant. Frequent escape.

HAMAMELIDÆ.

49.	*Hamamelis virginiana*, L.	Witch Hazel.

CORNACEÆ.

50.	*Cornus canadensis*, L.	Dwarf Cornel.
51.	*C. circinata*, L'Her.	Round-leaved Dogwood.
52.	*C. stolonifera*, Michx.	Red-osier.
53.	*C. paniculata*, L'Her.	Panicled Cornel.
54.	*C. alternifolia*, L.	Alternate-leaved Dogwood.

CAPRIFOLIACEÆ.

55.	*Sambucus canadensis*, L.	Common Elder.
56.	*S. racemosa*, L.	Red-berried Elder.
57.	*Viburnum opulus*, L.	Cranberry-tree.
58.	*V. lentago*, L.	Black Haw.
59.	*Linnæa borealis*, Gronov.	Twin-flower.
60.	*Symphoricarpus occidentalis*, Hook.	Wolfberry.
61.	*Lonicera sullivantii*, Gray.	Sullivant's Honeysuckle.
62.	*L. glauca*, Hill.	Glaucus Honeysuckle.
63.	*Diervilla trifida*, Moench.	Bush Honeysuckle.

RUBIACEÆ.

64.	*Cephalanthus occidentalis*, L.	Button-bush.

ERICACEÆ.

65.	*Vaccinium pennsylvanicum*, Lam.	Dwarf Blueberry.
67.	*V. oxycoccus*, L.	Small Cranberry.
68.	*Arctostaphylos uva-ursi*, Spreng.	Bearberry.
69.	*Epigæa repens*, L.	Trailing Arbutus.
70.	*Gaultheria procumbens*, L.	Creeping Wintergreen.
71.	*Cassandra calyculata*, Don.	Leather Leaf.

OLEACEÆ.

72.	*Fraxinus americana*, L.	White Ash.
73.	*F. viridis*, Michx.	
74.	*F. Sambucifolia*, Lam.?	

URTICACEÆ.

75.	*Ulmus fulva*, Michx.	Slippery or Red Elm.
76.	*U. americana*, L.	American or White Elm.
77.	*U. racemosa*, Thomas.	Cork or Rock Elm.
78.	*Celtis occidentalis*, L.	Hackberry.
79.	*Morus rubra*, L.	Red Mulberry. On authority of Mr. Harris.

JUGLANDACEÆ.

80.	*Juglans cinerea*, L.	Butternut.
81.	*J. nigra*, L.	Black Walnut.
82.	*Hicoria ovata* (Mill.), Britton.	Shell-bark Hickory.
83.	*H. glabra* (Mill.), Britton.	Pignut.

CUPULIFERÆ.

84.	*Betula lenta*, L.	Sweet or Black Birch.
85.	*B. papyrifera*, Marshall.	Canoe or Paper Birch.
86.	*B. nigra*, *L.*	Red or River Birch.
87.	*B. pumila*, *L.*	Low Birch.
88.	*Alnus incana*, Willd.	Speckled Alder.
89.	*A. serrulata*, Willd.	Smooth Alder.
90.	*Corylus americana*, Walt.	Wild Hazel-nut.
91.	*C. rostrata*, Ait.	Beaked Hazel-nut.
92.	*Ostrya virginica*, Willd.	American Hop Hornbeam.
93.	*Carpinus caroliniana*, Walt.	Iron-wood or Water Beech.
94.	*Quercus alba*, L.	White Oak.
95.	*Q. macrocarpa*, Michx.	Bur Oak.
96.	*Q. bicolor*, Michx.	Swamp White Oak.
97.	*Q. rubra*, L.	Red Oak.
98.	*Q. coccinea*, Wang.	Scarlet Oak.
99.	*Q. tinctoria*, Bartram.	Quercitron or Black Oak.

SALICACEÆ.

100.	*Salix nigra*, Marsh.	Black Willow.
101.	*S. humilis*, Marsh.	Prairie Willow.
102.	*S. candida*, Willd.	Hoary Willow.
103.	*Populus alba*, L.	White Poplar. Frequent escape.
104.	*P. tremuloides*, Michx.	Trembling Aspen.
105.	*P. grandidentata*, Michx.	Large-toothed Aspen.
106.	*P. monilifera*, Ait.	Cottonwood.

CONIFERÆ.

107.	*Pinus strobus*, L.	White Pine.
108.	*P. banksiana*, Lambert.	Northern Scrub Pine.
109.	*P. resinosa*, Ait.	Red or Norway Pine.
110.	*Tsuga canadensis*, Carr.	Hemlock.
111.	*Larix laricina*, Koch.	Tamarack or American Larch.
112.	*Juniperus communis*, L.	Common Juniper.
113.	*J. virginiana*, L.	Red Cedar.
114.	*Taxus canadensis*, Willd.	American Yew or Ground Hemlock.
115.	*Smilax rotundifolia*, L.	Common Green Brier.

It may be well to compare the woody flora of Western Wisconsin with that of the prairie region. Since presenting this paper several catalogues have appeared that will give us an accurate idea of the woody flora of prairie regions. Bessey and Webber, "Flora of Nebraska," "Bessey's Preliminary Report on the Native Trees and Shrubs of Nebraska." These two papers cover a large territory, while Hitchcock's Catalogue of the "Anthophyta and Pteridophyta of Ames," is limited in its scope, but includes, perhaps, nearly all of the woody plants within a radius of thirty miles. Bessey's list contains sixty-one trees and sixty-four shrubs, making one hundred and twenty-five woody plants. When Nebraska is more fully explored a few more may be added. Hitchcock's catalogue only gives seventy-five. Within a radius of thirty miles several more species probably occur, but the number will certainly not reach much beyond eighty. In the region about La Crosse, Wisconsin, one hundred and fifteen are enumerated. The genera *Crataegus*, *Salix* and *Fraxinus* carefully worked over will probably bring the number close to one hundred and twenty. Three of the species enumerated above have escaped from cultivation and a fourth has been naturalized. *Comptonia asplenifolia*, *Picea nigra* and *Thuja occidentalis* may still be found within this range. Several species named are scarcely shrubby. On the whole the region is well represented in woody plants. With few exceptions the species are northern, *Juglans nigra*, *Morus rubra*, *Gymnocladus dioicus*, have reached nearly their northern limit.

FOREST VEGETATION OF THE UPPER MISSISSIPPI.

BY L. H. PAMMEL.

The paper before the Academy consisted in a verbal communication of the salient features of the forest vegetation. It was afterward written out in full and sent to Garden and Forest (See Vol. IV. pp. 460, 472 and 531). As the paper may be of general interest to Iowa readers I give it essentially as it appeared in Garden and Forest. A few notes have been added.

The Mississippi river and its tributaries, from Trempleau, Wisconsin, to Dubuque, Iowa, are enclosed by bluffs, varying from two hundred to six hundred feet high. At Dubuque they are much lower than at La Crosse; in the latter place they are something more than five hundred feet above the level of Lake Michigan; sometimes they present steep, sandy rocks, in other places they are covered with a dense growth of trees. The region is well watered by numerous small streams emptying into the Mississippi, while it contains a number of streams of good size, as the Wisconsin, Black, La Crosse, Root and Turkey rivers. The smaller as well as the larger streams are well timbered with Oaks, Poplars, Birches, Maples, Hickories, Butternut, Walnut, Plums, Cherries, a few Conifers and southward, the Coffee-tree and Honey-Locust.

Much has been written concerning soils and the character of the vegetation. It is indeed a puzzling question, and I doubt whether it can truly be said that certain species, strictly confine themselves to certain definite soils, yet certain trees, as well as herbaceous plants, may preponderate in certain soils. Perhaps this may be due to the physical condition of the soil, rather than its chemical constitution.

The Soft Maple (*Acer saccharinum*, L.), Red Birch (*Betula nigra*, L.), are the predominating trees in the Mississippi, Wisconsin and Black river bottoms. They also follow up the smaller streams which flow into these rivers, but as soon as these streams are left these trees become rare. The Soft Maple and Black Birch occur most numerously where the lands are subject to overflows every year. Most of the Oaks never occur in such situations, yet the Swamp White Oak (*Quercus bicolor*, Willd.) is an exception.

The only place where this species occurs is in the low, sandy and black bottom lands of the Mississippi and Black rivers. The White Pine only occurs in the sandy rocks or sandy loam soil of the region, always near streams, but in the northern part of La Crosse county it is encroaching on the loamy soil. The Tamarack (*Larix larcina*) only occurs in cold, wet swamps

The soils of the region may be classed under sandy, loamy, calcareous, alluvial and peaty. The greatest areas of sandy soil occur near the mouths of the rivers. (This is not true for the interior of the State.) These sand prairies are not, however numerous on the west side of the river. As an illustration, at La Crosse, Wisconsin, there is a sand prairie some eight miles long and from one-half to three miles wide. The only arboreal vegetation growing on these soils are two species of Oak, Burr Oak (*Quercus macrocarpa*, Michx.), Black Oak (*Q. tinctoria*, Bartram), and occasionally the Green Ash (*Fraxinus viridis*, Michx.) and Black Birch (*Betula lenta*).

These trees, however, only occur in close proximity to the Mississippi bottoms. Other sand prairies similar to this one occur at Trempleau and Prairie du Chien, Wisconsin.

As regards the herbaceous vegetation on these prairies it might be said that it is a typical prairie flora. *Liatris cylindrica*, *Verbena stricta*, *Baptisia leucantha*, *Petalostemon violaceus*, *P. candidus*, *Oenothera rhombipetala*, *Bouteloua hirsuta*, *B. racemosa*, etc., occur very frequently, though the Sand Bur (*Cenchrus tribuloides*) is the most characteristic plant where the soil has been plowed or loosened by the winds.

The calcareous soils occupy the tops of the hills and are of smaller extent near La Crosse, Wisconsin, than Dubuque, Iowa. Birches, especially the Canoe Birch (*Betula papyrifera*, Marshall), are a most marked feature of it, but this species is by no means confined to soils of this character. Two other plants only occur, so far as I have observed, in this region on the calcareous soils; they are *Zygadenus elegans* and *Camptosorus rhizophyllus*. Loamy soils are by far the most abundant; they occur on the slightly rolling ridges and in the valleys. The White Oak (*Quercus alba*, L.) grows excellently in such soil. Alluvial soil does not occupy great areas, except at the mouths of some rivers. The great bottoms of the Mississippi consist mostly of a sandy soil, covered over in some places with a black, rich soil. The White Elm, Box Elder, and Soft Maple are common.

The peaty soils are impassable during early spring and summer. Few trees are able to grow—only an occasional Willow or Tamarack. The bulk of the vegetation consists of species of *Carex* and *Scirpus*. Now and then *Lilium canadense Cypripedium spectabile*, or, here and there patches of *Drosera ratundifolia* and *Pogonia ophioglossoides*, where the soil is very peaty and wet, appear.

During the past thirty years some important changes have taken place in the growth of timber along the river. The pioneer settler found little timber on the hills, except those with a northern slope. The timber standing on the sunny side was usually of poor quality, owing to numerous fires. Now, these lands are mostly fenced and fires are kept out, at least by the more enterprising farmers. The bleak hills are being rapidly covered with a forest growth.

It is not an uncommon thing to observe patches of Hazel (*Corylus americana*, Walt.) beyond the outskirts of the timber; here, in the course of a few years, will be found Oaks, Birches, Hickories and Poplars. The humus formed where Hazel grows is extremely rich and fertile, and I doubt whether trees could cover our treeless hills very fast without its help.

The best Oak growing along the Upper Mississippi is the White Oak (*Quercus alba*, L.). It is not uncommon to find trees with trunks eight to twelve feet in circumference. This species once covered a considerable portion of the ridges, especially on clay soil. The shaded slope on which the snow long remains in the spring is also a favorable situation for it. Young growth of White Oak is rapidly covering situations of this character, which formerly contained no timber. Flattened expansions of the stem are found just underneath the surface of the ground. From these arise a number of trunks. It is not improbable that, before the country was settled, late fires in spring kept the forest growth down, but after the cessation of fires a vigorous growth started. The timber of the White Oak is uniformly straighter and easier to cut than the Scarlet Oak (*Q. Coccinea*, Wang) or Black Oak (*Q. tinctoria*, Bartram). These Oaks grow in more exposed localities where the soil is drier and vegetation starts earlier in the spring, and for this reason fires usually damaged them more than any of the others. The old timber is usually gnarled and hard to split. The young growth is, however, straight and easy to work where fires are kept out. The soils on which they occur vary considerably. They do well on sandy, gravelly soil, as well as on clay and black soil, and even make considerable growth on poor, sandy soil.

Q. coccinea, Wang, is the more common species, although the forms are puzzling. The Red Oak (*Q. rubra*, L.) is the finest of the Oaks in this region so far as beauty is concerned. The trees are tall and straight, and sometimes yield five cords of wood. It is not an uncommon thing for them to yield three cords. The wood is easily worked, and this is owing largely to the locality and soil where the species usually grows. The large trees were less effected by the early forest fires than were the Black Oaks. The Red Oak occurs principally on shaded hill-slopes, where the snow long remains on the ground, also on clay ridges and black bottom lands. Young trees of *Q. rubra*, are the most easily recognizable of the Black Oaks when growing in such localities. Smooth bark and straight trunk, with few lateral branches distinguish them at once from specimens of *Q. tinctoria* and *Q. coccinea*.

One of the most variable Oaks, at least so far as general appearances go, is the Bur Oak (*Q. macrocarpa*, Michx.). On the sandy soil it is diminutive in size, producing numerous lateral branches. Here it is a spreading tree.

On the poor sandy soil between the Black and La Crosse rivers it is the most common Oak. On clay and rocky soil it occurs mainly in small groups. Some thirty miles east of La Crosse, in the Kickapoo Valley, Bur Oak is a most valuable forest tree. The trunk is straight with but few large lateral branches. In its habit it is wholly unlike the form growing on sandy, rocky soil. Many trees are ten feet in circumference. It does not grow in isolated groups, but acres are covered almost entirely with this species. It also occurs in the rich alluvial bottoms of various streams. The Swamp White Oak (*Q. bicolor*, Willd.) occurs only in the bottoms of the Black and Mississippi rivers. A large number of small trees occur near North Bend, Wisconsin. I have observed a few more just below La Crosse. It becomes more common southward; and a considerable number were observed near Turkey River Junction, Iowa. No large trees have been seen, though Mr. J. S. Harris informs me that he noticed some near La Crescent, Minnesota, many years ago. The only other Oak I have seen is *Q. Muhlenbergii*, Engelm. It occurred in considerable numbers on the south slope of a limestone bluff just west of North McGregor, Iowa.

The most conspicuous Maple is the Soft Maple (*Acer saccharinum*, L.) It occurs everywhere along the Mississippi, Black and Wisconsin rivers and their tributaries. It forms more than one-half of the forest vegetation of the Mississippi river, but becomes less common as the sources of the smaller streams are reached. It grows where the lands are usually subject to overflow, and the soil is sandy or alluvial. The Red Maple (*Acer rubrum*, L.) is not a common species. It occurs in the interior of the country, away from the Mississippi, on the black, sandy loam. Although the Sugar Maple (*Acer barbatum*, Michx.) occurs in the rich, rocky soil along the Mississippi river, it is most common in the interior of Wisconsin, away from the river. On low ridges drained by the Kickapoo river it is one of the most common of forest trees.

Acer spicatum Lam., although not a forest tree, deserves mention. It grows in sheltered situations, frequently overhanging sandy rocks, about La Crosse and Galesville. Between Dubuque and McGregor, Iowa, it grows in shaded, moist situations, in calcareous soils, commonly with *Sambucus racemosa*, L.

The Ash-leaved Maple (*Acer negundo*, L.) occurs in groups in the richer soils of ravines and bottom lands; it is seldom found in the bottom proper of the Mississippi river.

Two species of Hickory have been observed. Shell Bark (*Hicoria ovata*) and the Pignut Hickory (*H. glabra*, Mill., Britton). Both species attain considerable size. The habits of the trees are quite different. *H. ovata* grows on clay soil, usually in groups. *H. glabra* grows on various soils, such as rocky, sandy, and along creek-bottoms. Shaded and moist localities are favorable to its growth, which is much more rapid than that of *H. ovata*. The Butternut (*Juglans cinerea* L.) is much more common than the Black Walnut (*J. nigra*, L.), although both are found on the rocky banks of the Mississippi, and the Butternut is abundant in sandy and gravelly soil along the Kickapoo river, while Black Walnut was not observed in this region. The latter tree is confined quite closely to the immediate tributaries of the Mississippi. Along the Badaxe river and smaller streams about La Crosse it is quite common, but as the sources of the stream are reached it gradually diminishes in numbers. It needs a much richer soil than the Butternut.

The Cottonwood (*Populus monilifera,* Ait.) grows abundantly along the Mississippi river in bottoms, where both sandy and rich soil seem favorable for its development, and the trees are often of very large size. They are seldom found, however, on the uplands away from the streams except as recent introductions. The species is now sometimes found in the neighborhood of stone quarries in the loose clay soil. Trembling Aspen (*Populus tremuloides,* Michx.) is common in the rich, black soils of second bottoms, or the humus soil on the ridges. Near Dubuque it occurs around rocky ledges. The species grows in groups, sometimes several acres in extent. It is a short-lived tree, and is followed by more useful trees, like the Oak. The Large Poplar (*P. grandidentata,* Michx.) is less common than the last. It is found in more or less isolated groups in sandy and clay soils, and its growth is more rapid than that of the Trembling Aspen.

A few trees of the Sycamore (*Platanus occidentalis* L.) were observed at Turkey River Junction, Iowa. From this point southward it is more frequent in the Mississippi river bottoms.

The Hackberry (*Celtis occidentalis,* L.) occurs in rich soil of the bottoms of Root river and other streams; and not infrequently it is found on the rocky limestone cliffs, as at North McGregor, Iowa. It is a tree which can adapt itself to a variety of soils, and when cultivated does admirably on poor, sandy soil.

The Birches are fairly well represented, the most common species being the River Birch (*Betula ingra,* L.) It, with the Soft Maple, more typifies the timbered region of the Mississippi bottoms than any other tree. The Red, or River Birch, diminishes in numbers southward. The Canoe Birch (*Betula papyrifera,* Michx.) is common about La Crosse and Trempleau, Wisconsin, where it is usually found on the tops of the limestone bluffs, though also occurring in ravines and ridges as well as in sandy soil. On some of the rocky hills it is almost the only tree. It rarely attains great dimensions, except when growing in rich clay soil. Near Dubuque it is scarce. Mr. Reppert reports it from Muscatine; how much farther south it occurs in Iowa, I have not learned.

Yellow or Gray Birch (*B. lutea,* Michx.) is found more abundantly along the sandy, rocky cliffs of the Kickapoo. It also occurs near a Tamarack-swamp not far from La Crosse. It is not a common tree.

Quite a grove of small Kentucky Coffee-trees (*Gymnocladus dioicus,* L., Koch.) occurs south of La Crescent, in the Root river bottoms, and on the Wisconsin side there are two or three trees about seven miles below La Crosse. They are from twelve to fifteen feet high. The species is much more numerous on steep hillsides near North McGregor, but none of the specimens are large. From this point southward it is more numerous. I noted it at Clayton, Turkey River Junction and Dubuque. It does not occur in the interior of the country east of La Crosse, although I have seen it cultivated in Madison, Wisconsin.

The Honey-Locust (*Gleditschia triacanthos*) was observed near Turkey River Junction, Iowa, though it occurs as far north as McGregor and perhaps further. It is occasionally cultivated in La Crosse. A fine tree occurs on Mississippi street, near Western avenue.

Pyrus coronaria, L. Since this paper has been written Prof. L. H. Bailey* has worked out our Wild Crab and established several species. I have not had an opportunity to study carefully the character of the Wild Crabs found about La Crosse. The *Pyrus coronaria* as described in older systematic works is very common in thickets, sometimes forming large groves. Beautiful large trees occur in isolated places.

Plum (*Prunus americana*, Marshall) is widely distributed. It comes up spontaneously everywhere. In rich bottom lands, clay soil, black sandy loam and rocky soils. Cheney Plum, now well known in cultivation, occurs wild near Chaseburgh and elsewhere on the ridges. The species, if it be one, and there is certainly much doubt, is a very variable one. Prof. Bailey informs me that there are several good species in *Prunus americana*. Near La Crosse occur several distinct forms. I remember a case where one form occurring on a sunny hillside and ripens in August; the fruit is yellowish red. On the same sunny side of the hill, but some three quarters of a mile farther north, is another group. The plums are several weeks later, are longer and red.

Choke Cherry (*Prunus virginiana*, L.) is a very commons pecies, forming small groves in clay and black soil. It frequently occurs at the bases of gullies or ravines. The Wild Red Cherry (*Prunus pennsylvanica*, L.) occurs in State Road Cooley near La Crosse on rocky hills in woods.

Wild Black Cherry (*Prunus serotina*, Ehr.) is widely distributed, though somewhat local. In Coon Valley it is abundant, forming quite an extensive grove. Trees from six to eight inches in diameter occur, though the tree never attains the size it does in Missouri and Illinois. Several species of *Crataegus* are common, but as I have not worked over my material carefully they are omitted.

Basswood (*Tilia americana*) is largely influenced by moisture. Rich, damp, grounds, sloping to the north, are favorable situations for it, and it is commonly found along the rich bottoms of the smaller streams and creeks. On the low bluffs and rivers of the Kickapoo river it is abundant.

The American Elm, or White Elm (*Ulmus americana*, L.), is a common tree everywhere along the creeks and streams near springs; occasionally, also, in upland woods in dry soil. The Red Elm (*Ulmus fulva*, Michx.) is not uncommon on the rocky slopes of hills along the Mississippi. It is absent or rare in the interior of the country. The Cork Elm (*Ulmus racemosa*, Thomas) is far less common than *U. Americana*. It occurs near La Crosse, especially in the Kickapoo valley near Bloomingdale, and I observed it also near Turkey River Junction, Iowa.

According to Mr. J. S. Harris, the Red Mulberry formerly grew in the Root river bottoms. I have not, however, seen it growing wild, though specimens said to have been brought from there are growing in Hon. J. W. Losey's old lot on Fifth street. Scattered specimens were found at North McGregor, Iowa. Since writing the above I have learned of its occurrence at McGregor also, though evidently it only grows in sheltered situations as Mr. Kennyon writes. It is more numerous near Dubuque.

Two other conspicuous deciduous trees occur in rocky woods and shaded north slopes, Hop-Hornbeam (*Ostrya virginica*, Willd.) and Hornbeam (*Carpinus caroliniana*, Walter).

*American Garden, Vol. XII, No. 8, 1891, p. 469.

The White Pine (*Pinus strobus*, L.) is the most common conifer along the Black River. In the northern part of La Crosse and in the eastern part of Vernon county it is common on the sandy, loamy soil; near the Mississippi river it only occurs on the sandstone ledges. Small groups occur on stiff sandstone ledge near Oehler's Mills, Morman Cooley and the sandstone ledge about seven miles from La Crosse near the Tamarack Swamp. Small groups also occur at Bangor. One small tree grew spontaneously in State Road Cooley on my father's farm. The nearest tree growing wild from this point is four miles. Large trees were once found at La Crescent, Minnesota, and quite a group of these Pines occurs near Clayton, Iowa. Northern Scrub Pine (*Pinus banksiana*, Lambert) occurs on the sandy prarie soil along the La Crosse and Black rivers, where little else grows besides *Bouteloua hirsuta*, *Panicum virgatum*, *Aristida*, *Petalostemon violaceus*, *Pentsteman pubescens*, *Lupinus perennis*, *Viola delphinifolia*, *Anemone patens var.*, *nuttalliana*, *Potentilla argentea*, *Baptisia leucophæa*. Norway or Red Pine (*P. resinosa*, Ait.) occurs in solated places in sand bottoms of the Black River, and much more commonly on the sandy, rocky ledges of the Kickapoo River near Rockton.

Hemlock (*Tsuga canadensis*, Carr) I have not seen along the Mississippi River, nor does it occur near the mouths of the Black, La Crosse and Wisconsin Rivers, but near Rockton on the Kickapoo River, which is tributary of the Wisconsin, numerous groups occur. Dwarf Cornel (*Cornus canadensis*), Trailing Arbutus or May Flower (*Epigæa repens*) and *Clintonia borealis* as well as ferns like *Aspleniun thelyteroides*, *Aspidium spinulosum var. intermedium*, *Onoclea struthiopteris*, flourish under its shade among decaying logs and leaves.

Tamarack (*Larix laricinva*) grows in the peaty swamps of La Crosse and Trempleau rivers. During dry portions of the year tamarack swamps are passable, but during wet years they are for the most part impassable. Owing to frequent overflows, which carry with them much soil from tilled land, these swamps are gradually filling up, and as a consequence, the Tamarack in these localities is losing ground. I found a small swamp near La Crescent, Minnesota, but in a few years this swamp will be a thing of the past.

Red Cedar (*Juniperus virginiana*, L.) grows along the Mississippi River in the sandy out-crops and limestone rocks, and most abundantly in the sandy bottoms of the Black River.

I have indicated, in a measure, the principal forest trees between Trempleau, Wisconsin, and Dubuque, Iowa. In the northern portion *Betula papyrifera*, *B. nigra*, *Juglans cinerea*, *Larix*, *Pinus strobus* are much more numerous than farther southward. *Platanus occidentalis*, *Gleditschia triacanthos*, *Gymnocladus dioicus*, *Juglans nigra*, *Quercus muhlenbergii*, and *Morus rubra* are southern trees which have moved northward along the Mississippi, and, therefore, are found close to its shores and the smaller streams tributary thereto.

PHÆNOLOGICAL NOTES.

ABSTRACT, BY L. H. PAMMEL.

Among the many interesting observations in connection with our flora is the relation that plants have to climatology. It is true the question is an agricultural and horticultural one only so far as it bears on questions of our cultivated plants. But with the addition of new plants every year to our list of those cultivated for utilitarian or ornamental purposes, it is important to record exact data in regard to their behavior under cultivation. But in plant climatology all plants should be studied with reference to various climatic conditions.

These studies should be made not only in other countries, but every State in the Union. If this is done it will be possible to say, with some certainty, whether given plants are adapted to certain climates. It will be possible for us to determine positively the variability of some plants and their behavior under different conditions. This subject has not received the attention it deserves in this country. Investigations of this kind have been made by Trelease, Halsted, Britton, Henry, etc.[1] Valuable observations have been made in Europe by Fritsch[2] and others. Observations like Reissenberger's, on the time of flowering and maturing of seed of cultivated plants like oats, wheat, corn[3] and grape over long periods of years, are of great importance. The paper will be published in full in Bulletin Torrey Bot. Club.

The paper was divided up into the following heads:

I. A comparison of the appearance of flowers and leaves, etc., for the years 1886 and 1891.

II. Notes on the effects of frost on the falling of leaves, as well as the frost limit of certain plants.

III. A succession of flowers for the years 1886 and 1891.

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[1]First and Second Annual Report Wisconsin Agricultural Experiment Station, 1883, p. 56; 1884, p. 59.

Bulletin of the Iowa Agricultural College Department of Botany, 1886, p. 44.

Bulletin Torrey Bot. Club, Vol. VI, No. 42, p. 235.

Report of Board of Regents University of Wisconsin, 1881.

[2]Thermische constanten fur die Bluthe und Fruchtreife von 889 Pflanzenarten K. K. A Kad. d. Wissenschaften, Vienna, 1861. Sitzung.28, Nov., pp. 120, 1 plate Vienna, 1863.

[3]Ueber die zeit der Bluthe und Fruchtreife des Roggens der Weinrebe und des Maises nach vieljahrigen Beobachtungen in der Umgebung von Hermannstadt. Verh. und Mitth. d. siebenburg Ver. f. Naturw. in Hermannstadt XXXVIII. 1888. p. 121-152. Just. Johresb, 1888, Vol II, p. 51.

The observations for 1886 are based on those reported by Dr. Halsted. Those for 1891 were partly made by Mr. Eugene Browr, a special student in botany, Prof. Rolfs and myself.

In 1886, the Soft Maple (*Acer saccharinum*) was in flower on March 22; in 1891, April 11. *Ulmus americana*, in 1886, in flower, April 12; in 1891, April 18. The succession of flowers in herbaceous plants in 1886 and 1891 was: *Hepatica acutiloba*, April 9 (1886), April 12 (1891); *Capsella bursa-pastoris*, April 15 (1886), April 24 (1891); *Mertensia virginica*, April 20 (1886), April 28 (1891). Frost and its effects on some plants were noted: *Portulaca oleracea*, early in September, tips frost-bitten; October 7, more or less destroyed; October 9, plants black in an open field; *Panicum sanguinale*, injured seriously on October 8; *Borrago officinalis*, October 22, a few leaves affected; October 23, many leaves killed; *Scabiosa atropurpurea*, October 7, no injury; October 23, no injury; Nov, 11, no injury; November 21, some injury to leaves.

REPORT OF THE COMMITTEE ON STATE FLORA.

BY THE CHAIRMAN, L. H. PAMMEL.

The several catalogues of the flora of Iowa (Arthur, Bessey), as well as the early contributions by the late Dr. Parry and briefer articles and notices in journals and Gray's Manual give us a pretty accurate knowledge of the the phænogams and vascular cryptogams found in Iowa. In most cases, however, the range of species is not given. With a number of excellent local collectors in the field a lively interest has been awakened in collecting and bringing together information. Since the appointment of this committee one important contribution to the State Flora has been published. I refer to Prof. Hitchcock's Catalogue of the Anthophyta and Pteridophyta of Ames[1]. It is indeed a model catalogue in every respect. A short notice of trees found north of Dubuque has also appeared in Garden and Forest.[2]

In the preparation of this report I am indebted to Mr. F. W. Reppert, of Muscatine, who is a most excellent collector. Some specimens have also been contributed by Messrs. Stewart (Greenfield), Holway (Decorah), and Prof. Rolfs (Le Claire ank Keokuk).

I have arranged the matter as follows: I. Plants new to the State; II. New localities for rare plants; III. Local distribution of some Iowa trees; IV. Changes in our flora, especially in the introduction of weeds and their distribution.

1. Contributions from the Shaw School of Botany, No. 7. From St. Louis Academy of Science, Vol. V, No. 3.

2. L. H. Pammel: Forest Vegetation Along the Upper Mississippi, Garden and Forest, Vol. IV., p. 460, 472 and 531.

I. PLANTS NEW TO THE STATE.

Arabis perfoliata, Lam, Iowa City (Hitchcock).

Dicentra canadensis, D. C., Decorah. Mr. Witter informs me it is not uncommon on the Illinois side of the rive opposite Muscatine.

Chrysosplenium alternifolium, L Decorah; "In a deep ravine, northside of hill, in damp moss and probably the only locality within hundreds of miles." (Holway.)

Hypericum nudicaule, Walt. Muscatine; poor sandy soil.

Amphicarpæa pitcheri, Torr. and Gray. Muscatine; common.

Lespedeza violacea, Pers. Muscatine; in dry sandy soil, border of wooded hills.

Rhexia virginica, L. Muscatine; in wet, swampy depressions on sandy hills along Cedar river bottom. Not common.

Aster macrophyllus, L. Muscatine; rich, hilly woodlands. Two localities—Pine Mills, Montpelier Township.

Aster drumondii, Lindl. Muscatine, Iowa City. (Hitchcock.)

Gaylussacia, resinosa, Torr. and Gray. Muscatine; "The plant is quite abundant within a limited area, one-fourth to one-half mile." (Reppert.)

Ipomœa lacunosa, L. Muscatine; "Along the Mississippi river just above the city." (Reppert.) In sandy as well as rich soil.

Breweria pickeringii, Gray. Muscatine; "Sandy soil along railroad; Fruitland Station six miles below Muscatine." (Reppert.)

Tecoma radicans, Juss. Muscatine; Wyoming Hills, seven miles above Muscatine. "It occurs near habitations, but evidently spontaneous." (Reppert.)

Cycloloma platyphyllum, Moq. Muscatine; "Along B. C. R. & N. R. R. near the city; of recent introduction." (Reppert.) Perhaps brought with sand used for road ballast, 1891.

Bœhmeria cylindrica, Willd. Muscatine.

II. NEW LOCALITIES FOR SOME PLANTS.

Ranunculus flammula var. *reptans*, E. Meyer. Webster City; in moist, sandy soil near artesian wells close to the Des Moines river.

Polanisia graveolens, Raf. Muscatine; a form with narrow leaves and pods.

Astragalus distortus, Torr. and Gray. Muscatine; sandy soil, Muscatine Island.

Desmodium illinoiense, Gray. Muscatine; sandy soil. Ames. (Hitchcock). It is rather common in clay soil at La Crosse, Wisconsin, along the Mississippi river.

Parnassia caroliniana. Muscatine; banks of streams. (Lawler.)

Oenothera fruticosa. Muscatine, (Witter); not common. Greenfield; low grounds with *Spartina cynosuroides*; perhaps introduced.

Opuntia rafnesquii, Engelm. Breckenridge Ferry, Cedar River, Muscatine.

Eupatorium altissimum, L. Muscatine; Ames (Hitchcock, Halsted); Vinton.

E. serotinum, Michx. Muscatine; "Low grounds, common." Davenport. (Hitchcock.)

Prenanthes asper, Michx. Muscatine; frequent.

Monotropa uniflora, L. Floyd county. (Trigg.)

Androsace occidentalis, Pursh. Iowa City. (Hitchcock.)

Phlox bifida, Beck. Dr. E H. King, Muscatine, along Cedar River.

The species has also been reported from Vinton. See Bulletin Torrey Bot. Club.

Pentstemon grandiflorus, Nutt. Muscatine; "Sandy soil, sand mound, Muscatine Island. Cedar River". (Reppert.) Although the species occurs in different parts of the State it is not common.

Verbena angustifolia, Michx. Muscatine; dry soil along Mississippi and Cedar rivers. "Does not occur on ground elevated much above low water mark". (Reppert.)

Lippia lanceolata, Michx. Story City; sandy soil in bed of Skunk river. The species was also found on the banks of the Mississippi River at Prairie Du Chien, Wisconsin.

Pycnanthemum muticum, Pers., var. *pilosum*, Gray. Muscatine, Keokuk, Cedar Rapids, dry, sandy woods.

Salvia lanceolata, Willd. Ames (Sexton), 1890.

Froelichia floridana, Moquin. Muscatine; dry, sandy soil. Banks of Mississippi and Cedar rivers. Quite common along the Mississippi river north of Muscatine, especially at La Crosse, Wisconsin.

Polygonum tenue, Michx. Cedar Rapids; dry, sandy banks. Muscatine.

Euphorbia geyeri, Engelm. Muscatine.

E. serpens, H. B. K. Page county (Hitchcock); Harrison county (Burgess).

E. hexagona, Nutt. Muscatine; dry soils; infrequent.

E. dictyosperma, Fischer and Meyer. Iowa City (Hitchcock).

Croton glandulosus, L. Muscatine; common in dry, sandy soil. Occurring with it is a form almost destitute of saucer shaped glands.

C. capitatus, Michx. Muscatine. Davenport (Hitchcock).

Camassia fraseri, Torr. Le Claire.

Yucca angustifolia, Pursh. Council Bluffs, Sioux City (Hitchcock).

Maianthemum canadense, Desf. Muscatine. Sandstone ledges; rare. Ames (Sexton.)

Paspalum fluitans, Kunth. Muscatine.

Elusine indica, Gaert. Keokuk.

Festuca elatior, L., var. *pratensis*, Gray. Keokuk, Ames.

Phegopteris calcarea, Feé. Decorah (Holway).

Cheilanthes lanuginosa, Nutt. North McGregor. Limestone rock; not common.

Aspidium acrostichoides, Swartz. Muscatine.

A goldianum, Hook. Muscatine.

Lycopodium lucidulum, Michx. Muscatine; rare.

III. Disrribution of Some Iowa Trees and Shrubs.

Asimina triloba, Dunal. Specth's Ferry, McGregor (Kennyon), Dubuque (Guilford), Tabor.

Mr. Kennyon reports only a few trees and these do not appear to thrive. It has probably reached its most northern distribution along the Mississippi. It is not mentioned by Upham in the Flora of Minnesota.

Ptlea trifoliata, L. Muscatine; borders of woods in dry soil; frequent.

Vitis cinerea, Engelmann. Muscatine; "On an island in Mississippi river, opposite Fairport, Iowa." (Reppert.)

Æsculus glabra, Willd. Des Moines (Call); Keokuk; Boone (Budd); south of Des Moines.

Acer spicatum, Lam. Specht's Ferry and elsewhere along the Mississippi River, north.

Rhus canadensis, Marsh. Cedar Rapids; dry, sandy embankments.

Cercis canadensis. Muscatine; in rich forest soils most frequent at the base of the hills along the Mississippi river, in more or less protected localities; not common; Keokuk; Hamburg (Hitchcock). Prof. Call informs me that a very few trees also occur near Des Moines.

Gymnocladus dioicus (L.), Koch. McGregor and North McGregor, Iowa. I have reported it from La Crosse, Wisconsin. A few isolated groups and specimens occur farther north and in the interior of Minnesota, according to Upham.

Gleditschia triacanthos, L. Muscatine; the form without spines, infrequent; the form with spines, frequent in rich, alluvial soil. Largest trees from ten to sixteen inches in diameter, fifty to seventy-five feet high; Turkey River Junction, Ames and elsewhere in the interior of the State, along streams.

Morus rubra, L. McGregor; North McGregor; Ames.

Hicoria tomentosa. Davenport; Iowa City (Hitchcock); Muscatine.

H. pecan. Woodbury county (Hitchcock); Muscatine; Davenport (Fluke).

Hicoria sulcata (Willd.), Britt. Muscatine; Reppert says: "Frequent on the bottom lands and islands of the Mississippi river, from Fairport, Iowa (nine miles above), to a point twelve miles below Muscatine. This tree is probably not found excepting in the islands in the river on the Iowa side. Between these points it is confined mostly to the Illinois side of the river. On the Iowa side we have it mostly in the 'big timber' (twelve miles below Muscatine), which is a track of well timbered bottom land extending down the river about twenty miles. Individuals with leaflets 7–9 are not frequent, the prevailing number being seven. *H. pecan* (not frequent) and *H. minima* are the only hickories I have found associated with this species. I have not found mature nuts of *H. sulcata* which show the four-ribbed characters. It may be that this is shown in the immature form only as indicated in the specimens collected in August. The character of the 'odd leaf sessile or subsessile' as given in Wood's Class Book does not seem to agree with our specimen. Large trees of this as also of the other species are becoming rare owing to the merciless woodman's ax."

Quercus palustris, Du Rois. Muscatine; common in bottoms along Mississippi and Cedar rivers.

Q. bicolor, Willd. Muscatine, Turkey River Junction, Keokuk.

Q. Muhlenbergii, Engelm. Boone, North McGregor, Fremont county (Hitchcock), Keokuk (Rolfs).

Q. imbricaria, Michx. Decatur county, Van Wert (Hitchcock).

Betula papyrifera, Marshall. Muscatine, Dubuque.

B. nigra, L. Cedar Rapids; common in bottoms. North McGregor, Muscatine, Streams; common.

Pinus strobus, L. Clayton, Mitchell county (Zmunt); Davenport (Parry).

IV. Distribution of Some Weeds.

This short list is only intended to call out information and should not be considered as giving a complete distribution of the weeds mentioned.

Cleome integrifolia, Torr. and Gray. Muscatine; spontaneous, infrequent. Council Bluffs; in streets. (L. A. Williams.)

Hibiscus trionum, L. Muscatine, Le Claire; a common weed. Ames.

Grindelia squarrosa, Dunal. Keokuk, Boone.

Iva xanthifolia, Nutt. Boone, Keokuk; I have also seen this weed in considerable numbers near La Crosse, Wisconsin, and La Crescent, Minnesota.

Dysodia papposa (Vent.), Hitchcock. Ames, Boone.

Eclipta alba, Harsk. Keokuk.

Cnicus altissimus, Willd. Muscatine; in open woods, not occurring in open grounds. Ames.

C. altissimus, Willd. var. *discolor*, Gray. Cedar Rapids, Muscatine, Ames, in fields very common.

C. arvensis, Hoff. (Canada Thistle.) Taylor and Chickasaw counties, Muscatine, Lawler.

C. lanceolatus, Hoffm. (Bull Thistle.) Ames, Cedar Rapids, Muscatine, Keokuk. Wayne Co. (Lewis), Bonaparte (B. R. Vale); common in the northwest part of the State.

Lactuca scariola, L. Ames; streets (Hitchcock; Halstead); Muscatine; Marshalltown, Cedar Rapids, Des Moines, common in streets. Keokuk. This weed is common in all the places mentioned.

Verbascum blattaria, L. Muscatine; open grounds; infrequent. Ames (Hitchcock), College Farm (F. A. Sirrine).

Solanum carolinense, L. Ames; the weed has been established for three years, on Station grounds. Taylor and Greene counties; Adair county (H. C. Wallace); Keokuk, Muscatine, Lewis Co. (Hitchcock).

S. rostratum, Dunal. Polk City, Taylor county, Chariton (Brown), 1891. Ames, 1891. (Normany), 1881. Carroll county, 1890. Hamburg (Hitchcock). Agency (Mrs. Richman).

Plantago lanceolata, L. Ames; clover fields.

P. patagonica, var. *aristata*, Gray. Ames, Keokuk (Rolfs), Van Wert (Hitchcock); var. *gnaphalioides*, Gray. Humboldt (Harvey). Hamburg (Hitchcock). Sioux Falls (Crozier).

Chenopodium urbicum, L. Muscatine, Keokuk.

C. glaucum, L. Muscatine.

C. ambsosiodies, L. Muscatine; waste ground.

Atriplex patulum L. var. *hastatum*, Gray. Keokuk.

Salsola Kali, L. (Russian Thistle, Common Saltwort.) Lion City, Woodbury Co. (Hitchcock). It has been reported to me from Blyville, Nebraska (Armstrong) and Ellsworth, Minnesota (Miller).

Phytolacca decandra, L. (Common Foke, Scoke or Garget.) Muscatine; sparingly in fence rows; September, 1890.

Polygonum orientale, L. Muscatine; waste ground, not infrequent.

SOME FUNGUS DISEASES OF IOWA FORAGE PLANTS.*

BY L. H. PAMMEL.

The subject was treated under the following heads: Rust, smut, mildews, spot diseases and bacterial diseases. The synonomy is that given by Saccardo, "Sylioge Fungorum." The locality is Ames, and species were mostly observed by myself.

SCHIZOMYCETACEÆ. Bacteria Bacillus Sorghi, W. A. Kellerman. S. vulgare.

PERONOSPORACEÆ. Downy Mildews. *Peronospora trifoliorum* on Astragalus canadensis. (Halsted.) Vicia Americana.

P. graminicola on Setaria viridis, S. italica. It often produces distortions of parts of the flower and is especially destructive to young Fox-tail.

ERYSIPHEÆ. Powdery Mildews. *Erysiphe graminis* on Poa pratensis, P. arachnifera, P. serotina, Eatonia obtusata, Agrostis alba var. vulgaris, Triticum vulgare.

HYPOCREACEÆ. Ergot or *Calaviceps purpurea*, Tul., on Secale cereale, Elymus virginicus, E. striatus, (Halsted), Asprella hystrix, Agropyrum glaucum, A. repens, Calamagrostis canadensis, Glyceria fluitans (Halsted), Spartina cynosuroides (Halsted).

DOTHIDECEÆ. *Phyllachora graminis*, (Pers.) Fuckel on Agropyrum repens, Elymus Canadensis, Asprella hystrix, Panicum dichotomum.

P. trifolii (Pers.). Fuckel.

PHACIDIACEÆ. *Phacidium medicagiuis*, on Medicago sativa.

HYPHOMYCETES. *Scolecotrichum graminis* on Dactylis glomerata.

Helmithosporium graminis on Hordeum vulgare.

Cladosparium graminis on Avena sativa.

UREDINEÆ. Rusts. *Uromyces trifolii*, (Alb. and Schw.) Wint. on Trifolium pratense. T. incarnatum (F. A. Sirrine).

U. graminicola, Burrill on Panicum virgatum.

Puccinia andropogonis, Schw. on Andropogon provincialis, A. scoparius, Chrysopogon nutans.

P. emaculata, Schw. on Panicum capillare.

P. graminis, Pers. on Agrostis alba var. vulgaris. Agropyrum glaucun. A. repens, Triticum vulgare. Hordeum vulgare.

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*The entire paper, but adapted to general readers, was published in full in Monthly Review of the Iowa Weather and Crop Service. Vol. I., No. 5, p. 2; No. 6, p. 1; No. 7, p. 4; No. 9, p. 5. Vol. II., No. 1, p. 2; No. 2, p. 8; No. 3, p. 8; also separate 33 pp.

P. rubigo-vera, (D. C.), Winter on Hordeum jubatum, Triticum vulgare, Elymus Canadensis.

P. coronata, Corda. On Avena sativa.

P. sorghi, Schw. on Zea mays. A destructive species in some years.

P. vexans, Farlow on Bouteloua racemosa.

USTILAGINEÆ. Ustilaga Maydis (D. C.) Corda on Zea mays.

Smuts. *Ustilago Madis* on Zea mays. All varieties more or less, but it is much more severe on some than others. "In 1889 the experiment station had a row of corn, the seed of which came from Phillipine Islands. The growth was vigorous; in height it exceeded by several feet the tallest corn on the ground, produced well developed nodal roots. Not only were the blades and sheaths badly infested with corn smut, *Puccinia sorghi*, but many of the stems, sheaths and nearly every plant in the row was smutted." The row adjoining this one had some smut, but no more than other varieties grown some distance from it.

U. Hordei on Hordeum vulgare.

U. avenæ on Avena sativa.

U. tritici on Triticum vulgare.

U. bromivora var. on Bromus breviaristatus.

U. panici miliacei (Pers.) Wint. on Panicum capillare.

U. neglecta, Niessel, on pigeon grass (*Setaria glauca*); a very common species. It is sometimes thought to cause abortion in Iowa. There is little foundation for the opinion.

Tilletia striæformis on Timothy (*Phem pratense*); Blue grass (*Poa pratensis*) affects leaves and sheaths as well as parts of the flower.

T. fœtens (B. & C.), Trelease on wheat (*Triticum vulgare*), (Bessey.)

Urocystis agropyri on Wild rye, (Elymus canadensis); a very common species.

BACTERIA OF MILK, CREAM AND CHEESE, WITH EXHIBITION OF CULTURES.

ABSTRACT BY L. H. PAMMEL.

Some twenty or thirty different cultures were exhibited, partly obtained from milk, butter and cheese and some from rotting beets etc. The method of obtaining pure cultures with gelatin and agar cultures was explained. Thea ction of some of the bacteria on milk is rendering milk sour. The souring of milk is not due to a single germ, but a large number have the power of changing milk sugar into lactic acid. Of the many lactic acid germs some are especially important in giving the proper aroma to cream, and the butter made from it. Certain species of bacteria render cream bitter. The old *Clostridium butyricum* was once supposed to be the cause of bitter taste in butter. It has been shown that this germ does not render butter bitter, but there are a number of quite different germs which may cause such changes. Certain peculiar flavors are also due to the action of germs.

Red color in milk and cream is caused by *Bacillus prodigiosus;* blue milk by *Bacillus cyanogenus:* yellow milk is produced by *Bacillus synxanthus* cultures of pathogenic germs like *Bacillus pyocyaneus, Staphylococcus pyogenes* var. *aureus* and *S. pyogenes* var. *citreus* were shown, and it was stated that these may sometimes occur in milk and cause injuries.

CORN SMUT.

It is the generally accepted opinion among botanists that corn smut *(Ustilago zeæ-mays)* enters the tissues of its host during the early stages of corn, shortly after germination. These opinions are based on the careful experiments conducted by Dr. Julius Kuehn,[1] a careful German investigator. Last spring some experiments were started on the College Farm with the view of preventing this troublesome disease. It was expected, of course, that the results at the close of the season would show a decided advantage in the treated corn, but to my surprise the results were entirely negative.

In the meantime a bulletin was received from Prof. Kellerman,[2] in which the results of his experiments with Corn Smut are given in detail. The experiments on the College Farm were somewhat more extended than those of Prof. Kellerman. It is not necessary to give details in this connection. The results of some of these experiments are as follows:

A plat of ground was selected which for several years had been in grass, so that the chances were against any great amount of smut in the soil. Although the weather was somewhat unfavorable a good share of the corn came up, though the stand was considerably injured by ground squirrels. First planting, May 7; second planting, June 1. Sample *a* was treated with hot water: vessel one, 44–46° centigrade; vessel two, 53–55° centigrade. Time was not kept though it was subjected to this heat for several minutes. The corn of second planting was kept in one vessel subjected to 50–56° centigrade.

No. I—Treated, smutty; 1 ear; 3 staminate ears, 2 staminate 6
Not treated, smutty; 1 ear; 7 stalks 8

HOT WATER.

No. II.—Treated, smutty; 6 stalks.. 6
Not treated, smutty; 1 leaf; 1 ear; 5 stalks.................................. 7

No. III—This corn was planted on soil which had been planted to corn in 1890. Hot water treatment. Results of treated and check are as follows:

Smutted, treated: 2 ears, 4 leaves, 2 staminate ears, 3 staminate, 31 stalks.. 42
Checks not treated: 3 ears, 3 leaves, 9 staminate ears, 2 staminate, 21 stalks. 38

No. IV—Treated with ammonincal carbonate of copper.
Treated: 2 ears, 2 leaves, 3 staminate ears, 1 staminate, 30 stalks............. 38
Check: 10 ears, 1 leaf, 1 staminate, 20 stalks 32

1. Bot. Zeitung, Vol. XXXII, p. 122.
2. Bulletin No. 23. Kansas Agricultural Experiment Station. August, 1891. Manhattan. Kansas.

It is not necessary in this connection to detail more countings of treated and untreated plats. The results all show with unmistakable evidence that there were no beneficial results in treating corn for Corn Smut.

In No. I., 6 smutted plants against 8 in check.
In No. II., 6 smutted plants against 7 in check.
In No. III., 42 smutted plants against 38 in check.
In No. IV., 38 smutted plants against 32 in check.

From these results it seems to me that something more must be learned about Corn Smut before we shall be able to treat the disease. I should not, however, consider these experiments conclusive.

These experiments should not be considered as showing conclusively that smut does not enter the delicate tissues of corn by way of the seed. Incidentally he referred to some experiments now carried on at the College Farm, in which ammoniacal carbonate of copper, Bordeaux mixture, and other substances were mixed with soil, in which, afterward, corn was planted. Ammoniacal carbonate of copper in soil retards the germination of corn.

Dr. Erwin Smith has called my attention to the Brefeld's work, in which he shows that Corn Smut will enter any merismatic tissue.

SOME OF THE CAUSES AND RESULTS OF POLYGAMY AMONG THE PINNIPEDIA.[1]

BY C. C. NUTTING.

Several years ago the writer was much struck by the great sexual differences met with among the Gallinæ, and had noted the fact that there was a relation between sexual disparity in size and polygamy.

During the last summer an opportunity was afforded to carefully observe one species of the Pinnipedia, and these observations led to a perusal of all the available literature for facts concerning the relation between sexual disparity and polygamy in this order. The results of this study had already been outlined for a paper to be read before the Iowa Academy of Sciences, when an article appeared in the November number of the *Naturalist* entitled "Probable Causes of Polygamy Among Birds," by Samuel N. Rhoads.

The above facts are mentioned to show that the conclusions as to the cause of polygamy among birds on the one hand, and Pinnipedia on the other, were the result of independent investigations, and hence will serve to strengthen each other in some important particulars.

True polygamy is something of a rarity among the Mammalia. It must not be confounded with mere promiscuous sexual intercourse, such as is

1. Paper read before the Iowa Academy of Sciences, Jan. 1st, 1890.

often met with among the Herbivora. The term polygamy, in its strict sense, can properly apply only to those species in which a single male habitually copulates with several females, and jealously and persistently defends them from the approach of other males.

The most typical examples of this state of affairs are met with among the Pinnipedia, and ultra polygamy is exemplified by the northern fur seal *(Callorhinus ursinus)*.

Two striking facts at once arrest the attention of even the most cursory observer of this species:

1st, The astonishing extent to which polygamy is carried. Mr. Elliott thinks "that it will be nearly correct to assign to each male from twelve to fifteen females, occupying the stations nearest the water, and those back in the rear from five to nine. I have counted forty-five cows all under one bull."[2]

2nd, The no less astonishing disparity in size between the sexes. The average length of the male is 7½ feet, while that of the female is 4 feet. The male weighs 450 lbs., while the female weighs only 85 lbs. It will thus be seen that the male weighs nearly *six times* as much as the female.

Two questions arise in view of the above facts:

1st, Is there any relation between polygamy and sexual disparity in size? 2nd, If so, what is that relation?

The Pinnipedia are fortunately sufficiently numerous in species and individuals to furnish an ample field for the study of both of the above questions. They are all eminently gregarious in habit, a condition favorable to polygamy. The order furnishes examples of both monogamous and polygamous species, and almost every degree of sexual disparity in size to be found in the Mammalia. We can easily construct a series of species, ascending from those exhibiting the least sexual disparity to those exhibiting the greatest. We can then see what, if any, relation exists between sexual disparity and polygamy. We shall presently see that pugnacity on the part of the males plays a not unimportant *role* in our discussion, and for that reason the fighting proclivities of the males will also be noted.

The following arrangement, then, illustrates what might be termed the ascending series of sexual disparity. The relation of the sexes (monogamy, promiscuity, or polygamy) and the relative pugnacity of the males in relation to other males of the same species will also be noted in each case.

Odobænus rosmarus (Walrus). (*a*) Sexes nearly equal in size, the female not being notably smaller than the male. (*b*) Monogamous, according to the only information at the disposition of the writer.[3] (*c*) Disposition not at all quarrelsome, the animals of both sexes being singularly good-natured and peaceable, "huddling together like so many swine," although they will fight fiercely in defense of their young.

Cystophoro cristata (Hooded Seal). (*a*) Considerable sexual disparity. The male is 8 feet long, and the female 7 feet. Weight of male, 450 lbs.; female, 200 lbs. (*b*) Probably monogamous, although there is no direct evidence at hand. There is at least nothing to indicate that they are polygamous in the

2. Quoted from "Monograph of North American Pinnipeds" (Allen). Nearly all the material used in the above article has been taken from that work.

3 Monograph of North American Pinnipeds, p. 107.

sense used in this paper. (*c*) The males fight fiercely for the possession of the females.

Erignathus barbatus (Bearded Seal). (*a*) Considerable sexual disparity. Length of male, 10 feet; length of females, 7 feet 4 inches. Weight of males, two and one-half times that of females. (*b*) Strictly polygamous, according to the single authority found. (*c*) Males often have severe battles, the strongest males driving away the younger.

Macrorhinus angustirostris (Sea Elephant). (*a*) Great sexual disparity. The weight of the male is three and one-half times that of female. (*b*) Polygamous.[4] Elliott says that they "resemble the sea lion in their breeding habits." (*c*) The males "fight desperately for the females."

Eumetopias stelleri (Steller's Sea Lion). (*a*) Great sexual disparity. Length of males, 12 feet; of females, 8½ feet. Weight of male, three times that of female. (*b*) Strictly polygamous. This species maintains a regular harem, but "does not maintain any such regular system in preparing for and attention to its harem as is illustrated on the breeding grounds of the fur seal" (Elliott). (*c*) "The bulls fight savagely among themselves, and turn off from the breeding ground all the younger and weak males."

Callorhinus ursinus (Northern Fur Seal). (*a*) Extreme sexual disparity. The males weigh three times as much as the females. (*b*) Ultra polygamous, the males maintaining a large harem, and guarding the females with the greatest vigilance and courage. In fact, this animal is the most polygamous of all the Mammalia. (*c*) Males fight with greatest desperation and persistence for females.[5]

A consideration of the above series will disclose the fact that there is a close and constant relation between polygamy and disparity in size among the Pinnipedia. It also indicates that this relation is a *direct* one, the disparity increasing *pari passu* with the polygamy throughout the series. Another fact is rendered evident by this series, and that is that the combativeness of the males increases *pari passu* with sexual disparity and polygamy.

These facts having been reasonably well established, it is possible to construct a hypothetical history of events which will illustrate the successive stages by which a species might pass from a simply gregarious habit, in which monogamy, or at least promiscuity, prevails, to the extreme of polygamy practiced by the northern fur seal. Such a transition may be conceived to take place by the following steps or gradations:

1st. An eminently gregarious species would offer more favorable conditions for the introduction of polygamy than a nongregarious species. Our point of departure in this part of the discussion would then be a gregarious, monogamous species. If the principles deduced from an examination of the series presented in the first part of this paper be correct, this species should also be one in which there is little sexual disparity, and little or no fighting among the males for the posseession of the females. All of the

4 "The sea elephants appear to be exceptional among the Phrocidæ in the great disparity of size between the sexes, in which, *as well as in their breeding habits*, they closely resemble the Otaries." Monograph of North American Pinnipeds (Allen), p. 755. The italics are mine.

5 Elliott says he has seen one male fur seal fight fifty or sixty battles during a single season.

above conditions seem to be fulfilled in the case of the walrus (*Odobænus rosmarus*). This species will then stand for our point of departure.

2nd. The gregarious habit of the walrus offers a constant opportunity for a departure from the path of monogamous rectitude. This fact is well illustrated in human affairs by the great amount of social immorality found among the crowded tenements of our large cities. Constant opportunity offers the most powerful temptation to gratify desire, and this is doubtless as true among Pinnipedia as among men. The result of this is a departure from strict monogamy in the direction of promiscuity.[6] The harbor seal (*Phoca vitulina*) illustrates this stage in the process. So far as I can ascertain, this species is simply promiscuous in sexual affairs, but does not attain to polygamy in the sense used here. The sexual disparity is slight, the males being somewhat heavier, and but little, if any, longer than the females.

3d. The departure from monogamy in the direction of promiscuity results in constant rivalry on the part of the males to possess the most attractive, or the greatest number, of the females. Rivalry begets warfare, the world over. This purely individual and personal rivalry among the male Pinnipedia results in individual combats, in which courage, ferocity, and size are the controlling factors. We thus have instituted the most rigorous kind of sexual selection, by means of which the above desirable qualities are secured, propagated, and intensified on the part of the males. The females, on the contrary, seem to be practically passive. The writer has been unable to find any evidence that the female Pinnipedia exercise any choice in the matter of accepting or rejecting individual successful males. The sexual selection thus instituted is true sexual selection as defined by Darwin as follows: "This [sexual selection] depends on the advantage which certain individuals have over other individuals of the same sex or species, in *exclusive relation to reproduction*."[7] It differs, however, from a vast majority of instances of sexual selection in apparent absence of choice on the part of the female.

This stage in the development of polygamy is illustrated by the hooded seal (*Cystophora cristata*), which appears to be promiscuous in sexual matters, and in which the males fight fiercely for the possession of the females. The divergence in sex has become considerable, as already indicated, the males being more than twice as heavy as the females.

4th. The struggle for the possession of the females having become a fixed and intensified habit, and the sexual disparity continuing to grow more pronounced, the following results might be expected:

(*a*) The larger and lustier males would have their desire greatly intensified and their sexual powers appreciably increased.

(*b*) The smaller and weaker males would be crowded to the wall, and, in many instances, entirely deprived of all conjugal rights, which would be usurped by the larger and stronger animals.

As a result of these conditions, certain males would obtain possession of several females, and deprive all other males of access to them. This would be *polygamy* in the sense used in this paper. The whiskered seal (*Erignathus*

[6] This word, although questionable, is the only one known to the writer by which the meaning, indiscriminate intercourse, can be tersely expressed.

[7] The Descent of Man, p. 248. The italics are mine.

barbatus), in which the male weighs two and one-half times as much as the female, and polygamy prevails, would illustrate this stage in the process.

5th. Polygamy having become a fixed habit, all the conditions would tend to accelerate the divergence in size between the sexes. The selection by which the bulkiest and most pugnacious males would succeed in obtaining the females would be as rigorous as could well be conceived, and would result in very great sexual disparity. The males would become remarkably fierce and aggressive. The females, on the contrary, would become less and less disposed to offer any resistance to the males, and hence a remarkable difference in temperament would eventually separate the sexes. The males would be intensely pugnacious, jealous, and aggressive, while the females would be gentle, indifferent, and passive.[8]

Polygamy having become established, the causes or conditions which aided in its establishment would tend to its intensification to such an extent that some males would have scores of females in their harems, while others, indeed the majority, would be entirely deprived of marital rights. Such, in brief, is the state of affairs among the sea lions, of which the fur seal (*Callorhinus ursinus*) is the best example.

The above hypothetical history of events will serve to convey the writer's opinion as to what may have been the stages by which polygamy has arisen and become intensified among Pinnipedia. For the sake of the nonscientific reader, it may be well to say that there is no intention to convey the idea that the fur seal was first a walrus, then a seal, and finally evolved into a sea lion or fur seal.

Two other points deserve mention in connection with this highly interesting animal.

The question naturally arises, why do not the females increase in size by inheriting the increased bulk of the male? There are few more interesting and perplexing laws than those of inheritance, and among these one of the most elusive is the inheritance of certain characteristics by one sex alone. Darwin attempts to explain these facts by the hypothesis of pangenesis,—a theory which seems to have few, if any, supporters at present. Whatever may be the cause of the transmission of certain characters to one sex only, there are two facts that may help us to understand the disparity between the sexes of the fur seals:

1st. The great size of the male is purely a *secondary sexual character*, and as such would not be expected to be inherited by the female, whatever may be the reason or cause ultimately found to explain the fact.

2d. Small size is of direct advantage to the female in this case, and hence a *natural* selection[9] would tend to intensify this feature, or what is prac-

[8]Curiously enough, Darwin quotes Captain Bryant to the effect that the females of the fur seal "appear desirous of returning to some particular male" (Descent of Man, p. 257). A careful perusal of the detailed accounts of the habits of this animal collated by Allen, in his Monograph of North American Pinnipeds, fails to discover any exercise of choice whatever on the part of the female. It may further be said that even if she had a choice there would be no chance to exercise it, as she is immediately pounced upon by the nearest male upon landing, and usually handed about by the scruff of the neck by several males before finding her ultimate resting place.

[9]The selection here spoken of can hardly be termed a *sexual* selection, as the advantage accrues directly to the mother, and does not have the direct and exclusive bearing upon the reproductive act which is the essence of sexual selection. It is, of course, true that one sex alone is affected; but this fact alone is not sufficient to stamp it as sexual selection as set forth by Darwin.

tically the same thing, to keep the females from sharing in the increased size of the males.

The advantage referred to arises from the manner in which the females are handled by the males upon the landing of the former, which is described as follows by Elliott:

"The little cows have a rough-and-tumble time of it when they begin to arrive; for no sooner is the pretty animal fairly established on the station of bull number one, when bull number two, seeing bull number one off his guard, reaches out with his long, strong neck and picks the unhappy but passive creature up by the scruff of hers, just as a cat does a kitten, and deposits her on his seraglio ground; then bulls numbers three, four, etc., in the vicinity, seeing this high-handed operation, all assail one another, and especially bull number two, and have a tremendous fight, perhaps for half a minute or so, and during this commotion the cow generally is moved or moves farther back from the water, two or three stations more, where, when all gets quiet, she usually remains in peace."

Allen also quotes Captain Bryant as follows: "Frequently a struggle ensues between the two males for the possession of the same female, and, both seizing her at once, pull her in two or terribly lacerate her with their teeth."

It is evident that the more easily and quickly the females can be moved the better for them, as they are thus more likely to avoid being lacerated by the males, either in being stolen from one by another, or in being fought over as described in the last quotation. If this is true, the lighter females would be less likely to be injured by the savage males, and hence the heavier ones would be weeded out by a natural selection, which by its constant action would go far toward accounting for the great sexual disparity exhibited by these animals.

The remaining fact demanding explanation is the wonderful ability of the male sea lions to endure long-protracted fasts. On this point Mr. Elliott says that they "abstain entirely from food of any kind or water for three months at least, and a few of them stay four months before going into the water for the first time since hauling up in May."

"This alone is remarkable enough, but it is simply wonderful when we associate the condition with the increasing activity, restlessness, and duty devolving upon the bulls as heads and fathers of large families. They do not stagnate, like bears in caves."

It seems highly probable that this astonishing ability to endure protracted fasts is one of the results of the ultra polygamy practiced by these animals. A marked intensification of desire seems to be one of the immediate concommittants of polygamy among animals. A writer in a recent number of the **Naturalist*, says, in speaking of monogamous birds adopting a polygamous habit: "We may infer, therefore, that sexual power and high sexual characters go hand in hand, and that in proportion to the advance toward organic perfection virility increases."

The virility of the sea lion is probably more excessively developed than that of any other mammal. The sexual organization is of the most highly

* American Naturalist, November, 1890, p. 1030.

specialized type and differs in some important particulars (e. g., external scrotum) from most other pinnipeds.†

This excessive virility might lead to the habit of abstaining from food in order to secure and then guard the females. This abstinence in its incipiency would not be of very great duration, but the period might be lengthened by almost imperciptable increments throughout hundreds of generations until the surprising results noted above would be reached. The animals live on their own blubber during their long fast, and it is reasonable to suppose that the male progenitors of the sea lions which were the strongest and lustiest and possessed the most blubber, would be able to out stay their rivals, and hence obtain possession of a greater number of females and beget a greater number of offspring than those having less strength and blubber. Thus a process of selection would be instituted whereby animals would eventually be produced possessed of sufficient blubber and endurance to survive the effects of even such phenomenal fasts as are endured by the fur seal of the present day.

In the preceding pages the writer has endeavored to account for the following pecularities met with among the pinnipeds:

1. The relation between great sexual disparity in size and polygamy.
2. The manner in which polygamy may have orginated.
3. The origin and effect of excessive pugnacity.
4. The origin and advantage of great sexual disparity.
5. The origin and advantage of the ability to endure long protracted fasts.

The sexual disparity, excessive pugnacity and ability to endure protracted fasts, are all intimately related to polygamy either as *cause* or *effect.*

Up to a certain point pugnacity and disparity seem to have acted as causes of polygamy. Beyond that point they seem to be effects of polygamy, or at least, are accelerated or intensified by it. The ability to endure long fasts would seem to be purely an effect of polygamy.

SYSTEMATIC ZOOLOGY IN COLLEGES.

BY C. C. NUTTING.

A few months ago one of the curators of the Smithsonian Institution took occasion, in private conversation, to complain of the fact that our universities and colleges did not turn out men capable of taking hold of a collection of zoological specimens and working it up systematically. He said: "We can find plenty of students from Johns Hopkins, Harvard, the University of Penn-

† For further interesting particulars, see Monograph of North American Pinnipeds, pp. 382-405

sylvania, etc., who can do good work if they are put to investigating the embryology of a single species, or writing a thesis on the histology of certain organs. But we have great difficulty in finding men who are able to take hold of a collection brought in by some dredging expedition, for instance, and identifying and describing the specimens in a satifactory manner."

Dr. David Starr Jordan, now of Leland Stanford, Jr., University, protested earnestly, in a public address against what he termed the "German craze for morphology," which occupied the attention of biologists almost to the exclusion of much important systematic work which was being neglected.

Theodore Eimer, in his "Organic Evolution," says: "The tendency of the 'Scientific Zoology' of to-day is to *neglect the study of entire animals*. Anything that is not teezed with the needle, or cut with the microtome or examined with the microscope, is scarcely noticed at the present day, except by those who are exclusively systematists—even in questions connected with the evolution theory. For, strange to say, even the doctrine of evolution is left entirely, in Germany, to the decision of anatomy and embryology; that is, of the microscope, or else is given up to mere speculation, although Darwin himself used neither the former nor the latter, but external form, the life and the distribution of plants and animals, for his theory."

Far be it from me to belittle in the slightest degree the work of the morphologist. Upon the result of his labors must be reared the whole structure of the systematic zoologist. His work is not only important, but it is *vital* to any correct solving of the maze of questions which the systematist attempts to unravel. Upon the faithful and minute researches of the anatomist, the histologist, and above all, the embryologist, the success or failure of the systematist depends. As the foundation is to the building, so is morphology to Systematic Zoology.

But after fully and candidly admitting our great obligation to those who work with the dissecting needle, the microtome and the microscope, is there not still some justification for the complaints of such men as Rathburn, Jordan, Eimer and Cope? Is it not true that our largest and best institutions allow the "German craze for morphology" to monopolize the ground to the detriment of systematic work? Is there not a tendency to convey the impression to the student that there is little to be gained by "studying the entire animal," and that the specimen must be cut up before any observations of value can be made?

For my part, I think the men whom I have quoted have pointed out a real danger, which should be forced upon the attention of biologists, especially those engaged in educational work.

This state of affairs has come about in a perfectly natural way. The invention of the microscope and the perfection of methods in histological and embryological investigations, have literally opened a new world to the scientist, and the usual result of opening a new territory has ensued—a universal rush to occupy every available spot in the land of promise and the abandoning of equally valuable and important fields already under cultivation. But now that the rush is over, and the new territory fairly well occupied by eager and zealous workers, it may not be amiss to ask ourselves whether the old farms "back east" are not worth our attention, especially as we can now undertake the work enormously enriched by the wealth of facts which come in exhaustless profusion from the workers in the new territory.

One of the main reasons why systematic work has failed to command the attention that it deserves on the part of the college students is a wide-spread misapprehension as to its real nature and scope. A majority of students are wont to regard systematic zoology as particully to be shunned on account of what they consider its most essential character—an endless succession of fearful names—a veritable nightmare of polysyllabic horrors, the dead languages resurrected for the special discomfort of the unfortunate students. And when we consider the mutilations to which these same dead languages are often subjected before being introduced to the student, the wonder is that any youngster survives the first shock!

I speak feelingly because I speak from a sad experience. Never will I forget the abject despair with which I contemplated the long pages of classification, sub-kingdoms, classes, orders, families, genera and species in the back of Tenny's Manual, all of which I was expected to learn by heart and write on the blackboard under the pathetic delusion that I was learning "Zoology."

Not a single animal, alive or dead, was presented for inspection during a term's work in zoology (save the mark!) and if some of us, impelled by an unsatiable desire to learn, went to the woods and secured a few living facts, they were rigorously excluded if not expressly substantiated by the inspired Tenny. And this was in a so-called "university."

The professor of science had a microscope and one slide showing scales on a butterfly's wing, and for any student to have asked for permission to actually use that sacred instrument would have been as appalling as Oliver Twists' request for "more!"

This, although an extreme case, is not by any means an unique one, and many students still regard the endless and, to them, *meaningless*, classification as the sum and substance of systematic zoology.

Huxley hits the nail squarely on the head as usual when he says: "The idea that the ability to repeat any number of so-called "natural classifications," has any thing to do with real knowledge, is injurious alike to students and their examiners."

At the present time, fortunately, but little remains of what Lankester characterizes as "that state of mind which led to the regarding of the classes and orders recognized by authoritative zoologists as sacred institutions, which were beyond the criticism of ordinary men," and he goes on to say: "There was a theological dogmatism about the whole matter. To deny the Linnean, or later, the Cuvierian classes, was very much like denying the Mosaic Cosmogony."

The student should be given to understand that these formidable classifications are but the skeleton which his studies and investigations should clothe with living facts, so that finally the dry bones will be almost forgotten as he contemplates the beauty and the symmetry of the well-rounded, vital structure. He should be taught that classifications, so far from being inspired or sacred or permanent, are but temporary expedients to express the individual opinions of their originators, which opinions change with every review of the group classified.

The main question which I wish to present for your consideration is this: Is the study of systematic zoology especially adapted to the conditions of the college course? Has it any claim to rank along with structural zoology as a means whereby the best educational results may be attained?

The answer to these questions depends very largely, it seems to me, upon the college or university under consideration. In those institutions where well equipped biological laboratories are at the disposal of students, and the endowment is such as to make successful investigations in morphology possible, the study of comparative anatomy, histology and embryology offers unsurpassed attractions to the student and insures earnest and faithful work of the very highest educational value, unless the instructor is painfully lacking in the ability to use the means at his command.

In institutions possessing both laboratories and museums, both structural and systematic work can be undertaken. In this case, if it is considered best to divide the zoology between two chairs, two courses may be pursued.

1st. The systematic zoology may be regarded as supplementary to the structural, which excludes all students from systematic work who are unable or unwilling to devote two years to zoology.

2d. The structural and systematic work may be offered as two independent and co-ordinate courses, in which case each professor should be free to give so much instruction in the department of the other as may be required for a satisfactory understanding of the work in hand.

But there is a large class of colleges scattered over our State, where well equipped laboratories can not for the present at least, be afforded, and where the duties devolving upon the "Professor of Natural Sciences" are too manifold to admit of his taking the time necessary for good laboratory work even if the equipment were provided. In these colleges, it seems to me, systematic zoology offers some superior advantages if wisely taught.

One cogent argument in its favor is that it need not demand any great amount of equipment to commence with. The compound microscopes and their adjuncts, which usually require the bulk of the outlay in laboratory equipment, can be dispensed with. Dissecting microscopes, or even good coddington lenses with a few inexpensive accessions will suffice for the work. Considerable field work is indispensable on the part of both instructor and students. But field work is the very best way to learn zoology and is withal the most attractive and physically beneficial.

Text books can and should be eschewed *as* text books, and their place taken by some reliable manual, as Jordan's.

The time for going over the whole animal kingdom in a single term has long since passed. It can never result in anything but "going *over* it" in a very literal sense, without going into it at any point. Almost every teacher who can be said, in any true sense, to be prepared to teach zoology has made a more or less special study of some definite group of animals. That means that he knows a great deal more about some particular kinds of animals than of any others. Now, it is manifestly his wisest course to dwell most upon that which he knows the most about.

Let us suppose, for instance, that the "Professor of Natural Science" is an amatuer ornithologist. Birds, then, are obviously the animals which he should teach about. He, in all probability, has several of the standard works on ornithology such as Coues' "Key," Ridgway's "Manual," and perhaps Baird, Brewer and Ridgway's "History of N. A. Birds." It is likely, too, that he has a more or less extensive cabinet of bird skins. If not he can put his class to work collecting. Any boy that is old enough to go to college is old enough to handle a gun, and there are natural collectors in almost any class. It may be a survival from savage life, but a boy who does not like to hunt is a rare and abnormal specimen. The boys will provide specimens, or some resident farmer's lad will gladly scour the woods and secure birds at a few cents each. After the instructor has given a few preliminary lectures on the general character of animals, Vertebrata, Aves, the external parts of birds, he is ready to instruct them on field work, and spend a half Saturday with the class in the woods, each person armed with his field note book and two or three armed with shot guns. Jordan's "Manual" can be used in identification of specimens. But there is a distinct danger in the use of manuals, or rather in a sort of slavish adherence to them. The manual is intended simply as a means of identification usually by purely superficial characters, and its unrestricted use is apt to give undue prominence to these characters in the mind of the student, while other facts of fundamental significance are allowed to pass unnoticed. The manual should be supplemented by some more extensive work of reference such as Baird, Brewer and Ridgway's.

Give a specimen to each student, if there are enough to go around, or let several work together on one specimen. It is by no means enough for the student to simply identify the specimen, for he should learn all he can about the habits, distribution, etc., of the species represented, and report all these facts to the class for general discussion and comment by the instructor. Certain specimens will furnish texts for special lectures on such subjects of general interest as protective coloration, migration, secondary sexual characters, rudimentary organs, adaptive structures, mimicry, nesting habits, etc. Such talks will seldom fail to secure the attention of the class when brought in in reference to some specimen recently secured and studied. The instructor will often make the unexpected discovery that whole animals and live animals are often fully as interesting to bright boys and girls as animals which have been teezed with the needles or cut up with the microtome.

Two lectures a week, upon which full notes are taken and copied in permanent form, two hours devoted to field work, two to preparation of specimens, and two to identification and study, will fill up the time in a manner which will give variety to the work, exercise to the body, induce habits of observation and discrimination, and bring the student into direct contact with Nature. What more can we expect to accomplish in the time usually allotted to zoology in our smaller colleges? The best ornithologists that we have became so by this very method of field work, combined with the consequent identification and study of specimens and recording of observations.

Year after year the cabinet will become more and more complete, and the gaps in the series less and less conspicuous, until the local fauna will be well worked up for publication, when both class and instructor will feel that they have actually contributed something to the sum of human knowledge. The true spirit of the naturalist which has lain dormant in many a boy and girl, will be awakened to life and healthful activity; thanks to the teacher who wisely introduces them to Nature at first hand, without the dreary intervention of the text book and the disheartening task of learning pollysyllabic "classifications which have nothing to do with real knowledge."

Of course, the above is offered simply as a sample of a method of teaching systematic zoology. If the professor is an entomologist, let him make insects the subject of the term's work; if a conchologist, mollusks will yield the best results. If he has never become especially interested in any group of animals he should seriously consider the question as to whether or not he has missed his vocation.

OVIPOSITION OF ANOMALON SP.

BY C. P. GILLETTE.

While passing an apple tree August 18, on which were a brood of *Datana ministra* larvæ about one-third grown, my attention was attracted by the presence of a large Hymenopterous parasite busily ovipositing in their soft bodies and apparently much to their discomfort. The parasite was a large black *Anomalon sp.* not in my collection, unless, possibly, it is a variety of *A. pallitarse* Cress. It differs from Cresson's description by having its middle and hind pairs of legs entirely black and its face and antennæ entirely yellow.

This parasite was so intent upon her work that she did not leave when I pulled the limb down close to my face so that I could distinctly watch operations. The entire brood of larvæ were apparently alarmed and were striking their heads violently from side to side to frighten away their enemy The parasite stood upon a leaf in easy reach of a number of her victims. watching their movements and as soon as one became quiet enough she would quickly thrust it with her sharp ovipositor. The manner in which this was done was what especially interested me. I had supposed that these parasites would stand upon or above their victims and thrust down upon them, but such was not her manner. I was reminded of one who fences and with a quick thrust straight in front pierces his combatant. This insect stood upon her two back pairs of legs the front pair not being put to any use. The long abdomen was bent under the thorax and between the legs and the thrusts were made straight in front of the face. As the abdomen was brought forward the short ovipositor pointed straight in front like an index finger.

The larvæ when pierced did not drop to the ground but threw their heads higher in the air and ejected a dark colored liquid. So far as I saw, but one egg was deposited in each larva.

A NEW CECIDOMID INFESTING BOX-ELDER (*Negundo aceroides.*)

BY C. P. GILLETTE.

Cecidomyia negundinis, n. sp.

Galls.—The galls are produced from terminal buds on all parts of the tree, and each is made up of a number of transformed leaves and petioles, arranged in pairs opposite each other, in which the two leaves are opposite. They are sub-globular in outline and vary from less than one-half of an inch to nearly an inch in diameter. The outer basal portion of the gall is formed by an enormous enlargement of the bases of the petioles of two leaves which unite and form a receptacle like the cup of an acorn, holding the inner portions of the gall. In the central part of the gall the leaf blades may be entirely involved or their tips may be expanded.

Gall Flies.—Females, dry specimens. *Eyes* large, coal black and coarsely granulated. *Antennæ*, one half the length of the insect, 13 jointed, first joint globular, remaining joints cylindrical; second and third joints contracted in the middle; pedicels of joints, short, about one-fourth the length of the joints; all of the joints moderately set with hairs, the longest of which nearly equal the joints in length. *Thorax*, very dark brown, opaque, and naked, except two rows of long gray hairs in longitudinal grooves, running from collar to scutellum, and similar hairs at the sides of the thorax; scutellum of the same color as the meso-thorax, and with a few long gray hairs. Beneath the wings it is yellowish. *Dorsum*, dark brown; sides of *abdomen* and venter, light yellow; abdomen sparsely set with gray hairs above and below. *Ovipositor*, yellowish brown, and in specimens taken while ovipositing, it is exserted one and one-half times the length of the insect. *Legs*, rather pale; tibiæ and tarsi infuscate, rather densely set with silvery hairs. *Wings*, beautifully irridescent, and rather sparsely set with long gray pubescence, fringed all the way around; costal and first longitudinal nervures, rather heavy, and united at the apex of the wing as one continuous vein; the little cross vein between the first and second transverse nervures and the outer or upper branch of the fork in the third transverse nervure are almost obsolete and scarcely visible, except in favorable light. Length of dry specimens, one and one-half mm.; length of fresh specimens, two mm.

The eggs are of a bright orange color, four mm. in length, and much elongated; some are straight, others are variously bent, and all are pointed at one end, and usually with a short pedicel attached.

This insect is decidedly an injurious species. Trees upon the college campus that were worst attacked by this fly the past summer, have had not more than one-half their normal amount of foliage.

On the 18th of April, last, the writer noticed the flies abundant among the branches of the trees, and the process of egg-laying was carefully watched with a hand lens. The females were so intent upon their duties for the propagation of the species that they were not easily disturbed. They do not pierce the bud scales, but work their long, slender ovipositors far down between the scales, and there deposit a large nest of eggs, sometimes forty or more in a place. By separating the scales these clusters of eggs can be plainly seen with the naked eye. The irritation set up by these eggs and the maggots that hatch from them, aided, perhaps, by a poisonous secretion from the mother insect, causes the abnormal development of the part. The galls and the twigs supporting them all die a few weeks later, when the maggots drop to the ground. These dead galls turn black, and remain upon the trees, giving them an unsightly appearance.

EGG-LAYING OF THE APPLE CURCULIO—(ANTHONOMUS QUADRIGIBBUS SAY).

BY C. P. GILLETTE.

I am not aware that anyone has published actual observations on the method of oviposition by this insect. On the 13th of June, 1889, I was fortunate enough to see a female perform the entire operation which was as follows: First a cavity was eaten in the apple as deep as the beak was long, the bottom being much enlarged and sub-triangular in outline. The walls of the cavity converged to the opening which was only large enough to admit the slender beak. When first noticed the beetle had but just begun her work and it was thirty minutes before she had the egg cavity completed. The beetle, almost immediately after withdrawing her beak turned about and applied the tip of her abdomen to the small opening. After remaining in this position for about five minutes she walked away without turning about to inspect the work she had so neatly done. I at once plucked the apple and examined closely the identical spot where the beetle had been at work and was surprised to find that there was no puncture to be seen, but a minute brown speck instead which would not arouse a suspicion of what had been done. The beetle had smoothly plugged the little opening with what appeared to be a bit of pomace, probably excrement, and she had done the job so nicely that no one would suspect that the little speck marked the place of oviposition unless he had seen such marks before and had learned what they signify. With a sharp knife a section was made through the egg-chamber, with the egg at the bottom.

Although at first it is almost impossible to distinguish stung fruit from external appearances, it becomes very easy after a few days when the apples become gnarly and ill-shapen.

THE GALL-PRODUCING CYNIPIDÆ OF IOWA.

BY C. P. GILLETTE.

The Cynipidæ form one of the most interesting, but one of the least studied families of the Hymenoptera. It is the object of this paper to encourage the collection and study of the gall-producing Cynipidæ of the State. The species here mentioned have, with one exception (Rhodites multispinosa), been taken by the writer in the past two years in the vicinity of Ames, Iowa. There can be no doubt but what two or three times as many species occur in the State.

The writer will be glad to receive for study or determination any species that may be sent to him.

I give with each species mentioned a reference to the original description, a brief description of the gall and the localities from which the species has been taken, so far as known to me.

LIST OF SPECIES.

Rhodites multispinosi Gill. Bull. 7, Ia. Exp. St., p. 284. Entomologica Americana, v. VI., p. 25.

The galls are abrupt tumor-like excresences from three-fourths of an inch to over an inch in diameter and densely covered with sharp spines, growing on new shoots of a species of wild rose. Flies issue early in May. Iowa, Minnesota.

Amphibolips coccinea O. S., Proc. Ent. Soc. Pha., v. 1, p. 243.

This species produces one of the largest "oak apple" galls that we have. Large galls measure one and three-fourths inches in their greatest diameter, and about a fourth of an inch less in their smallest diameter. Externally there is a thin, smooth, brittle shell; at the center there is an egg-shaped central cell, surrounded by a loose spongy mass, which is easily separated from it; occurring on the leaves of *Q. coccinea*. Flies emerge about the 20th of June. Michigan, Iowa, D. C.

Amphibolips cookii Gill. Rep. Mich. B'rd of Agr., 1887, p. 475. Psyche, Vol. V, p. 220.

The galls are globular and juicy when green, much resembling the galls of *A. inanis* O. S., and measure from three-eighths to five-eighths of an inch in diamete. The galls are composed of a rather thin outer shell, and central cell held in place by stout radiating fibers. The galls are always found attached singly to buds of *Quercus rubra*; they fall to the ground in September and October. The flies emerge the following summer. Ia., Mich.

Amphibolips inanis O. S. Proc. Ent. Soc. of Pha., V. I, p. 242.

Globular thin-shelled gall from three-fourths of an inch to an inch in diameter with small central cell held in place by delicate radiating fibers. Occuring on leaves of *Quercus rubra* and *Q. coccinea* (?) in June. A common species east and west and one of the so-called oak-apples.

Amphibolips sculpta Bass. Proc. Ent. Soc. Pha., V. II, p. 324.

Produces a globular translucent gall from three to six eights of an inch in diameter, much resembling a large green grape but usually rosy in color. The galls are attached to the underside of the leaves of *Quercus rubra* and *Q. coccinea* (?). Flies appear about July 4. Connecticut, Michigan Iowa. Rather rare in Iowa.

Andricus (*Sub-gen. Callirhytis*) *clavula* Bass. Proc. Ent. Soc. Pha., V. IV, p. 351.

The galls are club-shaped enlargements of the ends of the twigs of *Quercus alba*. Flies emerge in July. Common east and west.

A. (*Callirhytis*) *cornigera* O. S. Proc. Ent. Soc. Pha., v. IV, p. 353.

Galls corresponding well with those of this species have been taken by the writer in Michigan and Iowa from twigs of *Quercus rubra*, but no flies have been reared from them and they may prove to belong to a different species. The gall usually occurs on *Q. palustris*. It is an abrupt woody enlargement surrounding small limbs and is usually from one to one and a half inches in diameter. From the outer rim of the gall are pushed out numerous seed-like bodies each containing the larva of a gall-fly. Virginia, Michigan, Iowa.

A. (*Callirhytis*) *operator*, O. S. Proc. Ent. Soc. Pha., V. I, p. 257. Galls undoubtedly of this species, but from which the flies had emerged, have been taken by the writer in Michigan and Iowa from twigs of *Q. coccinea*. The galls are an inch or more in diameter and appear as a mass of brown wool. If the woolly growth is picked in pieces it will be found to have many seed-like bodies attached to the twig. The flies emerge in July. D. C., Iowa, Michigan. The gall occurs in the eastern states on *Q. nigra*.

A. (*Callirhytis*) *punctatus*, Bass. Proc. Ent. Soc. Pha., V. II, p. 524.

The gall is a smooth, hard, woody swelling entirely surrounding a limb of Q. rubra. The galls vary from one to four inches in length and from one to two or more inches in diameter. The flies emerge in May. Connecticut, Michigan, Iowa, Delaware.

A. Callirhytis scitulus, Bass. Proc. Ent. Soc. Pha., V. III, p. 683.

The gall is a woody enlargement of the tips of the twigs of *Q. rubra* and *Q. tinctoria*, sometimes causing the death of the affected part: The flies emerge about July 1. Connecticut, Michigan, Iowa.

A. (*Callirhytis*) *seminator*, Harr. Treat. on Ins., 2d Ed., p. 432.

The gall of this species is a brown woolly mass from one to two inches in diameter and enclosing a large number of seed-like bodies each one of which contains an insect. Always occuring on the twigs of *Q. alba*. Iowa. Michigan, Flordia, Eastern U. S.

A. (*Callirhytis*) *tumifica*, O. S. Proc. Ent. Soc. Pha., V. IV, p. 356.

The gall is a hard swelling along the midrib, generally near the petiole of a leaf of *Q. tinctoria* and *Q. rubra*. Each gall contains several flies which emerge about June 20. New York, Iowa.

Andricus flocci, Walsh. Proc. Ent. Soc. Pha., V. II, p. 482.

Galls appear as little bunches of brown wool attached to the underside of the leaves of *Q. alba* and *Q. macrocarpa*. Under the woolly growth, attached to the midrib, are several small seed-like bodies about one-half as large as a kernel of wheat. The galls remain attached to the leaf over winter and the flies emerge in the spring. Illinois, Michigan, Iowa.

Andricus petiolicola Bass. Proc. Ent. Soc. Pha., v. II, p. 325.

The galls are hard, semi-globular swellings on the petioles of the leaves of *Q. montana*, *Q. macrocarpa*, *Q. alba*, *Q. bicolor* and *Q. prinus* (?). They vary in size from three-eighths to five-eighths of an inch in diameter. Flies emerge about June 20. Iowa, Michigan, Connecticut.

Andricus piger Bass. Can. Ent., v. XIII, p. 105.

The galls much resemble those of *Andricus tumifica*. They are irregular swellings along the midrib on the under side of a leaf of *Q. coccinea* (*rubra*). Galls collected in the fall of 1888 did not give the flies until the spring of 1889. Mr. Bassett in his description of this species says he obtained the flies in the fall. Connecticut, Iowa.

Andricus singularis Bass. Proc. Ent. Soc. Pha., v. II, p. 326.

Produces globular, thin-shelled galls with the central larval cell held in place by radiating fibers. The galls grow through the blades of the leaves of *Q. rubra*, projecting more from below than above. Flies emerge about the 10th of July. Connecticut, Michigan, Iowa.

Andricus utriculus Bass. Can. Ent., v. XIII, p. 78.

Producing small globular galls about one-eighth of an inch in diameter, on the leaves of *Q. alba*. Very often the galls entirely prevent the development of the leaf blade. The gall is without a larval cell. Flies emerge about June 10. Connecticut, Iowa.

Cynips dimorphus Ash. MS.

Producing red globular galls about one-eighth of an inch in diameter when full grown and occurring in clusters of from twenty to fifty, along the midrib and usually on the under side of the leaves. I have taken this gall in Michigan on *Q. macrocarpa*, *Q. bicolor* and *Q. prinus*, and it is very common in Iowa on the leaves of *Q. macrocarpa*. The galls fall from the leaves in September and October, and the flies do not emerge until the following summer. Florida, Michigan, Iowa.

Cynips strobilana O. S. Proc. Ent. Soc. Pha., v. I, p. 254 (gall), III, p. 690 (fly).

Producing clusters of galls from one to two inches in diameter, and made up of a large number of wedge-shaped pieces, attached to the tip of a twig of *Q. macrocarpa* or *Q. bicolor*. The galls remain attached to the twigs over winter, and the flies emerge the following summer. District of Columbia, Michigan, Iowa.

Acraspis erinacei Walsh. Proc. Ent. Soc. Pha., v. II, p. 483.

The galls are hard, globular or oblong excrescences, the size of a large pea or bean, attached to the midrib or one of the main veins of the leaves of *Q. alba*. The surface of the gall is densely covered with little seed-like points, most of which terminate in a vegetable hair. The galls are of a light yellow or straw color, often tinged with red. The insects issue in October, and are wingless.

Acraspis villosus Gill. Rep. Mich. B'rd Agr., 1887, p. 474. Psyche, v. V, p. 218.

Galls much resembling those of the preceding species, of a light yellow color, with longer and more dense growth of hairs, always globular and single-celled, attached to the under side of the leaves of *Q. macrocarpa.* Flies emerge in October. Michigan, Iowa.

Acraspis niger Gill. Bull. 7, Ia. Exp. Sta., p. 282; Ent. Amer., v. VI, p. 23.

The galls are perfectly globular in form, from one-fourth to three-eighths of an inch in diameter, and are covered with a short, dense pubescence, which gives them the appearance of felt on their outer surface. Attached to the under side of the leaves of *Q. alba* and *Q. macrocarpa.* The galls mostly fall before the leaves, and the flies emerge the following summer. Michigan, Iowa.

Acraspis macrocarpœ, Bass. Trans. Am. Ent. Soc., v. XVII, p. 84.

The galls are hard, egg-shaped excrescences from two to three-eights of an inch in length, occurring usually on the under side of the leaves of *Q, macrocarpa* and always attached to a vein. The black, wingless gall-flies emerge in October. New York, Ohio, Michigan, Iowa.

Biorhiza forticornis Walsh. Proc. Ent. Soc. Pha., v. II, p. 490.

A large number of the galls are usually crowded together about a young, thrifty shoot of *Q. alba.* They remind one of a large number of puff-balls closely crowded together, or of closely packed figs. The galls are yellowish in color, and each has a larval cell, held in place by radiating fibers. This species is also wingless, the insects emerging in the spring. New York, Illinois, Michigan, Iowa.

Biorhiza rubinus, Gill. Rep. Mich. B'rd Agr., 1887, p. 472. Psyche, v. V, p. 215.

The galls are small, globular, juicy bodies from two to three inches in diameter, occurring upon the leaves of *Q. alba* in October. Flies emerge the following summer. Michigan, Iowa.

Holcaspis duricoria Bass. Trans Am. Ent. Soc., v. XVII, p. 64.

Producing sub-globular sessile galls surrounding twigs of *Q. macrocarpa* and *Q. bicolor.* The galls are from three to four-eighths of an inch in diameter, and usually terminate in a small teat-like point. They are of a dense, corky material, and each has a free egg-shaped larval cell at its center. The galls are often so crowded together as to be much pressed out of shape. Flies emerge in October. Connecticut, Michigan, Illinois, Iowa.

Holcaspis globulus Fitch. Proc. Ent. Soc. Pha., v. II, p. 328.

The galls are globular, of a corky structure, like the preceding, occurring singly on the twigs of *Q. alba* and *Q. montana.* Flies emerge in October. Connecticut, Michigan, Iowa.

Dryophanta papula Bass. Can. Ent., v. XIII, p. 107.

The galls are very hard, irregular swellings upon the upper surface of the leaves of *Q. rubra* and *Q. coccinea.* The galls often have many sharp cone-like points. Flies emerge about July 10. Massachusetts, Connecticut, Michigan, Iowa.

Dryophanta liberæ-cellulæ Gill. Bull. 7, Ia. Exp. St., p. 283; Ent. Amer., v. VI, p. 24.

The galls are globular, from two to three-eighths of an inch in diameter, and grow through the blades of the leaves of *Q. rubra* and *Q. coccinea.* The galls much resemble those of *Andricus singularis* when green, but the outer shell is not so firm, and they collapse upon drying. The larval cell is not held in place, but rolls freely about in the gall. The flies emerge about May 20. Michigan, Iowa.

Neuroterus floccosus Bass. Can. Ent., v. XIII, p. 111.

The galls of this species appear as little brown, woolly patches on the under side of the leaves of *Q. macrocarpa* and *Q. bicolor*. Hundreds of these often occur upon a single leaf. On the upper surface above each gall is a little raised light colored spot. Ohio, Michigan, Iowa.

Neuroterus vesicula Bass. Can. Ent., v. XIII, p. 97.

The galls of this species are little thin-shelled vesicles, about one-tenth of an inch in diameter. These galls occur in the buds of *Q. alba* and *Q. macrocarpa*. Connecticut, Michigan, Iowa.

Neuroterus nigrum Gill. Rep. Mich. B'rd Agr., 1887, p. 475. Psyche, V, p. 218.

The galls appear as little pimples from one-twelfth to one-fifteenth of an inch in diameter, showing equally well from either side of the leaf. In the vicinity of Ames, Iowa, this gall is enormously abundant, many trees of *Q. macrocarpa* having hundreds of the galls upon nearly every leaf. The galls occasionally occur upon the leaves of *Q. alba*. Flies emerge early in the spring. Michigan, Iowa.

Neuroterus flavipes Gill. Bull. 7, Ia. Exp. St., p. 281; Ent. Americana, v. VI, p. 21.

The gall is a hard, woody swelling on the midrib or one of the main veins of the leaves of *Q. macrocarpa*, the leaf becoming wrinkled and deformed as the result. Large galls measure three-fourths of an inch in length by one-fourth of an inch in width. The flies issue early in July. Iowa.

Neuroterus vernus Gill. Bull. 7, Ia. Exp. St., p. 281; Ent. Amer., v. VI, p. 22.

The galls occur upon the leaves and stamen catkins of *Q. macrocarpa*. Upon the leaves they may occur anywhere along the midrib, but are most common at the base of the petiole. They do not produce a well-defined gall upon the leaves, but only a slight swelling of the part. The leaves, however, become much deformed, and sometimes the development of the leaf is almost entirely prevented. When the catkins are attacked they become much swollen and remain hanging to the tree until the larvæ are fully grown. Flies issue early in June. A very abundant species at Ames, Iowa.

ON SOME CARBONIFEROUS FOSSILS FROM JACKSON COUNTY, IOWA—[WITH EXHIBITION OF SPECIMENS.]

BY HERBERT OSBORN.

While on a hasty visit to Jackson county, Iowa, this summer, I was taken, by the kindness of Hon. C. M. Dunbar, to a lime quarry near Monmouth, in the western part of that county, about sixteen miles from Maquoketa.

I found there in the possession of Mr. Stewart, the owner of the quarry and kiln, some fine specimens of Lepidodron and Calamites, which naturally excited my curiosity (especially as they were so large as to preclude the idea of their having been brought from a distance as specimens), and led me to make special inquiry as to their occurrence.

Mr. Stewart stated that they were found on a hillside near his place, and described the formation in which they occurred as compact sandstone, outcropping near the top of the hills and extending in isolated outcrops as an open segment of a circle for a distance of about three miles.

The fossils, which are typical carboniferous forms, are imbedded in a compact sandstone. The size of some of the specimens seen, as well as the direct statements of Mr. Stewart, who is well informed on geological subjects, and whose statements may be taken as perfectly reliable, preclude any doubt as to their location. There would be no ground for supposing them erratics and deposited by glacial action, as no carboniferous rocks are known in the direction from which such deposits have come. It seems therefore certain that we have here a limited occurrence of carboniferous strata at a point very distant from the other strata of like age, and indicating a much more extensive area than present strata show. Whether this was actually connected with the great carboniferous area, and the intervening portion has been removed by erosion, or whether it represents a small area adjacent to the principal seat of carboniferous deposit, it would be difficult now to conjecture. It would seem well worth while to make a careful examination of the locality, and also of all elevated areas intervening between this and the nearest carboniferous outcrops to the south and west.

ABNORMAL PELAGE IN LEPUS SYLVATICUS.

BY HERBERT OSBORN.

The specimen of rabbit exhibited was killed a few miles south of Ames, in the early part of the past winter (1889–1890), and sent to me through Mr. H. P. McLain, of Ames. It is remarkable in having two extensive patches of very long hair, one running along each side of the back from the ears to the hips, so long as to droop down the sides to the lower line of the body, and also similar long hairs, in tufts, in front of the ears and on the upper part of each leg. The color is about like that of a poodle dog, and the extreme length of the hair gives the whole animal a certain resemblance to that variety of dog. The mounted specimen is preserved in the museum of the Iowa Agricultural College.

ON THE ORTHOPTEROUS FAUNA OF IOWA.

BY HERBERT OSBORN, AMES, IOWA.

(Presented December 29, 1891.)

The ORTHOPTERA are among the most important of the injurious insects of this State, almost all of the species being destructive, and scarcely one that can be considered as of any benefit. A list of the species occurring in the State is therefore of more than scientific interest and becomes important while considering the distribution of the destructive species.

The present notes refer almost entirely to the central part of the State, principally in the vicinity of Ames, and there are, doubtless, many other species to be secured by careful collection with special reference to this group in this locality, and still more with collections in the extreme corners of the State.

In the seventh biennial report of the Iowa Agricultural College (1877), Prof. C. E. Bessey published a "Preliminary List of the Orthopetera of Iowa," but since that publication a number of other species have been collected and some of the names included there were from incorrectly determined specimens, so that a revision is desirable.

Almost all of the species noted here are represented by specimens in the collection of the Iowa Agricultural College at Ames, but a few have been included on the authority of Prof. Lawrence Bruner, to whom also, I am indebted for determinations of a number of species.

Family FORFICULIDÆ (Order DERMAPTERA of some authors).

While differing in many respects from the true Orthoptera the Earwigs have been quite generally associated with them, and it will be in place to mention that we have one rather common species here, coming occasionally to light in summer time.

Labia minor is the species referred to, but the species suspected of occurring in the State by Prof. Bessey, has not as yet been observed in the State.

Family BLATTIDÆ (The Cock-Roaches).

Periplaneta orientalis L., Oriental Cock-Roach, apparently confined to larger cities. I have never seen it in houses in thinly settled localities. The insect mentioned under this name in Prof. Bessey's list must have been the following, which is very common:

Platamodes pennsylvanica. Very common indoors and out.

Ischnoptera borealis. Common in woods, especially under loose bark of fallen trees or stumps.

Ectobia germanica. I have seen this very plentiful in depots in Des Moines, but never in houses away from the city.

Family PHASMIDÆ.

Diapheromera femorata, Walking Stick, common, but never noticed in numbers sufficient to seriously defoliate trees. It is one of the most grotesque of our insects, and with its long slender legs and wingless body always excites the curiosity of observers.

Family ACRIDIDÆ.

Tettix granulata Kirby.

Tettix ornata Say. A quite common species, and with others of the genus to be found in numbers in fall and early spring, on smooth patches of earth on hillsides or in roads.

Tettix femoratus Scudder. Not so common as some of the species.

Tettix cucullata Burm. A plentiful species.

Acridium americanum Drury. Rare at Ames; has been received from Lee county, and is probably more common in the southern part of the State.

Acridium alutaceum Harr. Rather common.

Acridium emarginatum Scudd. Rather abundant at times, and, doubtless, capable of doing considerable damage.

Pezotettix scuderii Uhl. Rare at Ames, or at least, but seldom observed.

Pezotettix occidentalis Br. This, and the three species following, included on the authority of Professor Bruner.

Pezotettix gracilis.

Pezotettix albus Dodge.

Pezotettix nebrascensis Thos.

Melanoplus spretus Thos. "Rocky Mountain Locust," was in many parts of the State in the years 1875-8, but none, so far as known, for a number of years past.

Melanoplus femur-rubrum De G. Probably our most abundant locust, and one which causes great losses in grass land and clover.

Melanoplus bivitattus Say. Sometimes quite common and doing no little damage to clover and other crops.

Melanoplus differentialis Thos. Often abundant and destructive; confined mostly to grasses and cereals, but gathering in autumn on vegetables, asparagus, etc.

Melanoplus junius Dodge. Included on authority of Prof. Bruner.

Melanoplus luridus. On authority of Prof. Bruner.

Melanoplus angustipennis Dodge. On authority of Prof. Bruner.

Melanoplus abditum Dodge. On authority of Prof. Bruner.

Brachystola magna "Lubber Hopper." This species occurs in the western part of the State, but appears to reach its eastern limit in Crawford county.

Hippiscus haldemanni Scudd. A rather common species.

Hippiscus phœnicopterus Germ. Occasionally plentiful.

Hippiscus haldemanni Scudd. Another common species.

Hippiscus phœnicopterus Germ. Occasionally plentiful.

Dissosteira carolina Linn. "Dust Hopper." A very common species, easily recognized by its dusty color and the black under wings with yellow border.

Trachyrhachnia cincta. Rather rare.

Arphia tenebrosa Scudd. Rare in the central parts of the State, but probably common in the northwest.

Arphia conspersa. One specimen collected at Ames. Prof. Bruner informs me it is a Texan species, and its capture here unique.

Sphæragamon æqualis Say. A common species.

Sphæragamon collaris Scudd.

Tomonotus sulphureus Fab. Quite common.

Tomonotus carinatus Scudd. Sometimes abundant.

Encoptolophus sordidus Scudd. Generally common.

Tragocephala viridifasciata DeG. Common.

Tragocephala infuscata Harr. Common; very similar to the preceding, except in color; both forms appear quite abundant in early spring.

Stenobothris curtipennis Harr. At times rather common.

Stenobothris tricarinatus. Not noted as common.

Stenobothris æqualis Scudd. Probably the most common of the genus and likely to be destructive in grass where it abounds.

Chrysochraon viridis Scudd.

Chrysochraon conspersum Harr.

Mermiria bivittatus Serv. Usually rare.

Mermiria brachyptera Scudd. One immature specimen.

Family LOCUSTIDÆ.

Orchelimum nigripes.

Orchelimum vulgare. Quite common.

Xiphidium fasciatum. A very abundant species at times, and occurring on grass land and probably feeding in part at least, on grasses and clover.

Xiphidium nigropleurum.

Xiphidium brevipennis.

Xiphidium longipennis Scudd.

Xiphidium lanceolatum.

Conocephalus ensiger Harr. Fairly common. Along with other species of these prominent cone-headed species, it is a conspicuous insect during autumn.

Conocephalus nebrascensis Bruner.

Conocephalus attenuatus.

Conocephalus crepitans. A single specimen of this large and interesting species is in the collection of the Agricultural College.

Scudderia curvicauda DeG. Usually quite common.

Scudderia furculata.

Scudderia furcata.

Scudderia pistillata Bruner.

Amblycorypha rotundifolia.

Amblycorypha oblongifolia.

Cyrtophyllus concavus Say. Not common.

Thyreonotus pachymerus. A specimen presented by Mr. H. H. Raymond, was collected at Camp Douglas, Wisconsin, so it seems probable that it occurs in the northeastern part of the State. It has never been collected at Ames.

Ceuthophilus maculatus. Apparently not common.

Ceuthophilus lapidicolus. Not observed as common. The insect recorded under this name by Prof. Bessey proves to be the *U. nigra.*

Ceuthophilus divergens. Rather common.

Udeopsylla nigra. Our largest and probably most common Stone Cricket.

Udeopsylla robusta. Included on authority of Prof. Bruner.

Family GRYLLIDÆ.

Tridactylus apicalis Say. Seldom found in any numbers, but it may be swept from grass or low herbage in low ground and quite likely is more abundant than supposed, as it is so small as to easily escape notice.

Xabea bipunctata Fab. Rare, or at least but very seldom taken in the vicinity of Ames.

Œcanthus niveus Serv. Often abundant, but the adults have not been taken so commonly as *fasciatus.*

Œcanthus latipennis Riley. Rare. Probably more common in the southern part of the State.

Œcanthus angustipennis. Evidently not abundant. But few taken.

Œcanthus fasciatus. Quite abundant. Seems to be our most common form and is taken in numbers on wild sunflowers during autumn. Possibly the reason it seems more common is because of its abundance on these plants where it is noticeable and readily captured.

Oecanthus nigricornis Walk. Specimens apparently of this species occur with other forms, but are perhaps simply very dark forms of *fasciatus.*

Nemobius vittatus Harr. Very common and doubtless often destructive in meadows. It has been observed as especially abundant on hillsides with south exposure.

Gryllus abbreviatus. Very abundant, both indoors and out. Often injurious to clothing and doubtless destroys a considerable amount of vegetation, especially while in the larval stages.

Gryllotalpa borealis.

Gryllotalpa longipennis Scudd. This and the preceding species of Mole Cricket are evidently common at times, but from their habits seldom observed. The former has been sent us as injuring potatoes.

CATALOGUE OF THE HEMIPTERA OF IOWA.

HERBERT OSBORN, AMES, IOWA.

A first notice of the Hemiptera was presented to the Academy in December, 1887, and a second in 1889. The third installment was presented September, 1890, and comprised sixty-seven species. The previous lists, not having been published, it will make the catalogue of much greater value to combine them here. This group of insects is an exceedingly important one, containing many very injurious species. While many of the especially destructive forms have had extended notice, no list of the species occurring in the State has hitherto appeared. Even now it is impossible to present anything like a full list since many species have been collected that are yet undetermined, and some of them are certainly undescribed. Moreover, from the numerous species constantly added to collections and the species known to occur in adjacent territory we may be sure that many species still await the collector. It is believed, however, that the publication of the list at the present time will greatly assist in increasing our knowledge of the group and enable us more rapidly to complete a catalogue that shall be fairly complete. It has been considered best to include only those species actually seen or recorded by some competent authority. Many species could be included as probably occurring here, but to include them would make the list of small value as indicating geographical distribution.

SUB ORDER HETEROPTERA.

FAMILY SCUTELLIERIDÆ.

Homœmus proteus Uhl. Sometimes rather common, but apparently somewhat local in distribution.

Eurygaster alternatus Say. Not common.

FAMILY CORIMELÆNIDÆ.

Corimelæna nitiduloides Wolff.

Corimelæna lateralis Fab. Sometimes fairly common.

Corimelæna pulicaria Germ. Negro Flea Bug. Abundant. Sometimes destructive to plants and often troublesome on raspberries on account of its offensive odor.

FAMILY CYDNIDÆ.

Pangœus bilineatus Say. One specimen, Adams county.
Amnestus spinifrons Say. Two specimens, Ames, Iowa. Rare.
Amnestus pusillus Uhl. One specimen, Ames, Iowa.

FAMILY PENTATOMIDÆ.

Stiretrus anchorago Fab. Common, not abundant.
Perillus claudus Say. Occurs rarely in the State.
Podisus cynicus Say. Not abundant.
Podisus placidus Uhl. Rare.
Podisus spinosus Dallas. Abundant.
Podisus modestus Dallas. One specimen, Ames.
Liotropis humeralis Uhl. Quite rare; Ames, Iowa.
Podops cinctipes Say. Rare; Ames, Iowa.
Brochymena arborea Say. Common.
Brochymena annulata Fab. Common.
Neottiglossa undata Say. Not common.
Cosmopepla carnifex Fab. Common, sometimes injurious on grape; also reported destructive on potato.
Mormidea lugens Fab. Common.
Euschistus fissilis Uhl. Common.
Euschistus servus Say. One specimen. Loc. ?
Euschistus tristigmus Say. Common.
Euschistus variolarius Pal. Beauv. Abundant; our most common species.
Euschistus ictericus. One specimen, doubtless taken in the State, in collection of H. H. Raymond.
Cœnus delius Say. Rare.
Hymenarcys æqualis Say. Not common.
Hymenarcys nervosa Say. Usually rare.
Menecles insertus Say. Ames; rare.
Trichopepla semivittata Say. Not common.
Peribalus limbolarius Stal. Common. Frequents Golden Rod in autumn.
Thyanta custator Fab. Not common. This appears to be nearly its eastern limit for this latitude.
Nezara hilaris Say. Common.
Nezara pennsylvanica DeG.
Banasa euchlora Stal. One specimen.
Banasa calva Say. Not common.

FAMILY COREIDÆ.

Corynocoris distinctus Dallas. Common.
Archimerus calcarator Fab. Common.
Euthoctha galeator Fab. Common.
Metapodius femoratus Fab.
Metapodius terminalis Dallas.
Leptoglossus oppositus Say. One specimen from Winneshiek county.
Catorhinta guttula Fab. One specimen.
Banasa tristis DeG. "Squash Bug." Common, sometimes destructive, but usually much less abundant here than in eastern States or in Kansas.

Anasa armigera Say. Not abundant.
Alydus eurinus Say. Common.
Alydus ater Dallas. Variety of the preceding.?
Alydus 5-spinosus. Not common.
Alydus pluto Uhl.?
Protenor belfragei Hagl.

FAMILY BERYTIDÆ.

Jalysus spinosus Say. Not common, or but seldom seen.
Corizus hyalinus Fab.
Corizus nigristernum Sign. Common, often swept from low herbage.
Leptocorisa trivittatus Say. Common in the west part of the State, sometimes destructive to Box Elder trees.

FAMILY LYGÆIDÆ.

Nysius angustatus Uhl. False Chinch Bug. Very abundant at times; resembles chinch bug in size and form, but is of a light gray color. Feeds mainly on purslane, amaranths, etc., but may injure potatoes and other crops.
Orsillacis producta Uhl.? One specimen.
Ichnorhynchus didymus Zett. Not common; appears to be more plentiful westward.
Cymus angustatus Stal. Common.
Cymodema tabida Spin.
Ischnodemus falicus Say. Common.
Blissus leucopterus Say. "Chinch bug." Very abundant at times.
Geocoris limbatus Stal.
Geocoris bullatus Say. Common; affects sugar beets.
Œdancala dorsalis Say. Not common.
Ligyrocoris sylvestris Linn. Common.
Ligyrocoris constrictus Say. Several specimens from Des Moines.
Myodocha serripes Oliv. Rather rare.
Pamera basalis Dallas. Common.
Pamera bilobata Say. Rare.
Cnemodus mavortius Say.
Trapezonotus nebulosus Fall. Common.
Emblethis arenarius Linn. Not rare.
Rhyparochromus minutus Uhl. (MSS.)
Eremocoris ferus Say. Not common.
Microtoma carbonaria Rossi. Not rare; Ames, Iowa City, Des Moines.
Peliopelta abbreviata. Uhl. Common.
Melanocoryphus bicrucis Say. Rare at Ames.
Lygæus reclivatus Say. Common.
Lygæus turcicus Fab. Common.
Oncopeltus fasciatus Dallas. Not common.

FAMILY CAPSIDÆ.

Megaloceræa debilis Uhl. Abundant.
Megaloceræa rubicunda Uhl.
Miris affinis Reut. Common.

Leptoterna amœna Uhl. Common.

Trachelomiris oculatus Reut. Not abundant.

Lopidea confluens Say.

Phytocoris tibialis Reut. Ames.

Neurocolpus nubilus Say. Fairfax. Not common.

Compsocerocoris annulicornis Reut. Fairfax. Rhodes.

Calocoris rapidus Say. Very abundant; affects clover.

Oncognathus binotatus Fab. Ames and Fairfax.

Lygus pratensis Linn. "Tarnished plant bug." Very abundant and destructive, occurring on a great variety of plants.

Lygus plagiatus Uhl.

Lygus hirticulus Uhl.

Lygus invitus Say.

Lygus monachus Uhl.

Lygus ustulatus Uhl.

Coccobaphes sanguinarius Uhl.

Pœciloscytus basalis Reut.

Pœcilocapsus lineatus Fab. Common.

Pœcilocapsus goniphorus Say. Common.

Pœcilocapsus affinis Reut. Fairfax.

Pœcilocapsus marginalis Reut. Rather common.

Systratiotus americanus Reut. Fairfax.

Callicapsus histrio Reut.

Camptobrochis nebulosus Uhl.

Camptobrochis grandis Uhl. Rare.

Eccritotarsus elegans Uhl. Not common.

Sericophanes ocellatus Reut.

Hyaliodes vitripennis Say. Not common.

Ilnacora stalii Reut.

Malacocoris irroratus Say.

Halticus bractatus Say.

Stiphrosoma stygica Say.

Idolocoris agilis Uhl.

Macrocoleus coagulatus Uhl. A species agreeing with this, or very similar to it, occurs in abundance.

Plagiognathus pallipes Uhl.

Agalliastes associatus Uhl.

Agalliastes Sp.

FAMILY ACANTHIDÆ.

Triphleps insidiosus Say. Very abundant.

Acanthia lectularia Linn. "Bed-bug." Very abundant, *locally*.

Acanthia hirundinis Jenyns. Occurs in swallows' nests.

FAMILY TINGITIDÆ.

Piesma cinerea Say. Very abundant in 1887, occurring and breeding on Amaranth.

Corythuca ciliata Say. Abundant on Sycamore.

Corythuca arcuata Say. Common on Oak.

Gargaphia tiliæ Walsh. Common on Basswood.

Physatochila plexa Say. Fairfax.

Tingis clavata Stal. Fairfax.

FAMILY ARADIDÆ.

Aradus robustus Uhl. Abundant in 1886, *locally*.
Aradus similis Say.?
Aradus acutus Say.
Aradus americanus H. Schf. Common.
Aradus rectus Say.?

FAMILY PHYMATIDÆ.

Phymata wolfii Stal.

FAMILY NABIDÆ.

Nabis fusca Stein. Not common.
Coriscus subcoleoptratus Kirby. Common.
Coriscus ferus Linn. A very abundant species. Occurs in grass and preys upon a variety of injurious species.

FAMILY REDUVIIDÆ.

Sinea diadema Fab. Common.
Acholla multispinosa DeG. Common.
Fitchia nigrovittata Stal. Not abundant.
Milyas cinctus Fab. Common.
Diplodus luridus Stal. Not common.
Melanolestes picipes H. Schf. Common.
Melanolestes abdominalis H. Schf. Not common.
Pygolampis pectoralis Say. Rare.
Emesa sp. One specimen larva from Iowa City.

FAMILY HYDROBATIDÆ.

Hygrotrechus remigis Say. Common.
Hygrotrechus sp. One specimen.
Limnotrechus marginatus Say. Common.
Stephania picta H. Schf.
Metrobates hesperius Uhl. One specimen.

FAMILY VELIIDÆ.

Mesovelia bisignata Uhl. Once found quite plenty.
Hebrus pusillus Burm.

FAMILY SALDIDÆ.

Salda coriacea Uhl. One specimen.
Salda interstitialis Say. Common.
Salda humilis Say.

FAMILY BELOSTOMATIDÆ.

Zaitha fluminea Say. Abundant.
Belostoma americanum Leidy. Very common.
Benacus griseus Say. Easily confounded with *americanum*

FAMILY NEPIDÆ.

Nepa apiculata Uhl. Not common.
Ranatra fusca Pal. Beauv. Common.

FAMILY NOTONECTIDÆ.

Notonecta undulata Say. Common.
Anisops platycnemis Fieb.
Plea striola Fieb.

FAMILY CORISIDÆ.

Corisa alternata Say. Common.
Corisa Harrisii Uhl.

SUB ORDER HOMOPTERA.

JASSIDÆ.

Diedrocephala mollipes. Say. A very common species everywhere.

Diedrocephala noveboracensis Fitch. Quite common but more frequent near thickets or in rather rank herbage.

Diedrocephala coccinea Forst. Not an abundant species, the form distinguished as *quadrivittatus* by Say. is a quite well marked variety and apparently quite constant.

Tettigonia hieroglyphica Say. A very common form and quite variable presenting extremes of light green and also almost black in color.

Tettigonia bifida Say. But rarely taken.

Proconia costalis Fab. Received from Carpenter, Iowa. Not found in the central part of the state.

Dorycephalus Sp. An interesting species collected at Ames by Prof. Gillette.

Parabolocratus viridis Uhler, Not very common.

Helochara communis Occurs in the state but appears to be very much less common than in some parts of the country.

Gypona octolineata Say. A common species represented by varieties which doubtless include the forms described as *flavilineata* and *scarlatina* by Fitch. all of which seem to connect by intergrading forms with the typical *octolineata.*

Gypona colon Fitch. Rare. A well marked form.

Penthimia americana Fitch.

Acocephalus sp. An undetermined, probably underscribed, species occurs quite commonly on low herbage.

Scaphoideus immistus Say. Rather common.

Typhlocyba vitis Harris. The common and abundant Leaf Hopper affecting the grape.

Typhlocyba vitifex Fitch. Common.

Typhlocyba comes Say.

Typhlocyba basillaris Say.

Typhlocyba tricincta Fitch.

Typhlocyba obliqua Say.

Typhlocyba vulnerata Fitch.

Typhlocyba trifasciata Say.

Empoa albipicta Forbes.

Empoa fabæ Harr. A species very abundant on beans must belong to this species though no full description is at hand by which to reach a positive conclusion.

Empoa rosæ Harr. Doubtless common but as in preceding species available descriptions are meager.

Empoasca mali LeB. Common.

Empoasca obtusa (—?). Fairly common.

Deltocephalus inimicus Say. A most abundant and injurious species affecting grasses.

Deltocephalus debilis Uhl. Abundant and destructive in grass.

Deltocephalus Sayi Fitch. Common but not abundant.

Deltocephalus melsheimeri Fitch.

Deltocephalus Harrisii Fitch.

Deltocephalus retrorsus Uhl. (MS.)

Deltocephalus virgulatulus Uhl. (MS.)

Gnathodes punctatus Thunb.

Conogonus qagates.

Platymetopius acutus Say. This odd form is often to be found in considerable numbers.

Platymetopius frontalis VanD. Rare.

Grypotes unicolor Fitch. Common.

Athysanus curtisii Fitch. Taken in small numbers at Ames and Fairfax.

Athysanus striola Fall. Not common.

Athysanus obsoletus Kirsch.

Cicadula exitiosa Uhl. Common.

Cicadula 4-lineata Forbes.

Cicadula 6-notata Fall.

Phlepsius irroratus Say. A very common species here as well as throughout most of the United States and Mexico.

Phlepsius fulvidorsum Fitch.

Phlepsius spatulatus Van D. Not common.

Phlepsius nebulosus Van D. One specimen quite certainly collected in Iowa.

Eutettix jucundus Uhl. Rare. Specimens from Ames and Des Moines.

Paramesus sp. An interesting species undescribed.

Thamnotettix clitellarius Say. Rather common.

Thamnotettix seminudus Say. Common.

Thamnotettix melanogaster Prov. Common.

Thamnotettix kennicottii Uhl.

Cœlidia olitaria Say. Common.

Cœlidia subbifasciata Say. Quite common.

Idiocerus maculipennis Fitch.

Idiocerus alternata Fitch.

Idiocerus unicolor Fitch.?

Idiocerus provancheri Van D. (MS. ?)

Agallia quadripunctata Prov. Common.

Agallia sanguinolenta Prov. Very common, especially in clover.

Pediopsis insignis Van D.

Pediopsis tristis Van D.

Pediopsis viridis Fitch.

CERCOPIDÆ.

Clastopetera obtusa Say. Common.

Clastopetera proteus Fitch. Common.

Aphrophora quadrangularis Say. A very common species.

Aphrophora quadrinotata Say. Common at times, but not so constantly present as the preceding.

FULGORIDÆ.

Stenocranus dorsalis Fitch.

Stenocranus sp.

Delphax tricarinatus Say. Rather common.

Liburnia ornata Stal. Common.

Liburnia sp. approaches *vittatifrons.* Uhl., but is larger, darker and with longer wings than I have seen in specimens from other localities.

Cixius stigmatus Say. Not abundant.

Oliarus sp. An undertermined species; rather rare.

Helicoptera nava Say. Not abundant.

Ormenis pruinosa Say. Common.

Ormenis septentrionalis Spin. Am quite sure I have seen Iowa specimens of this common species, but have none at hand.

Amphiscepa bivittata Say. Quite common.

Bruchomorpha dorsata Fitch. Occasional.

Bruchomorpha oculata Newm. Rather rare.

Aphelonema simplex Uhl. More common than the preceding.

Lamenia vulgaris Fitch. Never noted as abundant.

Otiocerus signoretti Fitch. Seems to be our most common species of the genus.

Otiocerus wolfii Kirby.

Otiocerus stollii Kirby. Sometimes rather common.

Otiocerus amyotii Fitch.

Otiocerus degeerii Kirby. Not observed as common.

Phylloscelis pallescens Germ.

Scolops sulcipes Say. Sometimes rather common.

Scolops angustatus Uhl.

Scolops sp. A darker, longer winged form than either of the preceding is somewhat common.

CICADIDÆ.

Cicada tibicen Linn. The common "Dog Day Harvest Fly."

Cicada dorsata Say. One specimen from Poweshiek county brought in by a student.

Cicada rimosa Say. Specimens from Worth county and Tama county.

Cicada noveboracensis Fitch. Common, smaller than the preceding, and appears to me to be distinct though it has been regarded, by some writers, as a form of that species.

Cicada sepetendecim L. The seventeen year Cicada. Remarkable for the great length of its larval life. Two broods occur in the state, one occupying the eastern central portion and the other the south central portion.

MEMBRACIDÆ.

Ophiderma mera Say. Fairly common.

Ophiderma salamandra Fairm. Keokuk county. Probably will be found wherever black locust occurs.

Telamona reclivata Fitch.

Telamona monticola Fab. Not common.

Telamona ampelopsidis Harr. Not common. Perhaps this is identical with the preceding, but specimens in my collection show pretty distinct differences.

Telamona coryli Fitch (?). The single specimen at hand differs very slightly from Fitch's description which, however, is rather too meager for satisfactory determination.

Telamona acclivata Fitch. ?

Telamona cratægi Fitch (var. ?). Differs from Fitch's description and figure in lacking white band on back part of pronotum.

Telamona fagi Fitch (?). The outline of pronotum is a trifle different.

Telamona jugata Uhl. Apparently rather common.

Telamona fasciata Fitch.

Thelia acuminata Linn (?).

Thelia bimaculata Fab.

Thelia univittata Harr.

Thelia Uhleri Stal. Rather common.

Archasia galeator Fab.

Smilia vittata Am. et Serv. Several specimens from Waverly, Bremer county.

Cyrtosia vau Say.

Atymia querci Fitch. Rare.

Atymia inornata Say.

Ceresa diceros Say. Sometimes taken in numbers.

Ceresa bubalus Fab. A very common species and often destructive to trees by puncturing the twigs in depositing eggs.

Ceresa brevicornis Fitch. Not usually common.

Stictocepahala inermis Fab. Common.

Stictocephala festina Say. Probably same as the preceding but smaller and slightly different in form.

Entilia sinuata Fab. Quite common.

Publilia concava Say. Often abounds on *Helianthus* and other plants.

Enchenopa binotata Say. Common, not abundant.

Enchenopa curvata Fab. Common. Lives on clover.

Microcentrus caryæ Fitch. Rare, or at least seldom seen.

PSYLLIDÆ.

Livia vernalis Fitch.

Psylla quadrilineata Fitch.

Psylla carpini Fitch (?)

Pachypsylla celtidis-mammæ Riley. Very common on hackberry.

Pachypsylla sp. Very abundant on hackberry leaves.

APHIDIDÆ.

Siphonophora rudbeckiæ Fitch. A common species on Rudbeckiæ and a number of other compositæ.

Siphonophora ambrosiæ Thos. Reported from Sioux City by Dr. Cyrus Thomas, Third Rept. Ill. Ins. p. 50.

Siphonophora asclepiadis Fitch. A species common on milkweed is quite surely this species.

Myzus cerasi Fab. Very common on cherry.

Myzus persicæ Abundant on wild plum.

Myzus ribis Linn. Common on currant, producing curled and highly colored leaves.

Drepanosiphum acerifoliæ Thos. Common on Soft maple and a very similar form has been taken on the sycamore.

Aphis mali Fab. Common on apple.

Aphis pruni Koch. (?) I cannot say with certainty that this species has been observed though common plum plant lice would seem to belong here.

Aphis prunifoliæ Fitch. Common on plum.

Aphis rumicis Linn. On Wahoo, Pigweed, Shepherds Purse, and is recorded by authors as occuring on a variety of other plants in other states and will doubtless be found the same here.

Aphis maidis Fitch. Reported to me as occurring on corn.

Aphis brassicæ Linn. Very common on cabbage.

Aphis viburni Schr. On Snowball.

Aphis carduella Walsh. Common on thistle.

Aphis medicaginis Koch. ? Rare on clover.

Aphis cornifoliæ Fitch. Common on Cornus.

Monellia caryella Fitch. Collected once on hickory at Ames.

Chaitophorus negundinis Thos. Common on box elder.

Myzocallis (?) sp. A species apparently undescribed observed in abundance on wild rye, Elymus canadensis.

Callipterus sp. Collected from clover.

Callipterus (?) sp. Has been collected by Mr. F. A. Sirrine on Quaking Asp *Populus tremuloides.*

Melanoxanthus salicis Linn. Common on poplar and willow. It has been determined by Mr. F. A. Sirrine to migrate in fall from willow to poplar to deposit winter eggs, and the second agamic brood in spring to acquire wings and return to willow.

Lachnus salicicola Uhl. (?) Abundant on willow.

Lachnus dentatus LeBaron. Abundant on willow.

Lachnus longistigma Monell. Occurs on European basswood.

Schizoneura lanigera Hauss. No specimens of this species have been collected here, but specimens of what is very evidently its work have been sent me from various parts of the State.

Schizoneura cratægi Oest. Very plentiful on Thorn trees.

Schizoneura americana Riley. Common on elm, curling the leaves.

Schizoneura corni Fab. Very common on *Cornus* and is considered as identical with the *S. panicola* of Thomas, which occurs during summer and early autumn on grass roots.

Glyphina ulmicola Fitch. Quite common on elms, producing the "Cockscomb gall."

Pemphigus tesselata Fitch. Occurs on alder and has been sent to me from the northeastern part of the State.

Pemphigus acerifolii Riley.

Pemphigus populi-transversus Riley. On cottonwood.

Pemphigus populicaulis Fitch. Abundant on cottonwood.

Pemphigus vagabundus Walsh. Its galls often to be seen on cottonwood.

Pemphigus rhois Fitch. Common on sumac.

Pemphigus sp. On smilax.

Chermes pinicorticis Fitch. Sometimes abundant on pines.

Phylloxera vastatrix Planch. Common on grapes.

Phylloxera caryæ-foliæ Fitch. On hickory leaves, producing galls.

COCCIDÆ.

Aspidiotus ancylus Putnam.

Aspidiotus nerii Bouche. Common on oleander.

Diaspis cacti Comstock. On cactus in green-house.

Chionaspis furfurus Fitch. Common on a variety of trees and shrubs.

Chionaspis salicis Linn. Very abundant on willow and ash.

Chionaspis pinifolii Fitch. This species has been reported, but I have not seen it myself in the State.

Mytilaspis citricola Pack. Frequently seen on oranges and lemons in the market, and doubtless occurs on orange trees where grown in the State.

Mytilaspis pomorum Bouche. Common on apple.

Dactylopius adonidum Linn. Common "mealy bug" of green-houses.

Lecanium hesperidum Linn. Common on oleander, etc.

Pulvinaria innumerabilis Rathvon. Common on maple and other trees.

Kermes galliformis Riley. Common on oak.

Kermes sp. A species evidently different from the preceding has been collected several times.

Orthezia americana Walk.

Sub Order PARASITA.

PEDICULIDÆ.

Pediculus capitis DeG. A not infrequent insect in some places.

Pediculus vestimenti Leach. Not collected in Iowa, but should, doubtless, be recorded.

Phthirius inguinalis Leach. Occurs in Iowa as well as other States.

Hæmatopinus eurysternus Nitzsch. The most common suctorial louse of cattle.

Hæmatopinus vituli Linn. Less common than the preceding. Infests cattle.

Hæmatopinus urius Nitzsch. Common on hogs.

Hæmatopinus macrocephalus Burm. Occurs on horses; not common.

Hæmatopinus piliferus Burm. On dogs; not often seen.

Hæmatopinus suturalis Osborn. Very common on the ground squirrels Spermophilus tridecemlinatus and Franklini and also probably on the chipmunk Tamias striatus.

Hæmatopinus antennatus Osborn. Collected from fox squirrel.

Hæmatopinus sciuropteri Osborn. A very interesting species occurring on the flying squirrel *Sciuropterus volucella*.

Hæmatopinus hesperomydis Osborn. Occurs on the white-footed or deer mouse *Hesperomys leucopus* at Ames.

Hæmatopinus spinulosus Burm. On the rat, but not found in any great numbers; it is a very small species.

Hæmatopinus acanthopus Burm. Apparently common on our species of *Arvicola*.

Hæmatopinoides squamosus Osborn. Taken in very small numbers from the pocket gopher *Geomys bursarius*.

INDEX.

ERRATA.

Page 6 after line 7 insert, Meek S. E. Arkansas Unversity, Fayetteville, Arkansas.

Page 10, line 16 from bottom for *Strophystylus* read *Strophostylus*.

Page 10, line 3 from bottom for *Lacrosse* read *LaCrosse*.

Page 11, line 17 for *Templeleau* read *Trempleau*.

Page 16, line 8 from bottom for *volvanic* read *volcanic*.

Page 17, line 20 for *such* read *such*.

Page 30 in last title and article following for *Haine* read *Haime*.

Page 35, line 10 from bottom for *narrow-scale nohedral* read *narrow scalenohedral*.

Page 79 after No. 114 insert LILIACEAE.

Page 84, line 25 for *ingra* read *nigra*.

Page 86, line 5 for *morman* read *mormon*.

Page 86, line 23 for *thelyteroides* read *thelypteroides*.

Page 86, line 26 for *laricinva* read *laricina*.

Page 89, line 9 from bottom omit parenthesis around Lawler.

Page 89, line 6 from bottom for *rafnesquii* read *rafinesquii*.

Page 92, line 20 for *northwest* read *northeast*.

Page 92 for *Normany* read *Norman*.

Page 93, line 5 for *Sylioge* read *Sylloge*.

Page 93, line 16 for *Calaviceps* read *Claviceps*.

Page 93, line 23 for *medicagius* read *medicaginis*.

Page 93, line 26 for *Cladasporium* read *Cladosporium*.

Page 94, line 6 after *Ustiliginiae* omit all of that line and insert the line following and for *madis* read *maydis (D. C.) Corda*.

Page 94, line 24 italicize *striaeformis*.

Page 94, line 35 for *thea ction* read *the action* and for *is rendering milk sour* read *is to render it sour*.

Page 95, line 2 at end place period and line 3 read Cultures.

Page 95 after title Corn Smut read Abstract, L. H. Pammel.

Page 95, line 8 for *zea-mays* read *maydis*.

PROCEEDINGS

OF THE

IOWA ACADEMY OF SCIENCES

FOR 1892.

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Herbert Osborn, Ames, Iowa.

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The seventh annual session of the Iowa Academy of Sciences was held in the High School building at Cedar Rapids December 27 and 28, 1892.

The following papers were presented:

S. Calvin—"The Relation of the Woodbury Sandstones and Shales and the Inoceramus Beds of White to the Subdivisions of the Cretaceous proposed by Meek and Hayden;" "Note on the Structure and Probable Affinities of Cerionites dactylioides Owen."

C. R. Keyes—"Natural Gas and Oil in Iowa;" Some Mineralogical Notes;" "Surface Disintegration of Granitic Masses;" "Some American Eruptive Granites."

J. L. Tilton—"Strata Between Ford and Winterset."

C. O. Bates—"The Analysis of Water for Railway Engines."

F. M. Witter—"Some Observations on Helix cooperi;" "On the Absence of Ferns between Fort Collins and Meeker, Colorado;" "Notice of Stone Implements from Mercer County, Ills., and Louisa County, Iowa."

Gilman Drew—"Some Reason Why Frogs are Able to Survive."

C. C. Nutting—Presidential Address—"What We Have Been Doing;" "Report of Committee on State Fauna;" "The Significance of the Concealed Crests of the Flycatcher."

L. H. Pammel—"Phænological Notes for 1892;" "Relation of Frost to Certain Plants;" "Notes on the Flora of Texas;" "Pollination of Cucurbits."

F. C. Stewart—"Palisade Cells and Stomata of Leaves;" "A Key for the Identification of Weed Seeds found in Clover Seed."

F. Reppert—"Notes on the Flora of Muscatine."

W. B. Niles—"Preliminary Observations on a Cattle Disease of Frequent Occurrence in Some Parts of Iowa."

F. W. Mally—Preliminary List of the Saw-flies of Iowa."

H. A. Gossard—"Observations of Insects Taken in Clover."

Herbert Osborn and F. A. Sirrine——"Notes on Aphididæ."

Herbert Osborn—"On the Life-Histories of Certain Jassidæ;" "Notes on the Catalogue of the Iowa Hemiptera."

A talk on a Collecting Trip to Southern Mexico, illustrated with Lantern Views.

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THE RELATION OF THE CRETACEOUS DEPOSITS OF IOWA TO THE SUB-DIVISIONS OF THE CRETACEOUS PROPOSED BY MEEK AND HAYDEN.

BY S. CALVIN.

The cretaceous deposits of Woodbury and Plymouth counties are composed of sandstones. shales and certain calcareous deposits. The heavier beds of sandstone belong to the basal portion of the series, barely rising higher than forty feet above the level of the water in the Big Sioux river. The part of the column to which these heavier sandstones are confined is, however, not all sandstone, but consists of arenaceous beds alternating with beds of argillaceous shales. Above the more massive sandstones the beds, for a vertical distance of fifty to sixty feet, contain streaks and thin layers of sand, but shales preponderate. In certain typical exposures these alternating beds are followed by from thirty to forty beds of pure shales, dark in color, smooth and unctuous to the feel, and containing the remains of saurians related to *Plesiosaurus*, teleost fishes, and, in the uppermost beds, impression of Inoceramus. At the summit of the column, overtopping shales and sandstones alike, are the calcareous beds to which allusion has been made. These consist, in part, of soft, chalky material and in part of more indurated, though still soft, beds of fissile limestone that divides under the hammer or on exposure to the weather, into relatively thin laminæ crowded with detached valves of *Inoceramus problematicus* Schlot.

In the portion of the section between the massive sandstone and the saurian-bearing shale the beds are not everywhere constant. In some places they contain thin bands of ferruginous concretionary sandstone. At Riverside, for example, and at the works of the Sioux Paving Brick Co., there is a mass of rather thin bedded calciferous sand-rock in the upper part of this division, developed to a thickness of eighteen feet.

A generalized section of the beds along the bluffs facing the Big Sioux river, omitting some minute details and averaging local peculiarities of certain beds, would be, beginning at the base of the series:

1. Irregular beds of sandstone varying in color and texture and interstratified with thin beds of shale.................. .... 18 ft.
2. Grayish and mottled shales with thin ferruginous bands and arenaceous layers..... .... 12 ft.
3. Massive sandstone, mostly soft; but in places containing large concretionary masses several feet in diameter in appearance and hardness resembling quartzite. .... 10 ft.
4. Shales with usually two, but sometimes more, well marked thin bands of ferruginous concretionary sandstone ("Buttons" of the clay workers) 16 ft.
5. Band of impure lignite...4 to 6 inches.
6. Blue, yellow and red mottled clays (terra cotta clays), with selenite crystals and some streaks of sand.. 30 ft.
7. Argillo-calcareous or arenaceo-calcareous beds with much selenite (varying with locality)........... .... 20 ft.
8. Shales more or less unctuous to the feel, somewhat variable in color and texture, containing remains of saurians and teleost fishes, the upper beds sometimes bearing impressions of *Inoceramus problematicus*..... 40 ft.
9. Calcareous beds consisting of chalk and soft, thin bedded limestone, containing shells of *Inoceramus problematicus*, *Ostrea congesta*, and teeth of *Otodus*, *Ptychodus* and other selachians.......................... 30 ft.

Beds that are quite constant and easily recognizable in the region about the mouth of the Big Sioux river are No's, 3, 4, 5, 8 and 9. These, either singly or collectively, become the guides whereby the beds of the several exposures may be correlated. The deposits were traced up the Big Sioux valley for a distance of forty miles; they were followed up the Missouri river as far as Yankton.

In addition to the deposits exposed on the Big Sioux, Dr. C. A. White, under the name of the Nishnabotna sandstone, refers to the Cretaceous age a series of sandstones developed to a thickness of 100 feet along the river valleys in Montgomery, Cass, Guthrie and Greene counties. Referring to the work done by Meek and Hayden on the Cretaceous deposits along the Missouri river, and noting the names employed by these authors to designate the various sub-divisions of their "Earlier Cretaceous," Dr. White* says: "The Cretaceous strata, of Iowa, have so slight a development in comparison with those farther up the Missouri river

*Geology of Iowa, Vol. I., p. 288, 1870.

that it is difficult to determine their stratigraphical equivalents without actual comparison, which it has thus far been impossible to make. There is no doubt, however, that all the Iowa Cretaceous strata belong to the "Earlier Cretaceous" of Meek and Hayden, nor any doubt that the lower portion of ours is equivalent to a part of their Dakota group."

Without attempting, therefore, to synchronize the Cretaceous of Iowa with the Cretaceous formations studied by Meek and Hayden, Dr. White applies to all the strata at Sioux City lying below the chalk, the name of *The Woodbury Sandstones and Shales*, while the calcareous deposits, composed of chalk and soft Inoceramus-bearing limestone, he calls the *Inoceramus Beds.*

Below the mouth of Iowa Creek, about three miles east of Ponca, Nebraska, the Missouri river washes the foot of a high bluff in which Cretaceous strata, identical in all essential respects with those seen in Iowa above the mouth of the Big Sioux, are exposed to a height of more than a hundred feet. The several beds of the preceding section, from 2 to 8 inclusive, are easily recognized, and at the summit of the section, cropping out from beneath the thick mantle of loess, are indications of the chalky beds of number 9. Farther up the river, almost directly north of Ponca, there is another splendid natural section which is more than a mile in length and at least 150 feet in height. At the base of the section are the beds seen below the mouth of Iowa Creek, while above all the sandstones and shales lie from twenty-five to thirty feet of rather hard chalk and Inoceramus-bearing limestone. There can be no doubt that the beds near Ponca, Nebraska, are the exact equivalents of beds in Iowa. Indeed, one may look away from the exposure at the bend east of Ponca, across the plain which is here the combined valley of the Missouri and Big Sioux, for a distance of only ten or twelve miles to the corresponding exposures in Iowa. In the two bluffs that look toward each other from opposite sides of the plain, you may trace the same succession of strata that, but for the erosion of the two great streams, would still be continuous across the intervening space. Furthermore, the beds are about equally well developed on both sides of the valley.

Now, the exposure at the bend of the Missouri three miles below Ponca, Nebraska, is described in detail by Hayden.* The chalky, marly or calcareous beds, which are the exact equivalent of the Inoceramus beds of Iowa, are referred to the Niobrara group. The dark colored shale, identical with number 8 of the preceding section, is called the Fort Benton group, while all the complex mass of alternating sandstones and shales in the basal portion of the exposure is recognized as belonging to the Dakota group.

Between Ponca and St. James, about thirty miles on a direct line further up the Missouri, the chalky beds of the Niobrara group crop out on all the higher hill tops. The village of St. James is situated in the valley of Bow Creek, below the level of the chalk. In the eastern edge of the village is an exposure of Fort Benton shales presenting the same characteristics as seen at a recent land slide on the farm of Williams and Smith, a few miles north of Sioux City, in Iowa, and at the exposure near Ponca, Nebraska. This shale furnishes a very perfect skeleton of a saurian, as it was penetrated in digging a cistern on Sect. 35, T. 90, R 47., on the Iowa side of the Big Sioux. Another similar skeleton that was carried about the country some years ago for exhibition purposes, was taken from the same horizon near Ponca. A few weeks before my visit a portion of a skeleton, forty feet in length, was uncovered in excavating in Fort Benton shales near St. James. On

*First Annual Report of the United States Geological Survey of the Territories. 1867, pp. 47 and 48.

the tops or the hills near Bow Creek, the dark Fort Benton shales are succeeded by white or cream-colored chalk of the Niobrara division.

St. Helena, about eight or nine miles above St. James, is situated on a higher bluff, one hundred and thirty or one hundred and forty feet above the level of the Missouri river. The bluff rises as a vertical wall almost from the edge of the water. Between the river and the vertical escarpment, the base of the bluff is concealed by a talus composed chiefly of great blocks of chalk, but above the talus, and rising to a height of forty feet above the level of the water, is an excellent exposure of the dark shales of the Fort Benton group, differing in no essential respect from the corresponding shales exposed at the land slide above the creamery of Williams and Smith, or the shales occupying the same stratigraphical position near Ponca and St. James. Above the Fort Benton shales lie ninety feet of soft chalk belonging to the Niobrara. The Niobrara beds at St. Helena exhibit some points of difference from those seen on the Big Sioux, or on the Missouri across the valley in Nebraska. The valves of Inoceramus are no longer present in such numbers, but some of the layers are crowded with *Ostrea congesta*. One impression of the peculiarly corrugated muscular scar of *Haploscapha grandis* was noticed. The beds are uniformly chalky throughout, no part of the deposit being as much indurated as the Inoceramus-bearing beds near Ponca and Sioux City. The exposure at St. Helena is probably one of the most striking and interesting along the river, and Hayden refers to it time and again in the work already cited.

At Yankton, South Dakota, a short distance above St. Helena, and on the opposite side of the Missouri, the Niobrara beds are developed in great force. A large factory has been established about three miles west of Yankton to utilize the chalk in the manufacture of Portland cement. The part of the formation at present worked into cement lies above that exposed in the bluffs at St. Helena. It presents a breast about forty feet high. Below the base of the present working the chalk is known to descend to a depth of about ninety feet. The Fort Benton shales have disappeared beneath the level of the river; at all events they lie below the level of any observed exposures. On the hilltops above the cement factory the chalk of the Niobrara is overlain by the shales of the Fort Pierre group. Hayden speaks of this group as making its appearance on the summit of the hills, near the mouth of the Niobrara, but he might have found it thirty miles farther east developed to a thickness of fifteen or twenty feet.

The shales of the Fort Pierre group above the chalk, and of the Fort Benton group below, are highly charged with crystals of selenite, and selenite is by no means uncommon in the shaly portions of the Dakota group near Ponca and Sioux City.

With reference to the taxonomy of our Iowa section, beds 1 to 7 inclusive are the stratigraphical equivalents of beds near Ponca, Nebraska, which Hayden refers to the Dakota group. No. 8 includes beds that at Ponca and St. Helena have been referred to the Fort Benton group by the same author, and the *Inoceramus beds* No. 9, are the exact equivalents of the lower twenty or thirty feet of the Niobrara group. A part of the Inoceramus beds near Sioux City is soft and chalky; but a part as has been said, is harder, though by no means as hard as ordinary limestone. At St. Helena, Nebraska, and, so far as known, at Yankton, South Dakota, the beds are chalky throughout, the difference being doubtless due to the fact that the Sioux City area was nearer the shore line of the Cretaceous sea in which the beds were deposited. At Ponca, Inoceramus is about as common as at Sioux City, but the strata in which the cells are embedded are lithologically intermediate between the condition of the Inoceramus-bearing layers at Sioux City and the condition observed in the basal parts of the Niobrara group at St. Helena. Furthermore, the beds referred by Hayden to the Dakota and Fort Benton groups are as well developed at Sioux City as at Ponca. At Sioux City, however, we have only the attenuated edge of the Niobrara, but that fact in no way disqualifies so much as is developed from being the stratigraphical equivalent of the lower portion of the group as seen in greater force farther up the river.

The three divisions of the Cretaceous recognized at and near Sioux City in reality represent continuous sedimentation over a gradually subsiding sea bottom. The sandstones and shales of the Dakota group, with respect to the lower portions at least, were accumulated in a rather shallow land-locked sea. Currents swept the sand back and forth, sometimes building up, and again tearing down, previously constructed beds, and so produced the fine examples of cross bedding or current structure, so well illustrated near Springdale, a few miles northeast of Sioux City. The few molluscan species found in the lower part of the Dakota group indicate the presence of brackish water. The numerous vegetable remains which characterize the group imply that the large volumes of drainage waters which maintained the conditions favorable to the existence of brackish water mollusks, carried not only sand but swept in leaves and trunks of the willow, poplar, magnolia, and other forest trees, from the adjacent lands.

As the waters became gradually and progressively deeper, owing to subsidence of the sea bottom, the conditions favoring the acummulations of sandstones and the existence of brackish water mollusks disappeared. The shore line was shifted farther to the east. The sediments of the region about Sioux City became finer and settled down in regular layers beyond the reach of disturbing currents. The downward movement of the sea bottom seems not to have been altogether constant during the epoch of the Dakota group. There were occasional oscillations that from time to time permitted the formation of thin beds of sandstone, but before the close of the epoch the amount of sand that reached as far as Sioux City was insignificant, and fine clay shales greatly predominated. The shales of the Dakota group gradually merge into those of Fort Benton. During the second epoch the subsidence had carried the shore line so far to the east that all coarse sands were deposited before reaching the area in question. Before the Fort Benton epoch began the brackish water estuary had long been transformed into a portion of a clear open sea. At all events, during the epoch true marine mollusks, such as Inoceramus and Ostrea, had supplanted Cyrena and Margaritana, while marine saurians and teleost fishes multiplied and became the dominating types of the oceanic realm.

The soft limestone and softer chalk of the Niobrara group are indicative of still deeper waters and remoter shores. During this epoch no gross sediments from the land reached as far as Sioux City. Not since the earlier part of the Dakota group had it been possible for leaves and twigs of forest trees to be carried into the region. It was during this Niobrara epoch that the subsidence reached its maximum, and the maximum extension eastward of the Cretaceous sea was attained.

Toward the close of this epoch the upward movement of the land began, the sea withdrew, and shales of the Fort Pierre group were deposited above the chalk from Yankton westward.

When we recall the fact that the three groups recognized at Sioux City and Ponca represent the effect of continuous sedimentation over a subsiding sea bottom it will be seen that the question of dividing the sediments into distinct groups at all is simply one of convenience. Furthermore, any lines that can be drawn between the divisions, if divisions are to be made, must be to a large extent purely arbitrary. The upper portions of the Dakota merge gradually into the Fort Benton, while the Fort Benton group passes by gradual transition paleontologically, and in some places lithologically, into the calcareous beds of the Niobrara.

Farther west, where the sea was deeper and the conditions presumably more uniform, the distinctions between some of the groups cannot be maintained, and King has combined the deposits of the Fort Benton, Niobrara and Fort Pierre epochs under the single designation of the Colorado group. Hayden acquiesces in this arrangement in his annual report for 1874; but later, in his report for 1877, he makes the Colorado group include only the Fort Benton and the Niobrara, while the two upper divisions, the Fort Pierre and the Fox Hills, are united under the name of the Fox Hills group. The Dakota group with its coarse sandstones and leaves of forest trees is still recognized as a distinct division.

And this leads to another consideration that is of wide reaching importance in the correlation of synchronous geological deposits. The sandstones at the base of the Dakota group near Sioux City owe their physical and even their paleontological characters to conditions prevailing near the shore. As the bottom subsided and the shore was moved farther to the east, the character of the deposits at Sioux City changed, but coarse, cross-bedded sandstones and other littoral deposits, charged with leaves and twigs of forest trees, must still have been formed in proximity to the new shore line. Even while the chalk and limestone of the Niobrara epoch were being precipitated over western Iowa from solution in clear sea water that contained no trace of sediments, sandstones and shales, containing numerous impressions of leaves and branches of terrestrial plants, must still have been piled up along that most remote eastern shore. But if the shore deposits of the Niobrara epoch could now be found, it is probable that every competent geologist or paleontologist would refer them unhesitatingly to the Dakota group. Deposits absolutely synchronous may present very wide extremes of lithological and paleontological characteristics. It is possible, I think, to recognize a law which I have not seen expressly formulated, but which may run something in this wise: *Synchronous deposits of the same geologic basin are more likely to present uniform lithological and paleontological characters, if the geologist traces them along a line parallel to the shore of the basin. If the observations are made along the line that is radial to the geologic basin, or at right angles to the trend of the shore, the different parts of absolutely synchronous beds are almost certain to vary in lithological and paleontological characteristics so much as sometimes to make it appear that different parts of the same bed belong to different geologic epochs.*

This law may have greater force in connection with the study of Mesozoic and Cenozoic strata than in the study of the more ancient terranes, but even among the Paleozoics it must frequently have an important application.

ON THE STRUCTURE AND PROBABLE AFFINITIES OF CERIONITES DACTYLIOIDES OWEN.

BY S. CALVIN.

In his *Report of a Geological Exploration of a part of Iowa, Wisconsin, and Illinois*, made under instructions from the Secretary of the Treasury of the United States in the autumn of the year 1839, Dr. David Dale Owen describes and figures a small fossil from the "Coralline beds of the Upper Magnesian Cliff Limestone of Iowa and Wisconsin," under the name of *Lunulites? dactioloides*. The report was printed in June, 1840, and was reprinted with some additions and emendations in 1844. The fossil in question, *Lunulites? dactioloides*, is described briefly, as follows, on page 68: Truncated spherical, with five or six sided cellular depressions in rows around the circumference, like those on a thimble, one inch and a quarter in circumference." The illustration of the species, Figure 4, Plate XIII, exhibits a fossil with a spherical surface marked by rounded pits arranged quincuncially. The pits are relatively large and separated from each other by thick walls. Owen's figure is indeed a very imperfect illustration of the fossil as we now know it; and were it not for the text which describes the cellular depressions as five or six sided, and the fact that no other spheroidal fossils having the surface marked by polygonal depressions are known from the horizon of the Niagara limestone, the forms we have studied might never have been identified with Owen's species. The identification was first made by Meek and Worthen who, in the Geology of Illinois, Vol. III, page 345, give the results of their study of this species under the name of *Pasceolus? dactylioides* Owen. They recognize the difference between the form they describe and Billings' genus *Pasceolus*, but without deciding the zoological relationship of the form under consideration, and even without settling the question of whether it was an external or internal cast, they propose for it the new generic name of *Cerionites*.

In the fourth volume of the Geology of Wisconsin, page 267, Prof. R. P. Whitfield effects another change in the spelling of the specific name, and discusses the characters of the species in question under the head of *Cerionites dactyloides* Owen, although in the description of Plate XIII, Whitfield allows the name to stand as *Cerionites dactiloides*.

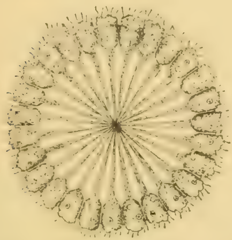
Concerning the specific name I think it must be evident that Owen intended to use a term implying, not that the fossil described was *like a finger*, but that it was *like a thimble*—something to put on the finger. The word that comes nearest to standing for thimble may be spelled with our Roman letters *dactulios* from which we may derive dactilioides, the form in which Owen probably intended to write it, or *dactylioides*, the more correct spelling employed by Meek and Worthen.

Cerionites is found in Iowa about the middle of the Niagara limestone, being most plentiful at the horizon represented by the exposures near Maquoketa, in Jackson county. The matrix is a buff or yellowish dolomite, and the fossil itself as usually found, and as it was seen by Owen and Messrs. Meek and Worthen, is a more or less compressed sphere, from three-fourths of an inch to an inch and a half in diameter, composed of the same material as the matrix, and marked on the surface by shallow pits that are usually six sided, though the number of sides may vary from four to seven. The pits vary also in size, although the relations are not absolutely constant; still in general the larger pits belong to the larger individuals. A small tubular opening descends from the bottom of each pit to the center of the sphere. For a good illustration of the usual appearance of the fossil the reader is referred to the Geology of Illinois, volume III, plate 5, figure 2c.

The appearance of the fossil varies with the conditions under which it was preserved. There are also differences of appearance due to variations in modes of growth. Meek and Worthen recognize an upper and a lower side differing in respect to size and character of the pits. Whitfield speaks of a point of attachment. From a study of a large series of individuals we may now demonstrate that the normal colonies of *Cerionites*, when alive, were spherical, unattached bodies, in which the structures now indicated by the pits were similar in size and other characteristics over the entire surface. On the surface of a number of our specimens we have a series of prisms, about a tenth of an inch in length, with their inner rounded ends resting in the concave pits. These prisms, which correspond in number and size with the pits of the surface, as we usually see it, are very loosely attached to the body of the fossil and to each other; indeed, it is evident that between the individual prisms, and between the ends of the prisms and the bottoms of the pits, their laminæ of some sort have been dissolved out. Moreover, the prisms are of the same material as the matrix, and also of the same material as the fossil itself.

Now, in all our dolomites the fossils are usually in the form of casts. Chitinous and calcareous structures are dissolved away, and the places these structures occupied are, in a majority of instances, vacant; what was hollow in the original fossil has been filled with the material of which the embedding rock is constituted, and what was solid is simply an unoccupied space. Bearing these facts in mind we can easily restore the original solid parts of *Cerionites*. All the solid parts of our present fossils of this genus from Iowa were hollow. The vacant spaces between the prisms referred to, and between the wounded ends of the prisms and the bottom of the shallow pits were occupied by these laminæ of chitinous or calcareous matter. The small opening leading from the bottom of each pit toward the center of the sphere was occupied by a slender cone that was probably hollow, especially at its larger outer end. The spaces now occupied by the prisms were hollow and bounded by their walls, constituting the laminæ already mentioned; so that we would get, as a result of our efforts to restore the solid parts of the original organism, a number of shallow, polygonal coherent cups, with thin chitinous walls, so arranged as to enclose a spherical space, each cup sending toward the center of the sphere a slender radial tube or rod of the same chitinous material. The tubes or rods were certainly very delicate at the center of the stem, at which point they were probably all more or less intimately united and from which they diverged as radii, one to the bottom of each cup.

Cerionites, therefore, was a colony of individualized units of some sort. Each separate individual was surrounded by thin chitinous or calcareous theca, that took the form of a shallow polygonal calyx. Each was united to the center of the sphere, the point at which growth began, and from which it proceeded outward along radial lines, by a slender thread of protoplasm which was also inclosed in a delicate chitinous sheath. The colony was free, and doubtless moved through the water with the graceful rolling motion that characterizes colonies of *Uvella* and *Synura*. The movements of the still more beautiful and much more familiar *Volvox globator* will convey to users of the miscroscope a correct idea of a mode of locomotion I fancy they might have witnessed, without the aid of the "tube," in all the sheltered covers of the Upper Silurian period where Cerionites congregated. It is probable that the skeleton was chitinous rather than calcareous. It was flexible enough to undergo extensive deformation without breaking, and exposed parts were frequently decomposed before the entire structure was embedded.



Ideal section of Cerionites (original).

The zoological position of *Cerionites* is less clear than the structure of its skeletal parts. It is scarcely probable, however, that the zooids that inhabited the delicate chitinous thecæ, attained the rank of *Hydrozoa*. It seems more probable that they were rather gigantic *Protozoa*. At all events I know of nothing to render such a view improbable. Some of our modern protozoa are about as large as the smaller individuals of *Cerionites*. Individuals of the genus *Noctiluca* are often a twentieth of an inch in diameter, and the gigantic *Actinosphæria* to which I called attention in the *American Naturalist* for 1890 (Vol. 25, page 934), are even larger. Many of the *Protozoa* secrete a chitinous case or lorica. Many, as *Uvella* and *Synura*, live in spheroidal colonies in which the individuals are attached by bands of more or less modified protoplasm, to the center of the sphere, and in *Synura*, each zooid is contained in a separate membranous sheath which takes the form of calices here conceived to have been present in *Cerionites*. Figures 12 and 13, plate i of Kent's *Manual of the Infusoria*, representing *Megosphæra planula*, approximate very closely the figures that must be made to express my conception of a living colony of *Cerionites*. The figure accompanying this paper is simply an attempt to represent diagramatically an ideal section of such a colony.

NATURAL GAS AND OIL IN IOWA.

BY CHARLES ROLLIN KEYES.

During the past decade no geological question has awakened more popular interest than that of the possibility of finding natural gas and petroleum within the limits of the State. In a number of places shallow borings have yielded from time to time sufficient quantities of natural gas for local use. At some of these places the citizens are kept constantly in a feverish state of expectancy which is ever ready to burst beyond all reasonable bound at the slightest provocation There is scarcely a county in the State where the problem has not been agitated to a greater or less extent. Some have even gone to considerable expense in testing but without success.

The excitement occasioned by the discoveries of gas and oil in Pennsylvania, Ohio and Indiana was second only to that of gold in California. The rapidity with which the new fuel was utilized everywhere is fresh in the minds of many. The complete revolutions wrought in the various industries are familiar to all.

With gas and oil in abundance in the neighboring states; with a close similarity of geological formations; with an expectant people already testing in different parts of the State, the question naturally arises: What are the probabilities of obtaining these substances in Iowa?

Before attempting an answer, however, it may be desirable to review briefly the conditions of a successful flow. These conditions fall under two heads:

(1) The Origin.

(2) The Accumulation.

Origin.—The different theories concerning the origin of natural gas and mineral oil need not be considered in detail here. Nearly all geologists now believe that organic matter buried in the rocks at the time they were laid down is the real source of petroleum; some regarding it as a kind of distillation through means of moderate heat; some, as the result of decomposition.

Manner of Accumulation.—Contrary to popular opinion petroleum is a widely distributed substance. The well known dolomites of Chicago contain large quantities. Orton has shown that the Waterlime formation, of Ohio, which is a compact magnesian limestone having a thickness of 500 feet in places, contains not less than 2,500,000 barrels of oil to the square mile. This is rock through which the oil is disseminated so as to be perfectly unavailable; yet, if it could be gathered into one place that contained in only three townships would equal nearly 260,000,000 barrels, or the total amount obtained from the Pennsylvania and New York oil field up to the year 1885. Now, in Iowa there are doubtless rocks as rich in oil as the Ohio Waterlime. The Lower Carboniferous limestones in the southern part of this State are good examples.

With oil almost universally distributed, what are the conditions of its accumulation in quantities of commercial value? For the financial success of an enterprise of this kind four conditions must be fulfilled. The absence of any one of them can only result in failure. There must be:

(1) A suitable receptacle or reservoir to allow the oil and gas to accumulate.

(2) A non-porous cover to retain these substances.

(3) A particular geological structure or arrangement of strata.

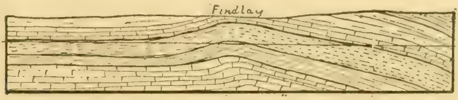
(4) A pressure sufficient to force the oil and gas to the surface.

The Reservoir is commonly a coarse sandstone, conglomerate or porous limestone. There rocks allow the ready transmission of liquids or gases from one part of a stratum to another.

In order that the gas or oil may be retained within the porous stratum, some close grained rock must overlie it. This impermeable layer is usually found in some shale.

Thus far the origin and conditions of accumulation of the oil and gas are to be found almost everywhere on the globe to a greater or less extent—wherever the stratified rocks are laid down. With all these conditions fully satisfied there is another very important factor—geological structure. The rocks must be tilted.

This causes in the porous rock a movement of the water, oil and gas particles—a free mechanical rearrangement. They accumulate in order of their specific gravity—the water at the bottom, then the oil and then the gas at the top. The particular structure of the earth's crust must be ordinarily an arch or anticline. The structure of the great oil belt at Findlay, Ohio, is as follows:



Cross section of the Findlay region. (After Orton.)

It is readily seen that having arranged themselves according to their specific gravities the gas occupies the central portion of the arch, the water the bottom and the oil a space between. When the top of the dome is pierced gas escapes; when the arch a little farther down is drilled into out flows oil; and if the strata near the base of the bow are penetrated only water appears. The formation of the arch is due to the same causes that elevates the mountains. A section accross the Appalachians to the Mississippi river shows sharp folds near the center of the uplift. In passing westward the folds get lower and lower until near the great river the strata are almost horizontal.

General section from the Appalachian to the Mississippi River.

In Pennsylvania and West Virginia some of the anticlines are so sharp that the top of the arches are fractured. If ever any gas had accumulated there it escaped long ago. In Ohio the folds are relatively low. They would not be impressed in existing topography, for erosion obscures geological structure of this kind by leveling the country—the elevations much more rapidly than the lowlands.

The next condition to be considered is the presence of rock pressure, as the Pennsylvania drillers term it. It only needs to be stated that according to the best evidence now at hand the pressure is artesian or hydrostatic and is measured by height of the column of salt water that would rise in any well were water struck instead of gas.*

Such, then, are briefly the conditions, the fulfilment of which are necessary for a successful flow of gas and oil of economic value.

Now, which of these conditions are satisfied within the limits of Iowa? Which are not, if any? What are the prospects of striking either substances under consideration in the State?

It has already been shown that large quantities of petroleum are doubtless disseminated through Iowa's rocks, just as elsewhere—the direct evidence being the actual presence of considerable amounts of hydrocarbons.

There is little doubt but that the porous strata or reservoirs and the shale coverings are present. This is indicated by artesian wells already put down in the different parts of the State, as well as by the succession of the beds observable in the northeastern part of the State.

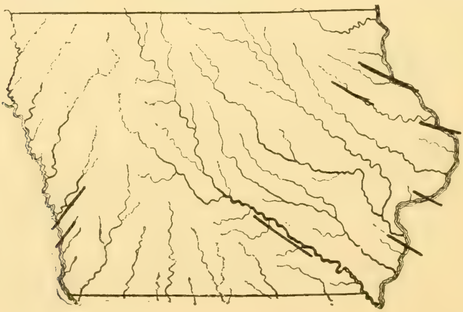
* The preceding remarks on the accumulation of the hydrocarbons are condensed largely from Orton and White who have done more than any other persons to place the oil and gas industry on a scientific basis.

The pressure is sufficient, as is known from several sources.

There remains yet one necessary condition unsatisfied. That is geological structure.

It is well known that the strata in Iowa have a general dip to the southward—the total amount of fall being probably in the neighborhood of 3,500 feet. But the State of Iowa is covered everywhere with a thick mantle of glacial deposits hiding from view the stratified rocks almost entirely. Numerous streams, however, have corraded their channels completely through the drift debris even into the underlying indurated rocks, thus exposing in many places the arrangement of the different layers. It will be sometime before anything like accurate and detailed cross-sections can be made across the State in the direction of the common inclination of the rocks. Yet good progress in this work has already been made.

There is a widespread opinion that the Iowa strata have still their uninterrupted seaward tilt unaffected by deformations of any kind. Such, however is not the case. Although far removed from mountainous districts orographic movements have affected the beds to a slight extent, producing low folds. A number of these low anticlines and shallow synclines have long been known, though rather vaguely. According to McGee, who has indicated recently some of the chief axes in a sketch map of the State, the anticlinals of the eastern part of Iowa trend southwestward. Other folds have been recognized in the central and western portions



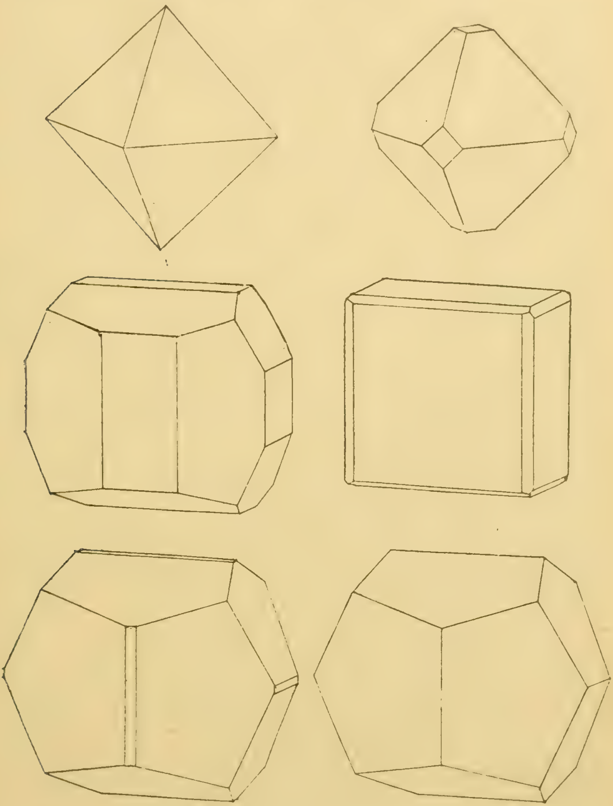
Sketch-Map of Iowa, showing Principal Lines of Deformation.

of the State. The extent of this folding is at present unknown, but in some cases it may prove to be very considerable; sufficient perhaps to satisfy the last requirement for a flowing well. It is not then beyond all hope that when, ere long the arching dome of some low anticline is pierced we may yet hear the mighty roar not soon forgotten, or listen to the gushing stream of liquid amber.

IOWA MINERALOGICAL NOTES.

BY CHARLES ROLLIN KEYES.

Pyrite.—Quite recently there have been obtained from limestone cavities in Lee county some small but very perfect pyrite crystals. The faces are brightly reflecting and meet in sharply defined edges. The more common crystallographic forms are the pentagonal dodecahedron, or pyritohedron, and the cube, with all gradations between the two. Though small they are perhaps the most perfect crystals of this mineral found in the state up to the present time.



PYRITE.—Upper two from Dubuque; lower four from Ft. Madison.

From the Kinderhook clays of Burlington were obtained a number of bright-faced specimens showing the cube with the corners very slightly truncated by the octohedron. These occur sometimes singly, sometimes in aggregates of considerable size.

In the black bituminous shales of the Lower Coal Measures at Des Moines occur some rather remarkable specimens of pyrite. The form is the octohedron modified very slightly by the cubic faces. In the direction of the crystallographic axes the octohedral corners have become greatly extended from the center forming long, series of octohedrons partly inclosed in one another, the terminal one in each of the six sets being almost perfect except on the end of attachment. With one series pointing directly in front and the opposite one directly behind the remaining arms forms a slender Swiss cross, whose dimensions are sometimes from four to six inches. These may be regarded as a large number of sub-individuals forming parallel growths, each individual represented by a thin plate between each pair of re-entering angles. The terminal octohedrons are often an inch along the edges. But if the skeleton were completely filled out the octohedral edges would measure five inches or more.

Calcite.—Among the "geodes" from the Keokuk limestone of southeastern Iowa, calcite is found in many different forms; a large variety of rhombohedrons and scalenohedrons and their combinations being represented. A particularly interesting occurrence is that of very perfect fundamental or cleavage rhombohedrons (R), with the planes of no other forms present. This is one of the rarer forms of the mineral under consideration and the known occurrences are very limited.

Gypsum.—Crystallized gypsum is a rather common occurrence in many of the coal measure shales of central Iowa. Some specimens discovered a short time ago seem worthy of special note since they are unusually perfect and are found in large numbers. The edges are sharply cut and faces brilliant. The crystallographic forms are $\infty P \breve{\infty}$, $P \breve{\infty}$, and ∞P. They assume the well known diamond shapes, with beveled edges. Not unfrequently individuals contain very distinct "shadow" crystals.

In some localities the crystals form swallow-tailed twins and become greatly elongated in the direction of the vertical axis. Examples of this kind sometimes attain a length of six to eight inches.

Millerite.—For a number of years past there has been noted occasionally in "geode collections" examined from different parts of Lee county in southeastern Iowa, certain specimens containing clear calcite crystals, traversed in different directions by minute yellowish filaments after the manner of the familiar *fleches d'amour* —the rutile needles in quartz. Recently in opening a large quarry near the city of Keokuk, in the compact Keokuk limestone some feet below the regular "geode bed" numerous cavities were encountered varying from three to twenty inches in size. These hollows have large, thickly set rhombohedrons of calcite jutting out towards the center. The faces are brightly polished and the edges are sharply cut. On some of the calcites have been found beautiful tufts of closely arranged, brass-yellow needles of millerite pointing from the center of attachment, in all directions to a distance of one-half to two and one-half inches. In some of the examples the tufts are made up of hundreds of filaments, often so close together that the needles of the different branches are interwoven, forming a dense matted mass. Often a large, perfectly transparent calcite has a tuft of long millerites completely inclosed in it; or a part of the tuft may be embedded in the lime crystal, the extremities of the needles left projecting outside.

The Keokuk occurrences are believed to be the most beautiful ever found in this country, if not in the world.

Mr. C. A. Flannery, of Keokuk, has very lately found another "nest" of similar geodes containing millerite. One specimen of calcite covered thickly with needles of the nickel sulphide weighed over fifty pounds. Still more recently equally fine specimens of millerite have been reported from Ft. Madison.

Eruptive Rocks in Iowa.—During the past few years a number of deep wells have been made in different parts of the State. The depths reached are from twelve hundred to two thousand feet. Several of these deep borings are of particular interest as they pass through all the sedimentary rocks into the crystalline basement below, penetrating the latter in some cases to the extent of several hundred feet. A typical gray granite has been recognized in some instances; in others different types of eruptive rocks.

The latest drilling in the northwestern part of the State is the well in Hull, in Sioux county. At a very considerable depth—between seven hundred and fifty and twelve hundred feet—several thick beds of flint-like rock were passed through. The different beds of the rock were separated by gravels or sands several feet in thickness, if the samples and records are to be relied upon. Some of the flint-like fragments were sliced by Mr. S. W. Beyer, of the Agricultural College, and upon petrographical examination proved to be typical quartz-porphyry—a truly igneous rock, very acid in character, essentially identical with granite, but cooling under somewhat different physical conditions. Under the microscope the ground mass appears microgranitic with large clear crystals of quartz and feldspar scattered through it. Both kinds of phænocrysts have the crystallographic angles rounded through magmatic corrosion. Characteristic embayments are also apparent. Now the interest in these eruptive rocks *in situ*, true lava flows of perhaps paleozoic date, so far beneath the surface, centers around their nearness to the great mass of metamorphosed sandstone known as the Sioux Quartzite. This quartzite outcrops along the Big Sioux river in the northwestern corner of the State, extending northward from Minnehaha county, South Dakota, to Pipestone and Rock counties, Minnesota. Its geographical extent is much greater than was formerly supposed; and it has lately been found well exposed in Iowa twenty miles to the southeastward of the outcrops heretofore noted. There are large exposures in Lyon county in the vicinity of Rock Rapids, where the stone is quarried, and borings indicate a much farther eastern extension. It has been usually believed that no other crystalline rocks appear in the neighborhood of the Sioux Quartzite outcrop. It is of considerable interest then to know that G. E. Culver* has very lately discovered in the midst of the quartzite of southeastern Dakota, in Minnehaha county, within less than half a dozen miles of the Iowa boundary, or more accurately in Sections 15 and 22, R. 49 west, Twp. 101 north, a large mass of diabase. It is exposed for fully a mile along one of the tributaries of the Big Sioux.

Hobbs,† who has examined the intrusive rock microscopically, finds it to be a well pronounced coarse-grained olivine diabase, with hornblende, biotite, ilmenite, and apatite present, in addition to the plagioclase, augite and olivine.

The presence of this massive basic rock of undoubted eruptive origin is very suggestive of the agencies that may have been involved, to some extent at least, in metamorphosing the old Sioux sandstone. Further investigations will doubtless disclose other similar types of eruptives in the quartzites of the neighborhood in all three of the states already mentioned.

The quartzite still has its planes of sedimentation clearly defined. It lies in low folds which are quite noticeable in many places.

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*Culver and Hobbs: On a new occurrence of Olivine Diabase in Minnehaha county South Dakota. (Trans. Wisconsin Acad. Science, Arts and Letters. Vol. VIII, pp. 208-210. Madison, 1892.)

†Loc. cit.

Concerning the geological age of the Sicux Quartzite a number of different opinions have been expressed.

From the first mention of this formation by Catlin, in 1837, in connection with the celebrated pipestone quarry, until 1866, when Hall entered the reigion, no suggestion was made regarding the age of the flint-like mass. Nicholet visited the quarry in 1838, and gave a very complete description of the rock; but for nearly thirty years no special notice appears to have been taken of the place. Hall, though not seeing all the exposures, concluded that the quartzite beds must be Huronian in age. Hayden, who examined the rocks about the same time, thought he had ample reason for regarding them as Triassic or Cretaceous. In connection with his work in Iowa, White was led to adopt Hall's opinion; while Winchell approaching the region from the Minnesota side referred the hardened sand-bed to the Potsdam—Upper Cambrian. Still later Irving expressed his view to the effect that the Sioux Quartzite was Huronian.

Though very little information bearing directly upon the geological age of the indurated sandstones of the Big Sioux region is yet available, the recent observations on the geology of northwestern Iowa are not without interest.

The presence *in situ* of the undoubted eruptive rocks mentioned and at no very great distance below the surface of the ground in the northwestern part of the State; the existence of diabasic masses in the midst of the quartzite mass itself; the folded and disturbed condition of the strata, all point to the great antiquity of the Sioux formation as compared with other rocks exposed within the limits of the State. The inference is, then, that the rocks under consideration must be very much older than any others exposed in Iowa.

SURFACE DISINTEGRATION OF GRANITIC MASSES.

BY CHARLES ROLLIN KEYES.

Throughout the drift mantled surface of Iowa, glaciated boulders of crystalline rocks are of common occurrence. They vary in size from a foot to more than fifty feet across. These boulders are rounded more or less, globular in form, though often slightly flattened on one side, sometimes on two. When closely examined, the outside is commonly found to be more or less affected by meteoric agencies, but the interior is fresh and unaltered as a rule. Most of the Iowa boulders are known to be of northern origin, coming from near or beyond the present northern boundary of the United States. In this region the granite, diabase and gabbro areas are usually firm, and but slightly decayed at the surface, the rocks having been planed and scored by glacial action. Passing beyond the limits of the glaciated region an entirely different set of phenomena is presented, and in an area of crystallines, the rocks are decayed for many, often one hundred or more feet below the surface, the bi-products remaining *in situ* until removed by running water.

It is to a granite area outside of the glacial boundary that attention is directed —an area in central Maiyland some twenty miles west of Baltimore, near the villages of Woodstock and Sykesville.

The Woodstock granite forms a small isolated patch midway between the two largest granitic masses of the region. Though having a superficial area of scarcely two square miles it is, economically, one of the most important occurrences in Maryland. Extensive quarries have been opened in it a short distance from the station of Woodstock, on the main line of the Baltimore & Ohio railroad. Nowhere among the Maryland granites is the phenomenon of jointing better shown than in the "east" quarry of the Woodstock area. The horizontal divisional planes are particularly prominent, and at first glance give the impression of true stratification. These principal joints extend for considerable distances. They are crossed by numerous inclined and vertical planes of natural cleavage, which are usually much less prominent than the major lines just alluded to.

As to the origin of the joints, it seems probable that they are due to two causes; in part to the contraction of the granite during its original cooling; in part to a subjection to severe tortion. The latter force is in all probability in action at the present time; for, as already stated, it would seem that, according to McGee,* crustal movement is in active operation in the Piedmont region at the present time. The optical disturbances of the granitic quartzes of the district may also be due in some degree to the same causes. The very marked rifting also points to the same conclusion. That systematic jointing may actually arise from strains of this kind has been satisfactorily proven experimentally by Daubree† and seems to find full confirmation in other more extensive trials, as well as in the field. On approaching the middle one of the three quarries in the Woodstock district fine illustrations of the weathering of granite are encountered. The quarry ledge has the appearance of a great wall of cyclopean masonry—layer upon layer of huge blocks rising one upon another with the regularity and precision of human effects. The separate blocks are more or less oblong in shape and often measure 15 to 20 feet in length, and from 2 to 6 feet in height; they are all more or less rounded, the spaces between the different boulders being filled with incoherent graniti sand derived from the decomposed edges and sides of the blocks. It is quite evident that the granitic mass was originally everywhere jointed and that atmospheric decay took place much faster on the edges and corners than on the flat sides of the great fragments, thus quickly rounding and forming them into boulders like those found throughout the drift areas. The sandy matrix is usually from 5 to 10 inches in thickness. The interior of the boulders is perfectly fresh and affords the best of rock for building purposes. As decomposition progresses the amount of interstitial sand greatly increases and the blocks become proportionately smaller.

Another interesting phase of rock decay shown in the same opening is the phenomena of spherical sundering; in which huge boulders have thick concentric shells which come off one after another, not very unlike the different coats of an onion.

It is very likely that it was during the later stages of rock decay just mentioned, within the glaciated region, that most of the drift boulders in nearly their present outlines were dislodged and transported by the glaciers. And it would appear probable then that the erratics had been previously prepared to a great extent before removal rather than rounded from angular fragments during transportation.

A still more advanced stage of disintegration is shown at Sykesville, where the weathering effects of the granite presents some striking contrasts with that of the Woodstock area and is much more complete. Decomposition extends from the surface downward for 30 feet or more in places. The decayed portion preserves all

*Seventh Ann. Rep. U. S. Geol. Sur., p. 619. 1888.

†Etudes de geol. Exper., p. 300.

the appearances of the granite itself, but under the touch it falls readily into sand. This loose arenaceous material is without boulders or pebbles; is easily excavated to a depth of many feet, and when suitably exposed to the action of running water is carried away as the sand along some water-course melts into the flowing stream.

The absence of glacial action in Maryland has thus left many phases of rock decay not usually met with in crystalline districts to the northward. In those areas where ice has acted vigorously in great masses the rock surfaces are often smooth and hard, with little or no traces of internal disintegration. South of the terminal margin of the last great glacial invasion, as in the state just mentioned, it is not uncommon to find in granitic and gneissic areas the rock broken down for many feet below the surface—the debris still remaining *in situ*. The depth to which this kind of rock decay takes place appears to increase rapidly in proportion to the distance passed over southward from the glaciated region, as has just been shown by Russell.*

SOME AMERICAN ERUPTIVE GRANITES.

BY CHARLES ROLLIN KEYES.

Two hypotheses, diametrically opposed, have been entertained by geologists in explaining the origin of large granitic masses. According to the one a granite is the last stage in the metamorphic alteration of mechanical sediments. According to the other a granitic mass is the product of the gradual cooling of an acidic molten magma under pressure. In the first case it is claimed that all the gradations have been traced in the same mass from undoubted clastics through slaty, schistose and gneissic phases to the truly granitic types; so that one end of an originally sedimentary deposit may be now unaltered, while the other end is a true holo-crystalline rock. On the other hand unquestionable eruptive granites are known to pass into gneiss and even into the schistose stages, through the agency of enormous compression. Regarding the facts deduced in the support of the first assumption and without referring to any specific instances, it seems quite probable that in the majority of cases bearing directly on this point sufficient discrimination has not been exercised along the lines separating the semi from the holo-crystalline areas.

Recently great stress has been laid on the metamorphosing influences of orographic movements in disguising the original character of rocks—making eruptives more and more like sedimentary deposits, and clastic beds more like massives. But without entering into a discussion of the general subject it is intended here to merely set forth some of the proofs that point to the eruptive origin of certain granites of Maryland. That these particular rocks are really eruptive in character has been seriously questioned by some, by others denied.

The rocks under consideration are scattered through the central part of the State within the eastern half of the Piedmont plateau—topographically the median one of three zones into which the middle Atlantic slope has been divided.

The granites of this region comprise four petrographically distinct types: Binary granite, Granitite, Hornblende granite and Allanite-epidote granite.

*Bul. U. S. Geol. Sur., No. 52. 1889.

The proofs that the granites in question are eruptive in nature is deduced from several different and independent sources:

(1) From field relations.

(2) From inclusions.

(3) From contact phenomena.

(4) From microscopical examinations.

(1) *Field relations of the granites.*—As stated elsewhere, the eastern half of the Piedmont region consists chiefly of gneisses broken through in numerous places by undoubted eruptives, as gabbro, diorite, pyroxenite and others, until now these rocks occupy fully one-half of the exposed surface of the district. Now, a careful tracing of the granite shows that they have cut indiscriminately across the igneous rocks mentioned, as well as the gneiss, passing uninterruptedly from one petrographically distinct mass to another. In other words, the acidic types of crystallines to all appearances seem to be younger in age than the gabbros and the most basic rocks, as if they, too, had broken through all the other eruptives. Near some of the granite masses true granitic and felsitic dykes are clearly defined and would ordinarily be regarded as apophyses of the main body, were the rock regarded as eruptive. Furthermore, at Dorsey's Run Station, for instance, large exposures show the granite spreading widely apart enormous layers of twisted and puckered gneiss. At Woodstock huge blocks are completely enclosed in the granite.

As already remarked, the line of contact between the granite and the contiguous rock is seldom determinable exactly on account of profound superficial decay. Yet, occasionally artificial excavations into the acid rock reveals clearly such contacts, as at the new quarry opened about two miles northwest of Garrett Park, where the line is very sharply defined between the granite mass and the adjoining soapstone belt.

(2) *Inclusions.*—Perhaps one of the most exclusive proofs of the eruptive nature of some of the Maryland granites is the occurrence in the mass of large numbers of inclusions—fragments of foreign rocks, both sedimentary and eruptive. These have all been described more or less at length in another place, to which reference may be made for fuller details. At Sykesville, where they occur so abundantly, the irregular angular fragments and blocks of all sizes are identical with rocks in the neighborhood. In most of the cases the interior of the foreign pieces are scarcely altered at all, though the exterior forms more or less completely metamorphosed shells of varying thickness. The Woodstock and Dorsey's Run granites show similar phenomena equally well, or even better. In both instances blocks of highly puckered gneiss are very prominent; and they all possess narrow marginal borders of dark, fine-grained, completely changed rock, which contrasts sharply with the light colored, surrounding granite. Certain outcrops near Garrett Park furnish good illustrations of the same kind; though here the granite has been squeezed considerably more than in the other cases mentioned. At this place there is one exposure showing numbers of small lenticular masses of a black color, which might easily be taken for inclusions but for their regularly bounded outlines. These are, doubtless, basic secretions which developed in the acid magma.

(3) *Contact Phenomena.*—For reasons elsewhere explained the contacts between the granitic masses and the adjoining rocks are rarely seen to advantage. The investigation of the contact zones have therefore been carried on largely with the inclusions. This has been very satisfactory on account of the variety of foreign rocks represented and the abundance of the fragments. In most of the fragments

it is only the outside which is changed, to the depth of from two to four centimeters, or more, the interior still often preserving the rock in its original character, so that no doubt arises concerning its composition and structure previous to its embedding in the granite. The contact zones are in all respects identical with the contact belts of other localities where acid eruptives have pushed up against the same kind of rocks.

Chemical analyses of the unaltered inclusions, the metamorphosed shells and the surrounding granites show that the altered shells have an acidity intermediate between the inclusions and the granites.

These proofs of eruptive origin of the Maryland granites are quite similar to those which Barrois* has formulated from granites of Rostrénen.

(4) *Microscopical Examinations.*—Aside from the ordinary microscopical characters indicative of cooling from fusion, certain of the granites under consideration show some additional phenomena pointing to the same end. These are large grains of micropegmatitic intergrowths of quartz and feldspar rounded through magmatic corrosion apparently and having the characteristic embayments so commonly associated with cases of this kind.

STRATA BETWEEN FORD AND WINTERSET.

BY J. L. TILTON, INDIANOLA.

[The following article was accompanied by a series of diagrams representing the size, location, and relative position of the various out-crops.]

Middle river rises on the eastern slopes of the divide in Adair and Guthrie counties. It flows just south of Winterset, in Madison county, then northeasterly to the northeast corner of Warren county, where it takes an easterly direction for four miles and flows into the Des Moines river, about eight miles below the city of Des Moines. Consequently, a line drawn along Middle river from its mouth to Winterset, a distance of about fifty miles, passes from close to the lower strata of what White calls the "Middle Coal Measures," across the entire series of both the "Middle" and "Upper Coal Measures." In the sections found along this line we may ascertain the local thickness of the different strata, some facts in regard to the continuity of the different strata and of the different seams of coal, also the position of the border between the "Middle" and "Upper Coal Measures;" or between the "Lower" and "Upper Coal Measures," following the classification that will probably be accepted.

In the diagram before you the different out-crops are so drawn by a scale as to represent the relative thickness of each of the strata, their distances apart and location. These diagrams are so placed side by side as to represent the continuation of the strata.

The explanation accompanying each stratum describes the surface appearance at the out-crop, regardless of what the texture of the stratum may be where atmospheric agencies have had less chance to work than at the exposure; yet, comparing the out-crops of the same stratum in sections adjacent to each other, we see in various places a change in structure not to be wholly explained by the action of atmos-

*Ann. de la Soc. geol. du Nord, t. XII, p. 106. 1885.

pheric agencies. The composition of the strata themselves is different. Here are not only numerous places where solid sandstone graduates into shale or into sand, but also places where sandstone graduates into clay, and places where the same strata differ in thickness. If the relation of the strata is correctly represented, six different seams of coal are here represented, all but one cut by erosion and varying in thickness, one, especially, a foot and a half thick thinning completely out in a mile and a half, its place being taken by a foot and ten inches of sandstone.

The change in the strata due to the decomposition of the sandstones is readily understood; the surface water percolating through the soil leaches out the iron oxide in the stone thus allowing the stone to crumble to pieces. The change from sandstone to clay in this particular locality seems to be due to differences in the direction and velocity of currents, while the same changes of elevation in the earth's crust that submerged the swamps and raised them above the water, also aided in varying the margins of the sand deposits.

Close to the western boundary of Warren county the river strikes against the hills which are here more precipitous than to the eastward. About three miles southeast of Winterset we find the section represented by the left diagram. The sandstone stratum lowest in this diagram I judge to belong to the "Middle Coal Measures," and to mark the division between the "Middle" and "Upper Coal." This stratum of sandstone you noticed continued in adjoining out-crops. The ledge of marble shale twenty feet in length is clearly a continuation of corresponding strata measured by White at Winterset three miles further on.

Near the mouth of the river indications of coal are much more abundant than further up the river. The last diagram on the right presents a section found one-fourth mile east of a bridge near Clarkson, though the strata were traced by out-crops along the bluff from this point to Ford, four miles further on. In the side of this bluff are to be found numerous entries near Ford, in one of which at a distance of fifty feet from the face of the bluff, three and one-half feet of pure coal was measured, the out-crop in the face of the bluff being two and a half feet.

ANALYSIS OF WATER FOR RAILWAY ENGINES.

BY C. O. BATES, CEDAR RAPIDS.

The following is one of a hundred analyses made along the Burlington, Cedar Rapids & Northern Railway. Nearly all the samples are from the State of Iowa. The analysis is supposed to explain itself so far as the results of such an analysis are concerned.

			Albert Lea, Minnesota, Well.	Cedar Rapids, Iowa. Cedar River.
	1.	When collected	July 5, 1890.	Average of several Analyses at differet seasons of the year.
	2.	When analyzed	July 10, 1890.	
	3.	Kind of weather week previous to collecting	Fair.	
	4.	Number of trains watering per 24 hours	7	
	5.	Number of gallons used per 24 hours	12,000	
	6.	Location of tank	600 ft. S. Depot.	
		This water contains in solution	Grains per	Gallon.
A	7.	Total solid matter	28.10	12.49
A	8.	Carbonate of Lime, $CaCO_3$	14.28	6.56
A	9.	Sulphate of Lime, $CaSO_4$	.24	.29
A	10.	Carbonate of Magnesia, $MgCo_3$	7.41	2.48
A	11.	Sulphate of Magnesia, $MgSO_4$	.40	1.07
A	12.	Oxides of Iron and Aluminum, Fe_2O_3 and Al_2O_3	.08	.28
A	13.	Silicia, SiO_2	1.60	.28
	14.	Total Incrusting Solids	24.01	10.96
B	15.	Alkali Chlorides, NaCl and KCl	.80	.64
B	16.	Alkali Sulphates, Na_2SO_4 and K_2SO_4	2.34	.28
	17.	Total Non-Incrusting Solids	3.14	.95
C	18.	Hardness—Equivalence in $CaCO_3$	32.49	12.56
C	19.	Total Magnesia and Lime Salts	22.33	10.46
C	7.	Total Solids on Evaporation	28.10	12.49
C	20.	Total Solids on Analysis	27.15	11.92
C	21.	Alkalies by difference	4.09	1.53
C	22.	Alkalies by addition	3.14	.96
C	23.	Pounds of Incrusting Solids per 1,000 gallons	3.43	1.56
C	24.	Comparison with Cedar River as unity	2.32	1.00
C	25.	Comparative rating	Bad.	Good.

A—Incrusting Solids.
B—Non-Incrusting Solids.
C—Additional Information.

Good...... 6 to 12	Comparative rating based on total gains of Incrusting Solids.
Medium...11 to 18	
Bad... ...18 to 28	
Very bad 28 to ∞	

SOME OBSERVATIONS ON HELIX COOPERI.

BY F. M. WITTER, MUSCATINE.

In "Land and Fresh Water Shells," Part I, by W. G. Binney and T. Bland, 1869, the mollusk to which I invite your attention is called *Helix cooperi*. In "Manual of American Land Shells," by W. G. Binney, 1885, this little mollusk is honored with the following synonymy: *Helix strigosa*, Gould; *Anguispira strigosa*, Tryon; *Helix cooperi*, W. G. Binney; *Anguispira cooperi*, Tryon; *Helix haydeni*, Gobb, *Patula strigosa*, W. G. Binney; *Anguispira bruneri*, Ancy. In this work Mr. Binney uses the second name proposed by himself, viz: *Patula strigosa*. Inasmuch as the regions inhabited by this creature are quite diverse in regard to climate and food, it would seem most likely a considerable variation in size, form and color would necessarily follow. It appears to be at home throughout the Rocky Mountain region in the United States.

On July 12th, 1892, I was just starting up the Rabbit Ear mountains, from the southwest corner of North Park. After crossing Colorado creek, a branch of Big Grizzley, dead *Helix cooperi* were noticed in the road. A little search soon revealed the living mollusk. Here is plenty of sage brush about two feet high, with here and there clumps of a woody plant about the same height as the sage brush, with a dark green leaf. Bunches of two or three kinds of herbaceous plants were common. The snails were in these bunches of herbaceous plants. A few I found crawling, but the greater portion were quiet, resting on the coarse sand or gravel, or on the stems or leaves of the plants in the shade. I could not determine the nature of their food. They did not seem to be under the sage brush. This, I thought, was due to the absence of herbaceous plants around and under the sage brush. There were four in our party, and we collected a quart in about twenty minutes.

On July 20th I was deer hunting in Danforth Hills, on a branch of Spring creek, about twelve miles north of Meeker on the White river, Rio Blanco county, Colorado.

During a rain, I happened to observe snails crawling about the damp weeds among the sage and other short brush. These were *Helix cooperi*. The weeds and brush were so wet I collected but few. Colcrado creek in North Park, and the Danforth Hills are on opposite sides of the great divide, about 100 miles apart. There is but little difference to be noted in the shells from these two localities, separated as they are by lofty, snow clad mountains.

On my return through North Park I collected a considerable number of *Helix cooperi* at the same locality on Colorado creek. These I wrapped in paper and brought with me alive. They formed an epiphragm over the aperture, and some of them may still be alive. A few were broken and I was surprised to find some of these almost filled with young snails, containing from 1½ to 2½ whorls. In looking up the literature of *Patula strigosa—Helix cooperi*, I find I am not the first to observe that it is viviparous.

These snails inhabit treeless, almost barren regions.

The altitude on Colorado creek is probably near 9,000 feet, and perhaps a thousand feet less in the Danforth Hills. I have the pleasure of presenting specimens of these mollusks for inspection by the members of this Academy.

ON THE ABSENCE OF FERNS BETWEEN FORT COLLINS AND MEEKER COLORADO.

BY F. M. WITTER, MUSCATINE.

Partly because of their grace and beauty, and partly because of the small number of species in any given locality and of their singular mode of growth and development, this group of plants has, to me, for many years been of more than common interest. Muscatine county is honored with about twenty-two species of ferns. As a rule these plants seek damp and shaded spots, and it would seem as if some of them will not thrive unless certain conditions of soil, water and exposure are secured. Hence, a rough, rocky region, with springs and more or less swampy ground would, most likely, be rich in individuals and in species of this interesting family.

It was my good fortune to make a wagon journey from Fort Collins to Meeker, Colorado, from July 6 to August 5, 1892. Our route lay from Fort Collins northwest through a continuation or southerly extension of the Black Hills to a point on the Union Pacific railroad, twenty miles from Laramie City on Laramie Plains, thence west across Laramie Plains and the Medicine Bow mountains to North

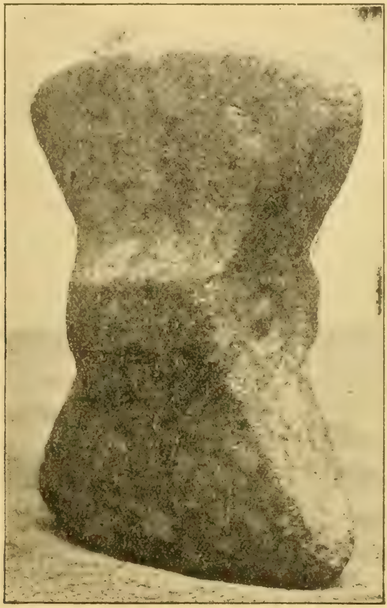
Park, a few miles north of Pinkhampton, thence along the west side of North Park to Rabbit Ear Peak, thence through Rabbit Ear Pass over the Park Range to the Bear river, at a point near Steamboat Springs, down the Bear river to Craig on Fortification creek, across Williams' River mountains, and the Danforth Hills to Meeker on the White river. I was on a sight-seeing and collecting tour, and among other things I expected a rich harvest of ferns. From the beginning to the end of the journey, over three hundred miles, entirely across the Rockies, I kept a close watch for ferns and orchids. The first ferns observed were along the foot of heavy sandstone and igneous rocks in the hills about fifty miles from Collins. These ferns were not in a flourishing condition, were small and scarce. The specimens I collected were lost, but I think they were a *Woodsia* or *Cystopteris*. No ferns were seen from this point till in a gulch near the foot of Park Range mountains, within two or three miles of the Bear river. Here the ferns were very abundant and very large. But one species *Pteris (aquilina ?)*, was noticed. Many plants were almost my own height. These two, and at the places named, only, make the list of ferns seen on this road across the Great Divide. One orchid, the species not yet determined, was abundant on the summit near Rabbit Ear Peak. Nothing further was observed in this family.

There must be some general cause operating to produce such marked absence of ferns along this line of travel. But one such cause suggests itself to me. Could it be the Alpine or sub-Alpine climate? The ferns observed were near the ends of my journey. Woodsia (?) was apparently struggling for an existence, but Pteris was well favored in a gulch on the south side, at the foot of a lofty mountain range. I have the general impression that ferns, other things being equal, become larger and more abundant in individuals and species as we approach the warmer regions of the globe. I could scarcely be mistaken as to the paucity of ferns as mentioned above. This may have been noticed long ago and perfectly satisfactory reasons set forth, but mention of any such observations have escaped my attention.

NOTICE OF A STONE IMPLEMENT FROM MERCER COUNTY, ILLINOIS, AND ONE FROM LOUISA COUNTY, IOWA.

BY F. M. WITTER, MUSCATINE.

The Mississippi river separates Mercer county Illinois, from Muscatine county, and Louisa county, Iowa, borders Muscatine county on the south. Both of these counties have yielded many valuable relics of the prehistoric people who once filled and owned these lands. The Davenport Academy of National Sciences has carefully worked these fields and Muscatine antiquarians have done likewise. But it is not of the numerous, conspicuous, fertile mounds of these regions I wish now to speak. Mr. Jas. Wier, of Muscatine, for the past few years has become a zealous collector of a great variety of curious things. Chief among these are stone implements which have been made or are supposed to have been made by some prehistoric or savage race. An implement was brought to him by a farmer in Mercer county, Illinois, which it seems to me bears the internal evidence of being genuine. The stone seems to be a kind of porphyry. It is quite systematically wrought in the shape of a double ax. At the common eye it is 1⅝ inches thick and 1¾ inches wide. It is $4\frac{3}{4}$ inches between the extreme convexity of the cutting edges. The cord of the cutting edges is $3\frac{5}{8}$ inches and from the center of the eye to the angle on the cutting edge is $2\frac{1}{4}$ inches. The cutting edges are but slightly convex. The sides of each bit are nicely worked, concave next to the eye then convex near the edge. The cutting edge itself on each bit is nearly $\frac{3}{4}$ of an inch thick.



Stone implement, about ¾ actual size. (From Photograph.)

I have examined all the literature at my command and fail to find anything satisfactory as to what this instrument is or was intended to be. The point, however, to which I wish to call especial attention is a start made to drill the eye. A hole is commenced nearly $\frac{5}{8}$ of an inch in diameter. This was done in such a manner as to leave a *core*. Now, what kind of a tool could this primitive man have had to do such work? It seems to me we are limited to the supposition that it was wood or bone. The cutting must then have been done with sand. Would this be the only way to do such work with the means at his command?

The implement from Louisa county is of Red Porphyry. It is supposed to be a shuttle. It was found near Grandview, Louisa county, Iowa, and is now owned by Mr. James Weir. I can hardly see how a stone so hard to work should have been chosen when a much softer rock would have done equally well.

The following measurements will give some idea of this instrument: The rim of the open side is flat or all in one plane, $2\frac{1}{2}$ inches long and $1\frac{1}{4}$ at its greatest width, an ellipse; the trough is ½ inch deep, with holes near each end; these were drilled from both sides with a conical instrument. The greatest depth of the implement is 1¼ inches, somewhat flattened on the convex edge over the holes.

Through the kindness of Mr. Weir I am permitted to exhibit these relics to the members of this Academy.

SOME REASONS WHY FROGS ARE ABLE TO SURVIVE.

BY GILMAN DREW, OSKALOOSA.

The Leopard frog (*Rana halecina*, Kahn) and allied species occur in considerable numbers and have a wide geographical distribution.

Being entirely defenseless, beset by enemies at every turn—fish, reptiles, birds and mammals—as well as being cannibals among themselves, subject to many diseases and the hardships of great extremes of temperature, they are, withal, able to maintain their numbers.

They are able to survive—first, on account of their activity and mode of life, being equally at home on land and in water ; secondly, they are able to resist great changes in temperature ; thirdly, they can go for many months without food, and fourthly, they are very productive.

Disturbed on land, they generally jump into the water, where they find a hiding place and remain motionless unless danger approaches very near. Pursued in water, they either dive among the rocks or into the mud, or in some cases escape to the land. In either case, in localities where they have not often been disturbed, they may easily be approached if all motions are made slowly and carefully, but quick motions will generally cause alarm. A frog can be most thoroughly alarmed, especially one that has lived for some time in a region infested with snakes, by running a stick toward it, causing the grass to rustle. In such a case, if not where it can immediately plunge into the water, it executes a series of frantic leaps with great rapidity, stopping only when at a considerable distance from the place of disturbance. When disturbed in any other way, the same frog will seldom make more than three or four jumps, and these are made with more deliberation.

Living, as many frogs do, in a climate where the temperature for some months is below the freezing point of water, and having no covering to protect themselves against severe cold, they survive this part of the year in a state of hibernation in the bottoms of the rivers and ponds, supposedly buried in the mud or sand. Judging by the time frogs disappear from the banks of streams, they seem to hibernate at about six to ten degrees C., and by the time that the first hard freeze comes, they have disappeared, in general, for the winter. In some cases, they may, during thaws, come out before the general break-up in the spring, but not as a rule. For some time before they finally hibernate, they spend the nights under water, probably in a state resembling hibernation, coming out again during the warmer portions of the day.

In warm weather, a frog, when disturbed in the water, will generally dive, remaining under water only two or three minutes. When they receive a bad scare, they may remain below the surface for twenty minutes or more, and in a glass can, where they are able to watch all movements around them, they may stay under water for more than thirty minutes without any movements being made intended to scare them. How long they can be forced to stay under water without drowning, when not in the hibernating state, was not experimented upon.

Caged frogs, left in a moderately warm place, about twenty degrees C., seldom move unless disturbed, but when disturbed are very active. As the temperature is lowered they become less active. At from ten to five degrees C., when confined in a vessel of water a frog will generally go to the bottom, and after scratching around for some time, stop its movements, remaining entirely submerged, and respiring through the skin alone. It may rise to the surface and respire several times before finally settling down. At about two or three degrees C., frogs seem to become uneasy, slowly stretching their legs and attempting to crowd themselves further down. This continues for some time after zero is reached, at which temperature they are quite restless.

At any time down to this point activity can be restored by gradual warming, and after torpor has set in, complete activity can be restored only by heat. In this condition of torpor, the muscles readily respond to stimuli both electrical and mechanical, showing them to be quite irritable. After repeatedly punching such a frog with a stick. it shows its uneasiness for a number of minutes, stretching its legs, spreading its toes, and even coming to the surface for a few swallows of air. The eyes generally remain closed most or all of the time while in this condition of torpor, but in some cases they are not closed at all, although the frog is not disturbed by quick and direct motions very near them. When the eyes are touched they respond with a wink, commonly remaining closed thereafter.

Two frogs were placed in a jar of water which was reduced in temperature to the freezing point seven different times. For the first three times they responded much in the manner described, but the fourth time and thereafter, one of them, after staying down for some time, arose to the surface and respired just as the water began to freeze, continuing respiration even while the ice was forming around him. On the seventh cooling both came to the surface in the same manner. These actions, however, may have been accidental. No delicate instruments could be obtained to experiment on the difference in temperature of the frogs and the surrounding water, but it was not great, as the thermometer used would show no change when the bulb was placed immediately upon the body of one

One frog was placed in a towel where the temperature of the atmosphere was two degrees below zero C. for six hours, and although in a perfect torpor was capable of slight movement on handling, and on warming regained perfect activity.

A frog kept in my room was one night subjected to a fall in temperature that froze the water in which he sat sufficiently to inclose the principal part of the head, all of the legs and the sides in ice. A little water remained, bathing the under surface of the body, and the back, which was above the surface of the ice, had a moist appearance. By carefully thawing this frog out he lived and was kept for fully two months afterward, showing that the vitality had not been greatly reduced. On going to the frog cage in the morning, all of the frogs, thirty-seven in number, were found entirely motionless and surrounded by ice, which, as the water had frozen had evidently by the movements of the animals been kept in a mushy condition, in which there was a very little water. This happened a second time, and in neither case was there a single death.

Two frogs were placed in a room where the temperature was one-half degree above zero, one wrapped in a towel, the other put in a pasteboard box filled with water, so that most of the expansion due to freezing would be relieved by the breaking of the box rather than exerting the whole strain on the frog. These were left over night. In the morning the thermometer marked sixteen degrees below zero. The one wrapped in a towel was found frozen stiff and the other in a block of ice. Neither of these showed signs of life on being thawed out.

Four frogs were left in a cage for a week, during which time the temperature must have fallen at least twenty degrees below zero. When examined they were still enclosed in ice, and on being thawed out gave no signs of life.

Thus far no frogs have been frozen in ice without reducing the temperature much below zero, and under such circumstances it is barely possible that life can be sustained.

Last spring, while obtaining sets of developing frog eggs, a bottle containing a number undergoing the second cleavage, was placed on the window sill where it remained several hours. When examined the eggs were found to be completely enclosed in ice, but when shaken they would quiver in the albuminous mass surrounding them, showing that the albumen at least was not frozen. Supposing the eggs were killed, the bottle was left by the register, and when next examined the water was found to be much warmer than my hand. After all this many of the eggs completed their development and gave rise to active, evidently healthy, tadpoles.

The amount of heat that adult frogs can stand is considerable, but no appliances were at hand with which to experiment. The moist skin bars them from standing such high temperatures as have been stood by men, but it must be remembered that with men the temperature of the body varies only a few degrees, although the surrounding temperature may vary a great many degrees. With the frog the body varies through nearly as many degrees of temperature as the surroundings in which it is placed.

The prolonged vitality possessed by the muscles after destruction of the central nervous system, or even after isolation from the body has led to the use of frogs for some experiments in preference to most other animals. The heart may be beating thirty-six or forty-eight hours after removal from the body, and muscles will sometimes reopen to electric stimuli even after putrefaction has set in.

In all cases, in the live frog as a whole, or in the isolated tissues, vitalty is quickly destroyed by a lack of moisture. A frog escaping from a cage to a dry floor will generally die within twelve hours, and a muscle under experiment must be moistened at intervals or it loses its irritability in a very few minutes.

The length of time that frogs can live without food has caused many stories, such as finding live frogs in closed cavities in rocks. During the summer frogs eat great quantities of food chiefly insects and worms, and when winter comes they are in excellent bodily condition. The winter being passed in a state of hibernation the slight wastes are supplied immediately from the tissues, no food being taken. In tropical countries this is said to be reversed, the hot dry summer being passed in a dormant condition. When kept in captivity they readily eat flies and other insects, but as they will live for a considerable period of time without food, they are commonly so kept. It has thus been found that frogs will live three or four months without food and suffer but slight loss of tissue. They have been kept nine months in cages where there was no chance for them to obtain food, and in one instance some were kept fourteen months. In this case a number died, evidently by disease, which could not be resisted in this starved condition. At the end of this time the remaining frogs were greatly emaciated and apparently could not have lived many more months, but as they were then needed for laboratory purposes the experiment on their powers of endurance came to an end.

The productiveness of frogs has to do only with the preservation of the species, and with the great number of the tadpoles and adult frogs destroyed every year, it is necessary, if the species are to be preserved, that a correspondingly large number of eggs be produced.

PRESIDENT'S ADDRESS.

BY C. C. NUTTING.

What we have been doing:—

In choosing a subject upon which to address you on this occasion, it occurred to me that it might be profitable to present briefly as possible, the work done by the individual members of the Academy, aside from the papers presented before this body.

In calling upon the State to publish the proceedings of this Academy we have assumed to be a representative body of the working scientists of Iowa. Such an assumption could be made by any body of men who chose to call themselves scientists. It is my purpose in giving a resume of the year's work done by our Fellows, to demonstrate that the real workers are in our ranks, and that our body can support its claims by a creditable showing of achiévement. And this we are able to do in spite of the havoc made in our ranks by the removal from our midst of an unprecedented number of our best and most active workers.

Glancing down the list of Fellows we find that the following workers are no longer among us: *R. E. Call*, charter member, secretary for several years, and prominently active in all our meetings. *H. L. Bruner*, formerly of Drake University. *Erasmus Haworth*, called from Penn College to the State University of Kansas, one of the very first and best scientists on our list. *J. E. Todd*, charter member and at one time president of this Academy; a man beloved and honored by us all. *Seth E. Meek*, called from Coe College to the Arkansas Industrial University, the only Ichthyologist of eminence that we had.

All these known to have left the State since our last meeting. We can ill afford to do without them, and it will take not only good, but the *best* men to replace them.

About two months ago I sent a circular letter to the members of the Academy, requesting information concerning their work during the past year. The responses was quite general and gratifying, although several have not been heard from. This fact will explain the greater part of the discrepancies in the following resume.

But one of our mathematicians has been heard from. Prof. L. G. Weld, of the State University, has completed a work in "The Theory of Determinants," which is about to be issued. Competent reviewers have given it the highest praise. The subject is one involving discussion of mathematical principles of the most advanced order. Prof. Weld has also nearly completed a definitive determination of our latitude by means of a combined zenith and transit instrument furnished by the United States Coast and Geodetic Survey; probable error of result not > 1h of arc.

Our chemists have carried on their hazardous occupation without loss of life.

Prof. A. A. Bennett, has published Part I of a text-book on *Inorganic Chemistry*, and is now working on Part II; the whole work will embrace some seven hundred printed pages.

Prof. Floyd Davis has published a work entitled *An Elementary Hand Book on Potable Water*, published by Silon, Burdette & Co., Boston, and has, in the course of preparation, a work on *Water Analysis, Chemical, Microscopical and Biological*. He has also been working on a basis for *Sanitary Analysis of Water*.

Prof. W. S. Hendrixon has been carrying on investigations in *chloe-nitro-tolnicline*. He has prepared six of these bodies, including their acid derivations, and determined their constitution.

Prof. G. E. Patrick has published conjointly with F. A. Leighton and D. B. Bisbee a series of experiments on "Sweet versus Sour Cream Butter."[1] He doubtless has published other papers during the year, of which I have obtained no list. The ranks of our geologists have been thinned by the removal of Profs. *Haworth* and *Todd*, but the remainder have been working all the harder.

Dr. S. Calvin, State Geologist, has published the following papers:[2] "Report on Some Fossils Collected in the Northwest Territories, Canada, by naturalists from the University of Iowa; illustrated, giving a description of *Pentamerus dicussatus* Whitearos. "Two Unique Spirifers from the Devonian Strata of Iowa;" illustrated; a description of *Spirifera urbana* Calvin, and *Spirifera macbridii* Calvin. "A Geological Reconnoissance in Buchanan county, Iowa," in which a rectified section of Devonian strata is presented, in which seven strata are represented. "Notes on a Collection of Fossils from the Lower Magnesian Limestone from Northeastern Iowa," in which the following new species are described: *Straparollus claytonensis, Straparollus pristiniformis, Raphistorna multivolvatum, Raphistorna pancivolvatum* and *Cysteceras luthii*.

Dr. Calvin has also published numerous *reviews* and editorials in the *American Geologist*, besides organizing and getting under way the Geological Survey of Iowa.

Dr. Charles R. Keyes has completed and sent to press during the past year his report for the Missouri Geological Survey on the Paleontology of Missouri, embracing about 600 royal octavo printed pages and over sixty plates—600-700 figures, and large colored geological map of the State; also a report for the U. S. Geological Survey on the Granites of Maryland including about 100 pages of text and fifteen full paged plates—some of them colored. For the forthcoming annual report of the

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1Bulletin No. 18, Iowa Agricultural Experiment Station.

2Bulletin from the Laboratories of Natural History of the State University of Iowa Vol. II, No. 2.

Iowa Geological Survey he has prepared a preliminary report on coal, a sketch of the geological formations of Iowa, an annotated catalogue of minerals and a bibliography of Iowa geology. Has published besides the following papers:

The Principal Mississippian Section.[1]

The Classification of the Iowa Carboniferous Rocks of the Mississippi Valley.[2]

The Platyceras Group of Paleozoic Gasteropods.[3]

A Remarkable Fauna at the Base of the Burlington Limestone in Northeastern Missouri.[4]

The Present Basal Line of Delimitation of the Carboniferous in Northeastern Missouri.[5]

"Nickel Ore" from Iowa.[6]

Besides a number of shorter notes, reviews and newspaper articles.

Prof. S. W. Beyer has prepared for publication a preliminary report on certain deep wells in the State in connection with his investigations on the artesian waters for the Iowa Geological Survey.

Our botanists are also few in number at present, but are not inclined to take a back seat on that account.

Prof T. H. McBride, of the State University, has published a beautifully illustrated account of the "Myxomycetes of Eastern Iowa."[7] Sixty-six species are described.

A feature which surely will prove of great value to botanists is the keys to families and genera scattered through the work.

Prof. McBride is now extending his labors to the *Fungi of North America.*

Review of "Monograph of the Myxomycetes." Ger. Marssee, London. (In press.)

Prof. L. H. Pammel, of the Agricultural College, has published the following papers: "On the Seed Coats of the Genus Euphorbia;"[8] Illustrated; with a partial Biblliography. He concludes that the seed coats offer few characters of systematic value.

"Fungus Disease of the Sugar Beet," especially in Iowa.

"Temperature of Plants," read at the Rochester Meeting of A. A. A. S., showing that temperature in shaded ground is lower than in open ground.

Report on "Some Observations on Parisitic Fungi in 1892." The fluctuations of temperature were very sudden. Peach trees suffered greatly from *Taphrina deformans*, *T. amea*, *T. pruni*, *Puccinia rubigo-vera* and *P. graminis* were reported as common.

Prof. Pammel is now working on a paper on the "*Chromogenic bacteria*," at Ames, in which a full bibliography and descriptions of new species will appear.

He is also carrying on a series of experiments in crossing curcubito, which show that the species experimented with will not cross.

Among the zoologists active work has been carried on as follows:

Gilman Drew has been observing the habit of dragon flies.

Prof. H. W. Norris, of Iowa College, has made an important contribution to animal morphology in the shape of a paper on "The Development of the Auditory

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[1] Bulletin Geological Society of America, Vol III, pp. 283-300, 1 plate.
[2] Dissertation Johns Hopkins University, 1892, 24 pp., 1 plate.
[3] American Geologist, Vol. X, pp. 273-277.
[4] Am. Jour. Sci. (3), Vol. XLIV, pp. 447-452
[5] American Geologist, Vol. X, pp. 380-384.
[6] Engineering and Mining Journal, Vol. LIV, p. 634.
[7] Bulletin from the Labratories of Natural History of the State University of Iowa Vol. II. No. 2.
[8] Trans. St. Louis Acad. of Sci. Vol. V., No. 3.

Vesicle," the first of a series of "Studies on the Development of the Ear of Amblystoma," commenced in the Journal of Morphology, Vol. VII, No. 7. So far as I am aware this is the most important morphological work done by any Iowa zoologist during the year. Reconstructions in wax from serial sections were made, and the whole subject clearly presented in a series of excellent figures. Prof. Norris has also published an account of the "Development of the Ovule in *Grundilia squamata*." [1] He is at present continuing his studies of the Vertebrate Ear, especially in Batrachia.

C. C. Nutting has published a review of the late work on "Coloration of Animals, by Beddard [2]

"What is an Inherited Character?"[3] in which an atempt is made to show the impossibility of finding such a character that will be accepted by the Neo Darwinians.

"Report on Zoological Explorations on the Lower Saskatchewan River.[4] This report is devoted largely to the collection of birds made by a party from the State University in the summer of 1891. Over one hundred species were collected, and many interesting phases of plumage are described. A specimen of grouse containing the characters of *Dendragapus canadensis* and *D. Franklinii*, and a warbler containing specific characters of *Geothlypis macgillivrayii* and *G. philadelphia*, are described.

A paper has been prepared for publication on the "Vascular Supply of the Teeth of the Domestic Cat," and investigations on the poison apparatus and fangs of *Heloderma horridum* have been made resulting in the discovery of a beautiful demonstration of the homology of *teeth and scales*, the scales containing *true dentine*.

Prof. Herbert Osborn, of the State Agricultural College, has been active as ever. An important work is a paper on *Lice Affecting Domestic Animals.*[5] Illustrated. Fifteen species of these pestiferous insects are described. An introductory account written in plain English for the people is a commendable feature. The methods for exterminating several of the parasites are also given.

Professor Osborn and H. A. Gossard are the joint authors of *Reports on Injurious Insects*. Prof. Osborn's most important work this year, from a systematic standpoint, is his "Partial Catalogue of the Animals of Iowa."[6] The list of mammals is from a previous list by the author and one by F. W. Goding.

The list of birds is, as the author says, condensed from one published by Chas. Keyes and Dr. H. S. Williams in 1888. Two species are added by Prof. Osborn, *Lanis atricilla*, Ia.(?) and *Callipepla squamata*, reported by Prof. J. E. Todd in 1889.

The lists of Reptilia and Batrachia are based on the collections in the Agricultural College museum. A list of fishes is added by Prof. S. E. Meek.

The lists of Hymenoptera and Lepidoptera are based on the collections of the Agricultural College.

In his list of *Coileoptera*, Prof. Osborn has added 384 species to the list of 871 species published by H. F. Wickham in the Bulletin from the Biological Laboratories of Natural History of the State University of Iowa, Vol. 1, No. 1, 1888.

The following is a partial list of other scientific papers published by Prof. Osborn during the year 1892:

Am. Nat., Aug., 1892.
Science, 1892.
Am. Nat., Dec., 1892.
Bulletin from the Biological Laboratories of S. U. I., Vol. III, No. 1.
[5] From Bulletin No. 16 Iowa Agric. Experiment Station.
[6] Published by authority of the Board of Trustees of Iowa Agricultural College.

Report of a Trip to Kansas to Investigate Reported Damages by Grasshoppers. Insect Life, Vol. IV, pp. 49-56.

The Clover Seed Caterpillar (in connection with H. Gossard). Insect Life, Vol. IV pp. 56-58.

An Experiment with Kerosene Emulsions. Insect Life, Vol. IV, pp. 63-64.

Origin and Development of the Parasitic Habit in Mallophaga and Pediculidae. Insect Life, Vol. IV, pp. 187-191.

Notes on Grass Insects in Washington, D. C. Insect Life, Vol. IV, pp. 197-198.

The True Bugs, or Heteroptera of Tennessee. Insect Life, Vol. IV, p. 224. (Review.)

Notes on the Life History of Agallia sanguinoelenta, Prov. (Osborn and Gossard.) Canadian Entomolgist, Vol. XXIV, p. 35. (Abstract of same paper in Proc. Acad.)

On the Orthopterous Fauna of Iowa. Can. Ent., Vol. XXIV, p. 36. (Abstract from Proc. Acad.)

Note on the Species of Acanthia. Can. Ent., Vol. XXIV, pp. 262-265.

Honey Bee, or House Fly. Can. Ent., Vol. XXIV, pp. 270-271.

Also newspaper articles on economic subjects.

Prof. F. M. Witter has been at work on the fauna of the region around Muscatine.

Prof. B. Shimek, of the State University, has published a paper on "*Pyrgulopsis scalariformis*,"[1] in which the author concludes that *P. scalariformis* and *P. mississippiensis* are identical and calls them by the former name.

A list of 38 species of shells found associated with *Pyrgulopsis* is added.

When it is remembered that every one of the men whose work has been referred to in the preceding account is forced to respond to the innumerable calls made upon the college professor or teacher for time and energy, and that all of the work was done in addition to regular work, and papers read before this Academy, the showing which I have been able to make has certainly been most creditable. It amounts to a demonstration that a majority of the real scientific workers of Iowa are included in our number, that this Academy is a thoroughly representative body of men.

In looking over the list of persons in attendance on the last meeting of the *American Association for the Advancement of Science*, at Rochester, N. Y., I find the names of ten Iowans; *seven* of the ten are members of the *Iowa Academy of Sciences*, and one of the remaining three is the wife of one of our most honored members, leaving only two of the ten *not* connected with this body. Such facts are surely significant and show that our legislators were right in officially acknowledging our Academy as *the* representative body of Iowa scientific workers.

REPORT OF COMMITTEE ON STATE FAUNA.

BY C. C. NUTTING, CHAIRMAN.

About two months ago the chairman of this committee sent a circular letter to all the members of the Academy asking for notes that could be used in this report. Up to the time of writing, December 19th, only one member has responded to this request, giving an interesting note concerning one species of animal new to the State, and a note concerning the disappearance of the beaver from Big creek, Tama county.

Under these circumstances it is impossible to give as full a report as could

[1]Bulletin from Laboratories of Nat. Hist. State University of Iowa.

be desired, as an individual cannot be expected to cover the whole field of Zoology. We will attempt, therefore, a report on the Vertebrates alone.

During the past year Prof. Osborn has published a "Partial Catalogue of the Animals of Iowa[1]," which furnishes a convenient basis upon which to build in completing the list. In this report all species not mentioned in Osborn's catalogue will be regarded as new to the State.

MAMMALS.

Putorius longicauda, Bonaparte.—New to the State. Two specimens collected in Johnson county and now in the University museum.

Mephitis putorius (L.).—New to the State. Reported from North Tama county, and specimen deposited in Agricultural College museum. It has also been reported from Johnson county, but specimens have not been submitted.

Canis lupus, L.—Reported as appreciably increasing in numbers in the northern part of the State, especially in Fayette county.

Cariacus virginianus, (Bodd.)—A specimen of this deer was killed last winter in Johnson county. There is a strong probability, but not a certainty, that the animal had escaped from confinement in another part of the State.

Castor fiber, L. Beaver.—A family of beavers is reported by Sirrine as having worked on Big Creek, North Tama county, for eight years past, but not a trace of them could be found last fall.

Lepus campestris, Bachman. Prairie Hare.—This species is slowly working its way south. Last year it was reported by Prof. Witter from Muscatine county, and during the past fall a specimen was killed in Johnson county, and is now in the State University museum.

BIRDS.

The following species are for the first time reported from Iowa:

Sterna hirundo, Linn. Common Tern. Johnson county, Iowa. Specimen in University museum.

Sterna stchegrava, Lepech. Caspian Tern. Johnson county, Iowa. Reported by John Williams. Specimen in University museum.

Phalacrocorax dilophus floridanus, Aud. Florida Cormorant. Johnson county. Specimen in University museum.

Glaucionetta islandica, (Gmelin). Barrow's Golden-eye. Secured by Robt. E. Leach, Independence, Iowa, October 11, 1892. Specimens in University museum.

Chen caerulescens, (Linn.).[2] Blue Goose. Whiting, Iowa. D. H. Talbot. Specimens in University museum.

Philacte canagica, (Sevast.). Emporer Goose. Johnson county, Iowa. Fall of 1887. J. T. Paintin.

Plegadis guarauna (Linn.) White-faced Glossy Ibis. Rippey, Iowa, 1891. B. F. Osborn. Specimen in University museum. Mr. Osborn reports there was a flock of thirteen near Rippey, but only one was secured.

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[1] Published by the authority of the Board of Trustees of the State Agricultural College.

egarded as a distinct species by Ridgway. See "Manual," p. 115.

Porzana jamaicensis (Gmelin), Black Rail. Burlington, Iowa, 1889.—Specimens in the flesh examined by me.

Tringa bairdii, Coues. Baird's Sandpiper. Two specimens killed near Iowa City last spring. Now in University museum.

Numenius borealis (Forst). Eskimo Curlew. Johnson county, Iowa. Frank Bond. Specimens in University museum.

Ægialitis semipalmata, Bonap. Semipalmated Plover. Secured near Iowa City last spring. Specimen in University museum.

[*Ictinia mississippiensis* (Wilson). Mississippi Kite. (Ridgway.[1])]

Falco mexicanus, Schlegel. Prairie Falcon. Storm Lake, Iowa. Frank Bond. Specimens in University museum.

Falco richardsonii, Ridgw.—Richardson's Merlin. Storm Lake, Iowa. Frank Bond. Specimens in University museum.

Rubo virginianus (Gmel.). Great Horned Owl. Common at Iowa City. Several specimens in University museum.

Chordeiles virginianus henryi (Cass.).—Western Nighthawk. Johnson county, Iowa. Specimens in University museum.

Calcarius ornatus, (Towns.).—Chestnut-collared Longspur. Cedar Rapids, Iowa. (Bailey.)

Dendroica vigorsii, (Aud.). Pine Warbler. Johnson county, Iowa. Spring, 1892. Specimen in University museum. •

Notes on changes in geographical distribution, or unusual occurrences of Iowa birds.

Anser albifrons, Gmelin.—White-fronted Goose. Johnson county, October 7th, 1888. J. T. Paintin.

Porzana noveboracensis, (Gmelin).—Yellow Rail. One specimen secured near Iowa City, 1892.

Strix pratincola, Bonap.—American Barn Owl. Several seen near Iowa City, December, 1876, by John Williams.

Nyctala acadica (Gmel.) Reported as occurring near Davenport by E. G. Decker.

Otocoris alpestris praticola (Hensh.). Prairie Horned Lark. Formerly unknown near Iowa City, but now abundant (John Williams).

Dolichonyx oryzivorus (Linn.). Bobolink. Increasing near Iowa City.

Xanthocephalus xanthocephalus (Bonap.). Yellow-headed Blackbird. The first specimen was secured in Johnson county in 1892, by J. T. Paintin.

Sturnella magna neglecta (Aud.). Western Meadowlark. This species is spreading eastward over the State. Dr. Calvin and Mr. Houser report it as becoming abundant in Cerro Gordo county.

Dendroica cærulea (Wilson). Cerulean Warbler. Rather common near Iowa City last spring.

Coccothraustes vespertinus (Coop.). Evening Grosbeak. Of very irregular occurrence near Iowa City. None seen last year. Two secured in December, 1892, by J. T. Paintin.

Loxia leucoptera (Gmel.). White-winged Crossbill. A flock summered near Iowa City in 1885 (J. T. Paintin).

Plectrophenax nivalis (Linn.). Snowflake. Two specimens in the flesh brought to the University museum by J. T. Paintin last winter.

In concluding the notes on birds, it may be said that there is a well marked

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•Originally entered in this report by mistake. Of doubtful occurrence in Iowa.

movement of the northern and western species toward the south and east. Almost without exception the novelties included in the above list come from the north and west.

Among mammals the same is true, although the evidence is not so extensive. The Prairie Hare is the most marked case in point.

REPTILES.

The following species are not found in Prof. Osborn's catalogue. Specimens of each are in the University museum.

OPHIDIA.

Eutainia saurita (L.). Johnson county, Iowa.
Coluber guttatus, L. Rippey, Iowa. B. F. Osborn.
Diadophis punctatus (L.). Rippey, Iowa. B. F. Osborn.
Crotalus horridus, L. Iowa City, Iowa.

LACERTILIA.

Eumeces septentrionalis (Baird).

BATRACHIA.

Amblystoma jeffersonianum (Green), Baird. Specimens from Iowa in University museum.

FISHES.

The following species should be added to the list on the basis of specimens from Iowa in the University museum.
Ammocœtes niger (Raf.), Jordan. Iowa City.
[*Moxostoma microlepidota*[1] (Le S.), Jordan. Iowa City.]
Cliola forbesii, Jordan.[2] Iowa City.
Acantharchus pomotis (Baird), Gill. Iowa City.

SIGNIFICANCE OF THE CONCEALED CRESTS OF FLY-CATCHERS.

BY C. C. NUTTING.

In all the works on animal coloration that have come under my observation, there is a marked absence of any attempt to account for the concealed crests of bright colors on the crown of many birds, notably the *Tyrannidæ* or "Fly-Catchers."

The writer, although the first, so far as he knows, to offer an explanation for this class of facts, was for a long time compelled by press of other duties, to defer for a number of years any considerable investigation in this direction. Last summer, however, he took the time to examine the collection of *Tyrannidæ* at the Smithsonian Institution, probably the largest series of this exclusively new world group in the world.[3]

[1]This is doubtless the same species that is entered by Meek in Osborn's list as *M. duquesnii*, and is therefore *not* a species new to the State.

[2]Synopsis of Fishes of North America. Jordan and Gilbert, 1882, p. 174.

[3] The writer wishes to take this opportunity to acknowledge the never failing courtesy and patience of Mr. Robert Ridgway in facilitating the examination of the splendid collection under his charge.

The facts ascertained by this examination were briefly as follows:

Out of sixty-one genera examined, seventeen contained species characterized by the possession of concealed crests, and forty-nine contained species without them. That is about twenty-six per cent of the genera contained species with these crests and seventy-four contained species without them.

It has been held that these crests afforded a good generic character among the *Tyrannidæ*, but the facts just given would militate against this view, a generic character which fails six out of seventeen times being of very questionable value.

To one acquainted with the North American *Tyrannidæ* only, there would seem to be a relation between large sized birds and the possession of these crests. *Tyrannus*, *Pitangus*, *Milonlus* and *Myiodynestis* are the largest of our Fly-Catchers, and they all possess concealed crests, while the remaining N. A. genera (seven) all comprise smaller birds none of which exhibit the crests.

An examination of all the genera of the family, however, shows that this distinction breaks down almost completely, the average length of those species with the crests being 6.53 in., and that of those without the crests being 6.47 in., an entirely insignificant difference which would be much reduced if the long-tailed species of *Milonlus* were taken out of the first class.

There is, as would be expected, a marked relation between the general color of the birds and that of the crests.

Thus out of seventeen genera with crests, thirteen had red or yellow crests associated with an absence of yellow in general color. Only two had red or yellow crests associated with white in general coloration, and one of these, *Milonlus*, showed red on the axillars.

Thus we see that in sixteen out of seventeen cases, or 94 per cent, there is a marked relation between the color of the concealed crests and the general coloration of the birds.

A condensed statement of the facts may be as follows:

First—About 25 per cent of the genera of *Tyrannidæ* contain species possessing concealed crests.

Second—This crest has no reliable value as a generic character, holding good in only two-thirds of the genera.

Third—There is no relation between the size of the birds and the possession of concealed crests if we take the whole family into account, although in North America the largest species have crests, while the smaller have none.

Fourth—There is an obvious relation between the color of the crests and the general coloration of the bird, a large proportion of species with red and yellow crests, having yellow as a main feature of their general coloration.

Let us now attempt to explain the significance of concealed crests in the life of the birds. Their frequent occurrence would indicate *a priori* that they are of service to their possessors, and to point out that service is the main object of this paper.

In Vol V, page 396 of the proceedings of the U. S. National Museum is the first suggestion of the significance of these concealed crests that I have been able to find. It occurs in a report written by myself on a collection of birds from Nicaragua.

In discussing *Muscivora mexicana*, a species of Fly-Catcher with a marvelous fan-shaped, erectile crest, the following language is used:

"Is it not possible that this bird is provided with its remarkable crest for the purpose of attracting its insect prey, and that the slow and regular waving motion is calculated to still further deceive by a simulation of a flower nodding in the breeze?"

I may add that further observations on the same species convinced me that my explanation was correct.

Mr. Charles W. Beckham, in a paper published a year or two later (which I am unfortunately unable to find), has the following to say in relation to the common "Kingbird" or "Bee Martin:"

"Several years ago I saw one of these birds occupying an exposed perch on a pear tree in bloom about which many bees were darting. Several times I observed that the bird caught the insect without leaving his perch, by quickly turning his head and grabbing them. My attention being thoroughly aroused, I noticed that many of them seemed to fly directly toward him, the majority seeming to 'shy off' at a short distance and change their course, but very few that came within reach escaped him. The question naturally suggests itself: Did the thrifty hymenoptera mistake the fully displayed orange-red crown (I could see that the crest was erected) for a flower?"[1]

Mr. Beckham also quotes my own observations on *Muscivora mexicania* above referred to.

From that time to this there has been little attention paid to the matter, as far as I can ascertain. The later writers such as Wallace and Poulton have ignored the question entirely, although they recognize similar phenomena in regard to animals, and have grouped them together for purposes of discussion.

Wallace says:[2]

"Besides these insects which obtain protection through their resemblance to the natural objects among which they live, there are some whose disguise is not used for concealment, but is a direct means of securing their prey by attracting them within the enemy's reach."

"Only a few cases of this kind of coloration have yet been observed, chiefly among spiders and mantidæ; but no doubt if attention were given to the subject in tropical countries many more would be discovered."

Poulton in his "Colors of Animals," says:

"Special aggressive resemblance sometimes does more than hide an animal from its prey; it may even attract the latter by simulating the appearance of some object which is of especial interest or value to it."[3]

Mr. Poulton cites the case of the Asiatic lizard which is colored like the sand on which it lives. A fold of skin at the corner of the mouth is red in color and is "produced into a flower-like shape exactly resembling a little red flower which grows in the sand." This the lizard successfully uses as a decoy for catching its insect food.

Beddard is the only recent writer, so far as I have been able to discover, that alludes in any way to alluring colors among birds. After speaking of the alluring coloration of the lizard "fishing frog," etc., mentioned by Poulton, he adds:

"It is said that the brightly colored crests of many birds act in the same way as a lure. Here of course there can be no question of any special resemblance to a flower."[4]

And with this casual allusion Mr. Beddard leaves the question without discussion.

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[1] Quoted by me from Standard Natural History, Vol. IV, p. 499.

[2] "Darwinism," p. 210.

[3] "Colors of Animals," p. 72.

[4] "Animal Coloration," p. 188.

It seems strange that such a striking assemblage of facts as is exhibited by these concealed crests should have been left so long practically unnoticed by those who make a special study of coloration. A partial explanation may be found in the fact that no American has undertaken a serious study of coloration. The *Tyrannidæ* are all American, and British writers have had little opportunity to study their habits. Another important consideration is that the writers on coloration have concentrated their attention almost exclusively on insects, and have passed over the birds with an entirely inadequate examination of these strikingly colored animals.

Let us now turn to the argument, which is based partly on elimination, partly on the study of the habits of insectivorous birds in general, and partly on direct observation.

According to modern ideas all special organs or characters are supposed to be of special use in the economy of their posessors.[1]

Colors are useful to birds in many ways. These uses have been divided into four general classes, *protective*, *aggressive*, *directive* and *attractive*.

Protective coloration includes all cases where animals are helped in escaping their enemies by their colors, either by a resemblance to environment, which aids in concealment, or by a mimicking of dangerous or distasteful forms. This includes both true mimicry and warning coloration such as is exhibited by skunks. coral snakes, wasps, etc. It needs no argument to show that concealed crests do not come under this head.

Directive coloration furnishes a means by which individuals, particularly of gregarious species, may keep track of their fellows after being scattered. The crests of Fly-Catchers are probably concealed during flight and at any rate cannot be seen at a sufficient distance to be effective as directive colors.

Attractive coloration includes all cases when the colors serve to attract the attention and secure the favor of the mate. They are generally, among birds at least, secondary sexual characters and one usually considered to be a product of sexual selection. They are apt to appear in the male only, or to be especially intense in that sex.

One of the most notable peculiarities of the concealed crests of the Fly-Catchers is the fact that they are *invariably possessed by both sexes*. Among the sixty-one genera examined by me, there was not one in which the male alone had a true concealed crest, although in a few rare instances it was much more conspicuous in the male, and in one, *Muscivora mexicana*, the crests were equally conspicuous in both sexes, but crimson in the male and bright yellow in the female.

These crests, then, can hardly be regarded as secondary sexual characters, and hence, cannot be considered as coming under the head of attractive coloration in the technical sense of the word.

There remains but one more class of coloration, and that is *aggressive* coloration, which assists its possessors to capture their prey. It is the direct opposite to protective coloration; may be such as to aid an animal in stalking its quarry, or it may serve as a *decoy* to attract the prey within reach of the animal pursuing. It is evident that the bright crown patch of the kingbird can be of no service in concealing the bird from its insect food. Hence, by a process of exclusion we come to regard the concealed crests of Fy-Catchers as *alluring coloration*.

Of course, this reasoning is of little weight if taken alone. A much more im-

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[1]Rudimentary organs or characters would at first sight seem to be an exception to this rule; but rudimentary organs are, in nearly all cases at least, regarded as remnants of organs once functional and useful to their possessors.

portant step in the argument is taken when we discover that the *true concealed crests* are *always found among insectivorous birds*, and nowhere else, so far as I can discover, among American birds, at least.[1] They occur among the *Tyrannidæ Oxyrhamphidæ*, *Pipridæ*, *Tanagridæ* and the *Regulinæ*.

Now, all of these birds are essentially *insectivorous* and I have been unable to find

Now, when we add to these considerations and facts the observations of Mr. Beckham on the Kingbird, and myself on *Muscivora mexicana*, in which cases the crests were seen to be of direct service in alluring insects; the theory may be regarded as practically demonstrated, although a larger number of observations is greatly to be desired.

Another interesting fact is that all of these crests are *erectile*, and are conspicuous when erected, and partially or completely concealed when not erected. Insectivorous birds which are without these crests often erect the feathers of the crown when excited by anger or the proximity of food. I noticed last summer, while visiting Mr. Ridgway, that his pet song-thrush always erected its crown feathers when about to peck a fly from anyone's fingers, which was its habitual way of feeding.

Many *Tyrannidæ* have yellow or red as part of their general coloration. Some of these colors at the bases of the crown feathers would be exposed when the feathers are erected in the excitement incident on the approach of insect prey. If this tended to benefit the bird by attracting the insects, natural selection would preserve and intensify it, and we may thus see the means or method by which concealed crests may have originated.

It may be suggested in conclusion that these concealed crests are probably among Nature's latest devices wherewith she has equipped her feathered favorites. The fact that they appear among the most highly specialized genera of the *Tyrannidæ*, and are often specific and not generic characters, shows them to be lately acquired. Another indication of the same truth lies in the fact that, in many species, at least, the crests are acquired rather late in life, young birds having little or no trace of it.

PHÆNOLOGICAL NOTES FOR 1892.

BY L. H. PAMMEL.

It has always seemed to me that there is abundant room for such botanists as have little time to do original work to devote a few moments in taking notes on the leafing, flowering and ripening of seeds of our native and cultivated plants, in short everything that may be considered under the head of phænological observations. These observations, like those on the pollination of flowers may be made at odd moments and would be of great service to working botanists. If a few scattering botanists would only collect insects on various flowers and make field observations, then turn them over to a botanist like Mr. Roberts, it would be of incalculable benefit. So, too, in this phænological work botanists all over the country should make a few observations, bring them together so that some general conclusions

[1]There may be other cases among Central and South American birds, as lack of time prevented my going through the whole series as carefully as I could have desired.

a single well-defined concealed crest which is possessed by a non-insectivorous bird.

and tabulations might be made. I think it is fortunate that the Weather Bureau of the Department of Agriculture is undertaking this work and that Prof. Bailey is to bring together some of the scattered information on this subject.

But before any accurate phænological maps can be made it will be necessary to carry on these observations much farther than they have been carried. The published records, so far as I have looked them up only occur in New York, Wisconsin, Michigan, and Iowa.[1] It would no doubt aid systematic botanists somewhat if a phænological map could be prepared for the United States as Hoffman[2] has for Central Europe. If these records are to be of great value they must be taken with some care. Everyone is familiar with the individual differences to be found in some plants. Caspary[3] has called attention to the great variation of the time of flowering of certain plants in limited areas. This difference in the opening of flowers may be carried beyond the average period not only several days but as much as two weeks. Magnus[4] states that *Juglans regia* flowers seventeen days earlier in the closely crowded parts of Berlin than in the suburbs. This early flowering, he thinks, is not due to an individuality of the tree, but to the great amount of heat that is radiated by the numerous buildings. But many of these differences are individual variations of the tree or certain peculiarities of the soil. The writer has often observed great differences in the time of leafing and fall of leaves in trees and shrubs growing in close proximity. In the autumn of 1891 the writer had under observation several trees of the Soft Maple *(Acer saccharinum)*. The trees covered an area of not more than 900 square feet, yet the leaves began to turn yellow and lose their foliage at very different times. One tree was fully ten days later than the earliest one. The appearance of leaves of different individuals of this species is a matter of common observation.

In 1883 I made some observations on the leafing of different individuals of Shell Bark Hickory *(Hicoria ovata)* and Stag-horn Sumach *(Rhus typhina)*, which were reported by Prof. Trelease.[5] Individuals of these species showed considerable difference in the appearance of their first leaves. In part due to exposure and soil conditions no doubt, but part may have been an individual peculiarity. In making phænological observations it is of course important to select an average tree or specimen. Prof. Bailey[6] has well said "While the method gives us the characteristic of the individual rather than of the species, it is, nevertheless invaluable from the fact that it eleminates all variations due to soil and exposure; and the writer is confident,

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[1] Britton, Bull. Torrey Bot. Club Vol. VI No. 42, p. 235.

Leggett " " " " " " 44, p. 223.

Trelease first and second annual report Wis. Agrl. Experimental Station.

Halsted, Bull. Iowa Agrl. College, Dept of Bot. 1886, p. 42.

Bailey, Bull. No. 31, Michigan Agrl. College, p. 67.

Beal & Wheeler, Flora of Mich.

Pammel, Bull. Torrey Bot. Club Vol. XIX, p. 375.

[2] Petermann' Geogr. Mith. Vol. XXVII, pp. 19-26, two plates. Just. Bot. Jarhesb, 1881, p. 290.

[3] Ueber die zeiten des aufbrechens der ersten Blüthe n in Königsberg i Pr. Schriften der Physik-Oekon. Gesellsch. zu Konigsberg, Vol. XXIII, 1882, 115-126. Just. Bot. Jarhesb. 1882, p. 269.

[4] Monatschr. d. Vereins zur Beförd. des Gartenbaues der Königl. Preuss. Staatens, 24 Jahrgang, 1881, pp. 204-205. Just Bot. Jarhs., 1881, p. 291.

[5] First annual report of Wisconsin Agrl. Exp. Station, p 56.

[6] Bailey, Bull. No. 31, Agrl. College Mich. 1887, p. 67.

from a considerable observation, that even these selected and isolated specimens represent very closely the characteristics of the species."

By way of comparison I have added a table showing the appearances of some flowers in Ames, Iowa; Madison, Wisconsin; Lansing, Michigan, and Vienna, Austria. I have had to choose woody species as they were the only ones recorded for Lansing, New York, and Madison. It is to be regretted that these comparisons could not be obtained for the localities of the same year. Those of Vienna, however, represent the mean of ten years. Nothing is said about the lateness or earliness of the season in New York or Lansing. The season of 1892 for Ames was somewhat backward, and the spring of 1884 for Madison was normal, I think. In preparing these notes the writer is under obligations to several of the students of the College, but especially to Geo. W. Carver and F. C. Stewart. Many of the notes were made by myself at odd times. The length of branches is given; in some cases the greatest length is recorded, in others the average. A = average; T = terminal; L = lateral branches; Sh = long shoot; F = falling of leaves; O = early appearance of leaves.

	Ames, Iowa, 1892 (latitude 42°).	Madison, Wisconsin, 1884 (latitude 43°, 10').	Lansing, Michigan, 1887 (latitude 42°, 40').	New York (latitude 40°, 50').	Vienna, Austria, 1851-61 (latitude 48°, 20').	
Pyrus prunifolia	5-15	5-19	.....	4 21	4 26	
Pyrus malus	5-20	5-20	.....	5-4	4-20	
Amelanchier canadensis	5 1	.....	.....	4-14	4-18	Ames (Halsted) 1886, 4-20.
Prunus padus	.....	5-10	.....	.....	4-28	Kuhmo, Finland, 1887, 6-29.
Prunus avium	.....	5-10	.....	.....	4-19	
Prunus americana	.....	5-10	.....	.....	4-19	
Prunus virginiana	.....	5-16	5-12	.....	5-4	
Prunus serotina	.....	.....	.....	.....	5-24	
Prunus cerasus	.....	.....	.....	4-21	4-19	
Trifolium pratense	6-6	.....	.....	.....	5-30	St. Charles, Mo. (Pammel) 1892, 5-19, earlier probably.
Trifolium repens	6-14	.....	.....	.....	6-1	St. Charles, Mo. (Pammel) 1892, 5-19, earlier probably
Amorpha fruticosa	6-11	.....	6-6	.....	6-7	
Robinia pseudacacia	.....	.....	5-26	.....	5-30	
Gymnocladus dioicus	.....	.....	.....	.....	6-4	
Gleditschia triacanthos	.....	.....	.....	.....	6-5	Ames (Halsted) 1886, 6-2.
Vitis riparia	6-11	.....	5-20	.....	.....	Ames (Halsted) 1886, 5-20.
Ribes aureum	5-4	5-10	5-9	.....	4-17	
Ribes rubrum	5-10	5-10	.....	.....	4-18	
Ribes alpinum	5-15	.....	.....	.....	4-17	
Ribes nigrum	5-15	5-10	.....	.....	.....	
Rhus continus	.....	.....	6-1	.....	5 22	
Acer saccharinum	.....	3-17	.....	.....	.....	Ames (Pammel) 1891, 3-14. Halsted, 1886, 3-22.
Acer negundo	5-2	.....	4-27	4-21	.....	
Sambucus canadensis	7-7	.....	6-19	.....	.....	
Viburnum opulus	6-5	.....	5-14	.....	5-7	
Helianthus annuus	7-10	.....	.....	.....	8-16	
Taraxacum officinale	5-1	.....	.....	.....	4-21	
Rudbeckia hirta	6-29	.....	.....	.....	6-26	
Solidago rigida	.....	.....	.....	.....	8-10	
Silphium laciniatum	7-10	.....	.....	.....	7-29	
Zea mays	7-20	.....	.....	.....	7-20	

The table is, however, instructive as showing how these plants flower in different places. The species of *Ribes* flowering nearly at the same time in Ames and Madison, in Vienna twenty-three days earlier. Climate has not retarded or hastened the time of flowering. The flowering of *Pyrus prunifolia* about the same time in New York and Vienna, and nineteen days later in Ames and twenty-three in Madison. *Helianthus annuus* flowers n arly a month earlier in Ames, *Silphium laciniatum* about nineteen days. *Rudbeckia hirta* about the same time in Vienna and Ames. *Taraxacum officinale* about twenty days earlier in Vienna.

SPECIES.	March.	April.	May.	June.	July.	August.	September.	October.	LEAVES OUT.	Seeds ripe.	Height in inches.	REMARKS.
RANUNCULACEAE—												
Ranunculus septentrionalis		29							4-29 lvs. out 1 in. long			Flowers close between 5 and 6 P. M.
Ranunculus rhomboideus			3							6-5		
Ranunculus abortivus			2									
Ranunculus acris					7							Flowers probably earlier.
Anemone nemorosa			5									
Anemone virginiana			29							7-28		
Anemone pennsylvanica				5								
Anemone patens var. nuttalliana		23										
Catltha palustris		29										
Isopyrum biternatum		23										
Anemone thalictroides			25									
Aquilegia canadensis			24									
Anemone hepatica var. acua		4										
Delphinium azureum				18							24-36	
Clematis virginiana					16							Still in flower, 7-22.
Clematis pitcheri			29				14					
Thalictrum dioicum			5								20	
Thalictrum purpurascens											24-70	
MENISPERMACEAE—												
Menispernum canadense			18								Sh. 120	
BERBERIDACEAE—												
Podophyllum peltatum			12									
Berberis vulgaris											T. 24	
FUMARIACEAE—												
Dicentra cucullaria		23										
Fumaria officinalis					10							
CRUCIFERAE—												
Dentaria laciniata		28										
Cardamine bulbosa			19									
Cardamine flexuosa			21									
Draba caroliniana		22										Winter annual. Flowers nearly closed during cloudy weather
Nasturtium armoracia				1					4-8 one inch long			Flowered abundantly.
Nasturtium palustre				22								
Barbarea vulgaris		26										
Erysimum cheiranthoides												
Sisymbrium canescens			5									
Sisymbrium officinale				20								

Thelypodium pinnatifidum				18								
Brassica nigra											84	
Capsella bursa-pastoris		12										Winter annual
Arabis dentata			30									
CAPPARIDACEAE—												
Polanisia graveolens					10							
CISTACEAE—												
Helianthemum majus				20								Cleistogamous, flowers abundant 7-20.
VIOLACEAE—												
Viola pinnatifida			7									
Viola palmata, var. obliqua		29					28					Cleistogamous, flowers abundant 7-20. [on stem.
Viola pubescens			5									Cleistogamous, flowers abundant 7-20 in upper arils
CARYOPHYLLACEAE—												
Saponaria officinalis									4-7 starting			
Saponaria vaccaria					7							
Silene stellata					9							
Silene nivea				20				1				
PORTULACEAE—												
Portulaca oleracea									Badly frosted 10-16			Still in flower 10-3.
Claytonia virginica		9										
MALVACEAE—												
Abutilon avicennae							5					Still in flower.
Hibiscus trionum					15							Self-sown, persistent.
TILIACEAE—												
Tilia americana					1							
LINACEAE												
Linum usitatissimum			30							7-12		
Linum sulcatum										7-15		
GERANIACEAE—												
Geranium maculatum			15									In flower, Moberly, Mo., 5-19.
Geranium carolinianum										7-18		
Erodium cicutarium										7-16		Seeds sown 5-1
Oxalis violacea			7									
Oxalis corniculata			24						5-4 Seeds germinated. First pair of leaves			In flower at Moberly, Mo., 5-19
Oxalis corniculata var. stricta			30									
Impatiens fulva					15							
RUTACEAE—												
Xanthoxylum caroliniana			10								A 24	

SPECIES.	March.	April.	May.	June.	July.	August.	September.	October.	LEAVES OUT.	Seeds ripe.	Hieght in inches.	REMARKS.
CELASTRACEAE—												
Euonymus atropurpureus					5							
RHAMNACEAE—												
Ceanothus ovatus var. pubescens				1								
Ceanothus americanus												
Rhamnus frangula										7-5		In flower a second time, 7-5.
VITACEAE—												
Vitis riparia				11					F. 9-2		Sh. 168	Represents the largest growth.
Vitis labruscæ, cult									F. 10-16			
Ampelopsis quinquefolia					10				F. 9-29			
SAPINDACEAE—												
Æsculus glabra			10						5-8 in full leaf			
Acer saccharinum									F. 10-23	6-5	T. 36	5-21 Leaves affected by frost.
Acer barbatum, var. nigrum									4-23 First pr. of lvs		T. 6-24	
Acer negundo			2						4-23 First pr. of lvs		Sh. 48	Leaves falling 9-24.
Staphylea trifolia			28									
ANACARDIACEAE—												
Rhus glabra											A. 36	
Rhus radicans				20								
Rhus cotinus				12								
POLYGALACEAE—												
Polygala incarnata					16							
Polygala verticillata					20							
LEGUMINOSAE—												
Baptisia leucantha				18							48	
Baptisia leucophæa			30							7-20		In flower, St. Charles, Mo., 5-19.
Gleditschhia triacanthos									F. 9-16		36	In fl wer, St. Charles, Mo., 5-19.
Trifolium pratense				6								In flower, St. Charles, Mo., 5-19.
Trifolium repens				14								In flower, St. Charles, Mo., 5-19.
Trifolium procumbens				20								
Trifolium hybridum				15								
Pisum sativum				12								Planted April 15.
Amorpha canescens				27								
Amorpha fruticosa				11								
Astragalus caryocarpus			18									7-16 Large, fleshy and somewhat sweetish, pods still [green.
Astragalus canadensis					22							

Vicia americana						21					30	
Lathyrus venosus				20						7-20		
Psoralea argophylla					1							
Cassia chamaechrista					16							
Cassia marylandica							3					
Desmodium acuminatum					16							
Desmodium canadense					22							
Gynmocladus dioica									F. 9-20		30	Leaves nearly all off 10-16
Aplos tuberosa							25					Last date of flower.
Petalostemon violaceus							27					Last date of flower.
ROSACEAE—												
Potentilla canadensis				12					O. 4-11			
Potentilla arguta					9				O. 4-2		42	
Potentilla fruticosa					4							
Potentilla norvegica					19							
Geum album				29				12	O. 4-7		36	
Geum virginianum				20								
Amelanchier canadensis			1									
Pyrus prunifolia			15				27		F. 9-14			
Pyrus malus			20						F. 9-29			In flower at Moberly, Missouri, 5-19
Pyrus Iowensis			29			24			F. 11-1		6-25	Double flowered form petals, very persistent.
Pyrus Iowensis, Fluke Crab			26									
Pyrus communis			28								70	
Pyrus sinensis			5									
Pyrus americana			5								36	In flower a second time, 8-8.
Pyrus toringo			28									
Pyrus aucuparia			23								9	Flowers a second time in September.
Prunus chicasa			12									
Prunus americana											72	
Prunus cerasus									F. 10-14		48	
Prunus serotina				5					F. 10-16	8-16	50	In flower, St. Charles, Missouri, 5-19.
Prunus virginiana			28							8-4		Through flowering, 6-5.
Prunus pennsylvanica												
Prunus persica											72	
Crataegus punctata				8							T. 48	Through flowering, 6-14.
Cartaegus coccinea var. mollis			22								T. 48	Through flowering, 5-30.
Agrimonia eupatoria					2							
Rubus villosus				5						7-24		
Rubus occidentalis										7-10	Sh. 36-96	Still in flower August 24.
Rubus strigosus										7-16		
Rosa arkansana												Flowers sometimes double.
SAXIFRAGACEAE—												
Ribes cynosbati			5									
Ribes gracile			6									
Ribes floridum			15									
Ribes aureum			4							7-18		
Ribes alpinum			15									
Ribes rubrum			10							7-8		

SPECIES.	March.	April.	May.	June.	July.	August.	September.	October.	LEAVES OUT.	Seeds ripe.	Height in inches.	REMARKS.
SAXIFRAGACEAE--*Continued*—												
Ribes nigrum			15							7-8		
Heuchera hispida				5								
LYTHRACEAE—												
Lythrum alatum					15							
ONAGRACEAE—												
Oenothera biennis					28			12			36-60	
Circæa lutetiana					4							
FICOIDEAE—												
Mollugo verticillata												
UMBELLIFERAE—												
Daucus carota			23									
Osmorrhiza brevistylis			21							6-29		
Cryptotænia canadensis				19								
Cicuta virosa var. maculata					15						24-60	
Zizia aurea			30									Full flower, St. Charles, Missouri, 5-19.
Sanicula marylandica				14								
Polytænia nuttallii										7-1		
Eryngium yucuæfolium					24							
Tiedemannia rigida						3						
ARLIACEAE—												
Aralia racemosa					15							
Aralia quinquefolia			28									
CORNACEAE—												
Cornus paniculata				19						8-12		
Cornus circinata					3							
Cornus sericea									F. 10-16	8-20		
CAPRIFOLIACEAE—												
Viburnum opulus				5								
Lonicera albertii				4								
Sambucus canadensis												Occasional flowers still occur 8-4.
RUBIACEAE—												
Galium trifidum					15							
Galium aparine			29									
Galium concinnum			19									

COMPOSITAE—												
Erigeron annuus					11							Winter annuals. Last fall's sown seed in flower. 8 16
Erigeron divaricatus												
Erigeron canadensis											75	
Erigeron philadelphicus				10							12-40	
Erigeron strigosus						1						Winter annual. Last year's seed in flower, 8-1.
Artemisia ludoviciana									4-4 starting			
Lepachys pinnata					15						Sh. 50	Late flower, September 30.
Lepachys columnaris					15							
Rudbeckia hirta				29								
Echinacea angustifolia					2							Earlier than recorded.
Helianthus annuus							10				48-98	Mature about September 10.
Helianthus strumosus							10					Flowers till frost.
Heliopsis lævis				25								
Bidens frondosa											12-60	
Antennaria plantaginifolia		20										
Taraxacum officinale			1						4-1 starting			Late flower, November 8.
Centaurea cyanus				12					4-1 starting			Winter annual.
Centaurea americana					31							Seed sown about May 5.
Troximon cuspidatum			27									
Achillea millefolium				15								
Cnicus hillii			29						4 2 starting			
Cnicus altissimus var. discolor						4		28	4 12 1 inch long			
Cnicus lanceolata					25			1				
Hieracium longipilum									4-22 1 inch			
Lactuca scariola				1								
Coreopsis palmata					2							
Coreopsis tripteris							19					
Ambrosia trifida							12					4-13. Seeds germinating. Still in flower on 10-1.
Sonchus asper				22				1	5-18 foot long			Flowers open at 9 A. M.
Lappa major				30					4-9 1 inch long		66	
Maruta cotula				18								
Solidago latifolia								1	4-2 Leaves			Still in flower on last date given.
Solidago rigida							17		4-4 Leaves			Still in flower on last date given.
Solidago missouriensis						1						Still in flower on last date given.
Solidago serotina											26	Still in flower on last date given.
Solidago ulmifolia							17					Still in flower on last date given.
Solidago speciosa								20				Still in flower on last date given.
Solidago canadensis							15					Still in flower on last date given.
Solidago graminifolia							25					Still in flower on last date given.
Solidago nemorosa							27					Still in flower on last date given.
Aster multiflorus								1				Still in flower on last date given.
Aster sericeus								1				Still in flower on last date given.
Aster azureus								1				Still in flower on last date given.
Aster novae-angliae							24					Still in flower on last date given.
Silphium laciniatum					15						24-84	
Silphium perfoliatum											72	
Liatris scariosa					30					8-5		
Eupatorium perfoliatum							24		Persist till frost.		20-48	Still in flower on last date given.
Eupatorium ageratoides							27					

SPECIES.	March.	April.	May	June.	July.	August.	September.	October.	LEAVES OUT.	Seeds ripe.	Height in inches.	REMARKS.
LOBELIACEAE—												
Lobelia spicata				12								
Lobelia cardinalis						1						
Lobelia syphilitica												Late flower, October 1.
CAMPANULACEAE—												
Specularia perfoliata			29									Cleistogamous flowers much earlier.
Campanula aparinoides					1							
Campanula americana					16							
PRIMULACEAE—												
Steironema lanceolatum				13								
Steironema ciliata				17								
ELEAGNACEAE—												
Eleagnus angustifolia									F. 11-10		36	12-24. Many leaves still hanging to the trees.
OLEACEAE—												
Fraxinus viridis									F. 9-24		50 sprouts	Leaves falling rapidly on 9-29.
Syringa vulgaris									F. 11-1		L. 6, sp. 24	
Syringa persica												
APOCYNACEAE—												
Apocynum cannabinum				24								
ASCLEPIADACEAE—												
Asclepias tuberosa				30								
Asclepias purpurascens				24							24-40	
Asclepias incarnata				29								
Asclepias verticillata					10							
Asclepias syriaca				30							24-60	
GENTIANACEAE—												
Gentiana alba							20					
POLEMONIACEAE—												
Phlox divaricata			7									
Phlox maculata				12								
Phlox drummondii				22								Seeds sown about 5-5.
Polemonium reptans			18									

HYDROPHYLLACEAE—												
Ellisia nyctelea			12									
BORRAGINACEAE—												
Echinospermum virginicum				29								
Echinospermum lappula				21								
Onosmodium carolinianum				20								
Borrago officinalis				21								A winter annual.
CONVOLVULACEAE—												
Convolvulus sepium				10							96	
Convolvulus arvensis				20								
Cuscuta glomerata				27								
SOLANACEAE												
S lanum nigrum				19								Leaves frozen 9-16.
Physalis lanceolata				11							18	
Physalis pubescens				18								
SCROPHULARIACEAE –												
Scrophularia nodosa var. marylandica				10								
Pedicularis canadensis			7									
Castilleia sessiliflora			12									Flowers turn to purple after fertilization.
Ilysanthis gratioloides				2								
Linaria vulgaris			2									
Verbascum thapsus				12				1			72	Leaves persistent till frost.
Veronica anagallis				1								
Veronica peregrina			15									A winter annual.
Veronica virginica											60	
Pentstemon pubucens var. digitalis				21								
BIGNONIACEAE—												
Tecoma radicans						4						
VERBENACEAE—												
Verbena bracteosa				15								
Verbena aubletia					10							
Verbena stricta					1							
Verbena urticifolia					28							
Verbena hostata											80	
LABIATAE-												
Pycnanthemum lanceolatum					2						36	
Lycopus sinuatus					5							
Mentha canadensis					4							
Dracocephalum parviflorum					19							
Teucrium canadense					10							
tachys aspera					12							

SPECIES.	March.	April.	May.	June.	July.	August.	September.	October.	LEAVES OUT.	Seeds ripe.	Height in inches.	REMARKS.
LABIATAE—*Continued*—												
Nepeta cataria					1							Still in flower 10-21.
Blephilia hirsuta					4							
Monarda fistulosa					15						24-62	
Leonurus cardiaca					1							
Hedeoma hispida				12								
Scutellaria parvula				15								
Lamium purpureum				7								
PLANTAGINACEAE—												
Plantago lanceolata				25								
NYCTAGINACEAE—												
Oxybaphus nyctagineus				13								
Mirabilis jalapa												
ILLECEBRACEAE—												
Anychia canadensis												
AMARANTACEAE—												
Amarantus albus				20								Leaves frozen on 9-16.
Amarantus retroflexus												Leaves frozen on 9-16.
CHENOPODIACEAE—												
Chenopodium album				14								
POLYGONACEAE—												
Rumex acetosella			30									
Rumex altissimus			29									
Rumex crispus				6								
Polygonum aviculare				14					4-7 starting.			
Polygonum ramosissimum							14					
Polygonum pennsylvanicum												Affected by frost 9-16
Polygonum amphibium					14							
Polygonum persicaria												
Polygonum virginianum							11					
Polygonum convolvulus					25							
Polygonum incarnatum					10							
Fagopyrum esculentum				12								
Polygonum erectium				12								
Polygonum muhlenbergii					5							

ARISTOLOCHIACEAE—												
Asarum canadense		29										
EUPHORBIACEAE—												Still in flower on date given.
Euphorbia corollata					12							Still in flower on date given.
Euphorbia maculata											16-24	
Euphorbia heterophylla							2					
Ricinus communis							1					
URTICACEAE—												
Ulmus fulva			15						F. 10-20		52	
Ulmus americana			15								T. 6-15	Still in flower on date given.
Celtis occidentalis				5					F. 9-30		T. 6- 8	
Cannabis sativa												
Humulus lupulus							11					
Humulus japonica												
Morus rubra												
Urtica gracilis					4							
Laportea canadensis											52	
JUGLANDACEAE—												
Juglans cinerea											T. 4- 6	
Juglans nigra											T. 36	
Hicoria ovata									F. 9-23		Sh, 72, T.36	
CUPULIFERAE—												
Corylus americana												Leaves out at Moberly, Mo., 5-19.
Ostrya virginica												Leaves red 11-3.
Quercus alba												Leaves still green 11-3.
Quercus macrocarpa			27						F. 11-3		T. 30	
Quercus rubra									Out 5-15			
Quercus robur var. pedunculata												
SALICACEAE—												
Salix alba									F. 10-8		T. 12-36	
Populus monilifera									F. 9-21			
Populus tremuloides			17									
CONIFERAE—												Began second growth 8-1.
Juniperus virginiana		23									T. 14	
Larix europaea		27							F. 10-20		T. 18-8	
Pinus pumilio				3								
Pinus sylvestris				4					F. 9-19		T. 30	
Pinus strobus				17								
Pinus resinosa									F. 9-22		L. 7, T. 33	
Picea nigra											L.4-5, T. 18	
Picea excelsa											L. 7 T. 18	
Picea alba											L. 6 T. 22	
Abies concolor											T. 13	

SPECIES.	March.	April.	May.	June.	July.	August.	September.	October.	LEAVES OUT.	Seeds ripe.	Height in inches.	REMARKS.
ORCHIDACEAE—												
Habenaria leucophæa				5								
Cypripedium candidum		18										
Cypripedium pubescens		30										
IRIDACEAE—												
Iris versicolor				11								
Sisyrinchium angustifolium		15										
AMARYLLIDACEAE—												
Hypoxis erecta			10									
LILLIACEAE—												
Smilax herbacea		20										
Smilax herbacea, var. pulverulenta				13								
Lilium philadelphicum				18								A few in flower. 7-12
Lilium canadense				25								
Lilium superbum					1							
Erythronium albidum			29									
Uvularia grandiflora				7								
Smilacina racemosa			21	1								
Smilacina stellata			7									
Asparagus officinalis				7								
Allium tricoccum				28								
JUNCACAE—												
Juncus tenuis				1								
ALISMACEAE—												
Alisma plantago					13							
CYPERACEAE—												
Carer pennsylvanica		29										
GRAMINEAE—												
Poa pratensis				5								
Poa arachinifera				8								
Bromus mollis				11								Open before 7 A. M.
Bromus breviaristatus				10								
Arrhenatherum avenaceum				9								
Kœleria cristata												7-20 plant dry.
Stipa spartea				12						7-14		7-20 plant dry.
Phalaris arundinacea										7-16		Head dry, remainder of plant green.

Triticum vulgare (winter wheat)									7-20		Wintered well.
Secale cereale				16					7-16		
Hordeum jubatum									7-14		Late flowers, October 28.
Hordeum vulgare									7-22		
Avena sativa									7-28		
Zea mays (Sweet Corn)				20							Planted April 27; Early Minnesota.
Zea mays (Yellow Dent)				26					9-21		Planted April 27; Capital Corn.
Andropogon scoparius											
Andropogon furcatus					2						
Agrostis scabra											Flowers open in the evening.
Bouteloua curtipendula				22							
Elymus striatus									8-17		
Elymus canadensis				29						30	
Spartina cynosuroides				30							
Coix lachryma				31					9- 2		
Sorghum halapense					4						Sown on 5-1.
Setaria glauca									8- 1	36	
Setaria viridis									8- 1		

NOTES ON THE FLORA OF TEXAS.

BY PROF. L. H. PAMMEL, AMES.

In 1888 and 1889 the writer had the pleasure of spending a few months of two summers in studying a disease of cotton commonly known as Root-Rot of Cotton. Incidentally some attention was given to the phænogamic flora of the State.

The territory embraced is Central Texas, along the Houston & Texas Central R. R. from Denison south to Hempstead, as far west as San Marcos, in Hays county, and Marble Falls, in Burnet county. Soil and climate vary greatly, which is well shown by the character of the vegetation. The most important feature in the northern part is what is known as the Central Black Prairie region, which extends south through Ellis, and the northern part of Navarro counties. The soil of this region is mostly what is termed "black waxy"—an extremely tenacious soil, but in dry weather it becomes hard and cracks, sandy soil only occurring along streams. The character of the vegetation of the former is quite uniform. *Grindelia inuloides*, *Aplopappus ciliatus*, *Eryngium leavenworthii*, *Andropogon saccharoides*, *Xanthium canadense*, *Centaurea americana*, *Sabbatia campestris* are abundant everywhere. A white rotten limestone underlies the region. Frequent outcrops occur. Near river courses *Quercus durandii* is common. On the sandy soils *Quercus nigra*, *Juniperus virginiana*, *Gilia coronopifolia*. In the Central Black Prairie Region further west in Williamson, Travis and Hays counties *Prosopis juliflora* is common, becoming more so further west. Along the river bottoms of the Red and Brazos rivers the alluvium is very deep. The soil has a red color and is covered with magnificent trees of *Hicoria pecan*, *Juglans nigra*, *Platanus occidentalis* and *Populus monilifera*.

Along the Trinity river the soil has an entirely different aspect. The alluvium is of a grayish color owing to the source of the river which is a little west of the central black prairie region. *Celtis mississippiensis*, *Populus monilifera*, *Juglans nigra*, *Sapindus marginatus* are abundant. South of Navarro county the surface of the country is quite uniform; in many places there is scarcely any drainage. The soil is sandy or loamy, with a hard pan underlying it. Here and there are prairies with good and more or less black, sandy soil. *Quercus obtusiloba* is abundant. *Quercus virens* occurs in gulf prairie region in Washington county. This is also a tenacious soil. *Sabbatia campestris*, *Eustoma russellianum*, are common in this region along streams or partially open prairies. *Quercus obtusiloba. Croton texensis, Solanum eleagnifolium* abound. *Ilex cassine* occurs on sandy ridges near the streams. The climate[1] varies greatly. Along the Red river in December the mean is 41 degrees. The minimum for the same month was 2°; the maximum, 76°. At Corsicana the extremes are 6° and 80°, with a mean of 47.4°. The amount of precipitation also varies greatly; there being much more dryness in the region about Austin, than Dallas and Denison; at the latter place it was 46.3 inches in 1880; at San Antonio, about fifty miles west of San Marcos, the rainfall for the same year was 40 inches, distributed somewhat more evenly than in Denison. The amount of drouth some plants can stand is somewhat surprising. Notwithstanding the fact that in 1889 when I visited Texas, there had been a drouth of seven weeks, common plants like *Sabbatia campestris, Croton capitatum*, var., *lindheimeri, Castilleja indivisa, Eryngium leavenworthii* and many others looked fresh and bright in the morning. This is partly owing to the fact that the heavier soils are poorly drained and the hard pan contains considerable moisture even during very dry weather. In "black waxy" soils the water was so abundant in some cases that drops could be found on the roots of some plants when growing close to the rotten limestone. Annuals usually suffer much more from long standing drouths than perennials. They flower early and mature their seeds, and after the August or September rains it is not an unusual thing to see cotton and corn fields covered with various grasses like *Panicum sanguinale* and *P. glabrum, Elusine indica*, and *Leptochloa mucronata*, affording good forage. Weeds of various kinds become surprisingly numerous at such times.

In the arrangement of orders and genera Gray's systematic works have been followed. Some use has also been made of Coulter's contributions, U. S. Nat. Museum, Vol. II, Nos. 1 and 2. The nomenclature of these authors has been followed in the main. Where the specimens have been preserved they are marked (P.). The grasses were identified by Dr. Vasey some four years ago. *Rhamnaceæ* and *Ilicineæ* by Prof. Trelease.

DICOTYLEDENOUS PLANTS.

RANUNCULACEÆ.

(1) *Clematis pitcheri*, Torr. & Gray. (Leather Flower) Clay Station, Burleson county. Rocky woods. (P.)

MAGNOLIACEÆ.

(2) *Magnolia grandiflora*. (Large Magnolia.) Only as a cultivated tree. Yarborough, Grimes county. (P.)

ANONACCEÆ.

(3) *Asimina triloba*, Dunal. Denison, Grayson county.

MENISPERMACEÆ.

(4) *Cocculus carolinus*, DC. Navasota, Grimes county; College Station, Brazos county. Common in low places along streams climbing over bushes. (P.)

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[1]Hilgard Cotton Production. Tenth annual report. Pt. I. p. 673.

BERBERIDACEÆ.

(5) *Berberis trifolialata*, Moric. (Three-leaved Barberry.) Marble Falls, Burnet county, near Colorado river. On granite soils. Common in thickets. (P.)

NYMPHÆACEÆ.

(6) *Nymphæa advena*, Aiton. (Yellow Pond Lily.) Independence, Washington county. In prairie ponds not uncommon. (P.)

PAPAVERACEÆ.

(7) *Argemone mexicana*, L. (Mexican Poppy.) College Station, Brazos county; Denison, Grayson county. Flowers uniformly white. A common weed in light soil everywhere in central Texas. (P.)

CAPPARIDACEÆ.

(8) *Cristatella jamesii*, Torr. & Gray. Along near Clay Station, Burleson county. In gravelly soil. Not common. (P.)

CISTACEÆ.

(9) *Lechea drummondii*, Torr. & Gray. (Pinweed.) College Station, Brazos county. Dry sandy soil. Common. (P.)

PALYGALACEÆ.

(10) *Polygala incarnata*, L. (?) College Station, Brazos county.

(11) *Krameria secundiflora*, D. C. College Station, Brazos county. Open prairies. Not common. (P.)

HYPERICACEÆ.

(12) *Ascyrum hypericoides*, L. (St. Andrew's Cross.) College Station, Brazos county. Grassy prairies. Still in flower July 20th. (P.)

MALVACEÆ.

(13) Sida spinosa, L. (Common Sida). Navasota, Grimes county. (P.) R. D. Blackshear. College Station, Brazos county. A weed in cotton and corn fields throughout central Texas. Melissa, Collin county. Dallas, etc.

(14) Abutilon avicennæ, Gært. Dallas, Dallas county. Common.

(15) Hibiscus trionum, L. (Bladder Ketmia.) Melissa, Collin county. A weed in grain fields.

TILIACEÆ.

(16) *Tilia americana*, L. Basswood. Central Texas.

LINACEÆ.

(17) *Linum virginianum*, L. (Flax.) College Station, Brazos county. Still in flower July 18. Grassy prairies. (P.)

GERANIACEÆ.

(18) *Oxalis corniculata*, L. (Yellow Wood Sorrel.) College Station, Brazos county. Prairies, common.

RUTACEÆ.

(19) *Xanthoxylum clava-herculis*, L. (Prickly Ash.) Independence, Washington county. Common along fences.

(20) AILANTHUS GLANDULOSUS Desf. (Tree of Heaven.) Frequent escape.

ILICINEÆ.

(21) *Ilex opaca*, Ait. (American Holly.) Calvert, Robertson county. Along streams.

(22) *Ilex cassine*, L. (Cassena Yaupon). Brenham, Washington county. Sandy oak openings forming thickets; common.

(23) *I. decidua*, Walt. Melissa, Collin county. Common along streams in low grounds.

PHAMNACEÆ.

(24) *Berchemia scandens*, Trelease. (Supple Jack). College Station, Brazos county (P.); Calvert, Robertson county. (P.) Common climbing trees forty to sixty feet high. In low grounds.

(25) *Rhamnus caroliniana*, Walt. San Marcos, Hayscounty. (P.) In rocky places along San Marcos River. Clay station, Washington county (P). Sandy rocky ledges.

VICTACEÆ.

(26) *Vitis candicans*, Engelm. Everywhere in woods.

(27) *V. æstivaus*, Miln. Post Oak Grape. Denison, Grayson county. Fruit ripe in July and August. Denison, Grayson county.

(28) *V. cinerea*, Engelm. Denison.

(29) *V. cordifolia*, Michx. (Frost or Chicken Grape.) Denison, Grayson county.

(30) *V. riparia*, Michx. Denison, Grayson county.

(31) *V. rotundifolia*, Michx. College Station, Brazos county. In deep, rich woods.

(32) *Cissus stans*, Pers. College Station, Brazos county; Navasota, Grimes county; Calvert, Robertson county. A common species, and on the deep, rich soils of the Brazos a troublesome weed in cotton and cornfields.

(33) *Ampelopsis quinquefolia*, Michx. College Station, Brazos county; Denison, Grayson county. Common.

SAPINDACEÆ.

(34) *Cardiospermum halicacabum*, L. (Common Balloon Vine.) Melissa, Collin county. A weed in fields.

(35) *Æsculus flava*, Ait., var. *purpurascens*, Gray (?). San Marcos, Hays county. Low shrub in rocky woods. August 10th seed nearly ripe. Leaves all gone.

(36) *Ungnadia speciosa*, Endl. (Mexican Buckeye.) Clay Station, Washington county. Shrub in rocky woods. Shiny black seeds ripe July 15th. (P.)

(37) *Sapindus marginatus*, Willd. Soapberry tree. (Native China tree.) Melissa, Collin county. (P.) Dallas. Common in Trinity river bottom. Rich alluvial soil.

(38) *Acer saccharinum*, L. Denison, Grayson county.

(39) *Negundo aceroides*, Moench. Denison, Grayson county.

ANACARDIACEÆ.

(40) *Rhus copallina*, L. (Dwarf Sumach.) Melissa, Collin county. In woods. July 10 in flower. Burnet, Burnet county.

(41) *R. copallina*, L. var. *lanceolata*. Gray. Burnet, Burnet county. Collected with the species. Comes into flower later. Rocky, granitic soils, forming thickets.

(42) *R. toxicodendron*, L. (Poison Ivy.) Calvert, Robertson county. Climbing on trees in low ground. Common.

(43) *R. canadensis*, Marsh, var. *trilobata*, Gray. Burnet county. Granitic soils in woods. Common.

LEGUMINOSÆ.

(44) *Sophora affinis*, Torr. & Gray. Clay Station; College Station, Brazos county. Sandy woods.

(45) *Crotalaria sagittalis*, L. (Rattle-box.) Denison, Grayson county. Sandy soils; common.

(46) MEDICAGO SATIVA, L. (Alfalfa.) College Station, Brazos county. Prairies; common.

(47) *Dalea laxiflora*, Pursh. Ennis, Ellis county. Open prairies; common. (P.)

(48) *Petalostemon candidus*, Michx. Ennis, Ellis county. Prairies.

(49) *Sesbania vesicaria*, Ell. College Station, Brazos county. In low grounds along streams.

(50) *Glycyrrhiza lepidota*, Nutt. (Wild Liquorice.) Southern Texas. J. C. Watkins.

(51) LESPEDEZA STRIATA. Hook. and Arn. Calvert, Robertson county.

(52) *L. reticulata*, Pers., var. *angustifolia*, Maxim. Ennis, Ellis county. Prairies.

(52) *Centrosema virginiana*, Betham. College Station, Brazos county.

(53) *Clitoria mariana*, L. College Station, Brazos county.

(54) *Rhynchosia tomentosa*, Hook. & Arnot. Clay Station, Burleson county.

(55) *Cercis canadensis*, L. Ennis, Ellis county.

(56) *Cassia occidentalis*, L. White Hall, Grimes county.

(57) *C. chamæchrista*, L. Denison, Grayson county, Sherman.

(58) *C. marylandica*, L. Melissa, Collin county; Sherman, Grayson county.

(59) *C. tora*, L. Navasota, Grimes county. Weed in streets.

(60) *Prosopis juliflora*, D. C. (Mezquit, Screw-bean.) College Station, Brazos county. Prairies. (P.) Not common. Abundant in Williams county. Abundant about Austin, Hays county, forming groves on prairies or sandy hillsides. From a distance trees resemble peach orchards.

(61) *Gleditschia triacanthos*, L. Robertson, Grimes, Grayson and Collin counties. Common in low grounds along streams.

(62) *Desmanthus brachylobus*, Bentham, Sherman, Grayson county.

(63) *D. leptolobus*, Torr. & Gray. Sherman, Grayson county; Melissa, Collin county.

(64) *Schrankia uncinata*, Willd. Northern Texas.

ROSACEÆ.

(65) *Prunus americana*, Marshall. Denison, Grayson county.

(66) *P. angustifolia*, Marshall. Independence, Washington county.

(67) *Rubus trivialis*, Michx. College Station, Brazos county.

(68) *Rosa laevigata*, Michx. Navasota, Grimes county. Escaped.

(69) *Cratægus spathulata*, Michx. Clay Station, Yarborough, Grimes county.

(70) *C. coccinæ*, var. *mollis*, Torr. & Gray. Melissa, Collin county. Fruit ripe August 25th.

ONAGRACEÆ.

(71) *Œnothera biennis*, L. Central Texas.

(72) *O. speciosa*, Nutt. College Station, Brazos county. Prairies. Common.

(73) *Gaura parviflora*, Dougl. Navasota, Grimes county.

(74) *G. lindheimeri*, Engel. & Gray. Navasota, Grimes county. On sandy rocks. Dry soil.

PASSIFLORACEÆ.

(75) *Passiflora incarnata*, L. Independence, Washington county. Black soil, in orchards and waste places.

UMBELLIFERÆ.

(76) *Daucus pusillus*, Michx. College Station, Brazos county.

(77) *Eryngium yuccaefolium*, Michx. Ennis, Ellis county.

(78) *E. leavenworthii*, Torr. & Gray. Ennis, Ellis county. Melissa, Collin county. Rich prairie soils.

(79) *Discopleura capillacea*, DC. College Station, Brazos county.

(80) *Hydrocotyle umbellata*, L. Yarborough. In wet sandy soil.

CORNACEÆ.

(81) *Cornus candidissima*, Marsh. (?) Sherman, Grayson county. In woods.

CAPRIFOLIACEÆ.

(82) *Sambucus canadensis*, L. (Common Elder.) Dallas county. Rich soils, low grounds.

(83) *Vibunum molle*, Michx. Hempstead, Waller county. (P.) Sandy barrens.

(84) *V. prunifolium*, L. (Black Haw). Melissa, Collin county. (P). In low grounds, rich woods.

(85) *Symphoricarpus vulgaris*, Michx. (Coral-berry, Indian Currant.) College Station, Brazos county. (P.) Melissa, Collin county. In dry, open woods.

RUBIACEÆ.

(86) *Houstonia angustifolia*, Michx. College Station, Brazos county. (P.) Dry grounds in woods.

(87) *Cephalanthus occidentalis*, L. (Button-bush). Brazos county. Common in low grounds.

(88) *Diodia teres*, Walt. (Button-weed). College Station, Brazos county (P). A common weed on the dry sandy prairies.

COMPOSITÆ.

(89) *Vernonia altissima*, Nutt. College Station, Brazos county.

(90) *V. angustifolia*, Michx. (Iron-weed.) College Station, Brazos county. (P.) Common on sandy soils in woods.

(91) *Eupatorium serotinum*, Michx. (Boneset, or Thoroughwort.) Calvert, Robertson county. (P.) On clay hills along roadsides.

(92) *E. semiserratum*, DC. Hempstead, Waller county. (P.) Sandy barrens.

(93) *E. rotundifolium*, L. Hempstead, Waller county. Sandy barrens. In flower July 20. (P.)

(94) *E. perfoliatum*, L. (Boneset). Hempstead, Waller county. Sandy barrens. In flower July 20. (P.)

(95) *E. incarnatum*, Walt. College Station, Brazos county. In rich woods, low grounds. First flowers August 7. (P.)

(96) *Liatrus squarrosa*, Willd. (Blazing Star.) College Station, Brazos county. Post oak openings and prairies; common. (P.)

(97) *Grindelia inuloides*, Willd. Calvert, Robertson county. Black soil and prairies; common. (P.) Fruit mature August 15. (P.)

(98) *Aplopappus cilatus*, DC. Ennis, Ellis county. (P.) Black prairie soil and common along fences throughout north central Texas. In flower July 20.

(99) *Solidago serotina*, Ait. Sherman; Grayson. Common in woods. (P.)

(100) *Silphium asperrimum*, Hook. (Rosinweed.) College Station, Brazos county. Post oak openings and prairies.

(101) *S. laciniatum*, L. (Compass Plant.) Common, prairies of north central Texas.

(102) *Berlandiera tomentosa*, Nutt. var. *dealbata*. Torr. & Gray. Independence, Washington county. (P.) July 7, in full flower.

(103) *Engelmannia pinnatifida*, Torr. & Gray. Independence, Washington county. (P.) Post oak openings and sandy prairies. July 7, in full flower.

(104) *Ambrosia trifida*, L. (Great Ragweed.) Independence, Washington county; Navasota, Grimes county. Througout central Texas a common weed in low grounds.

(105) *A. psilostachya*, D. C. (Ragweed.) College Station, Brazos county, (P.); Sherman. (P.) In flower Aug. 20. Common throughout central Texas prairies and post oak soils.

(106) *Xanthium canadense*, Mill. (Cocklebur.) A common weed in black, cultivated prairie soils. Along roadsides. Where this weed grows the soil is considered excellent.

(107) *Rudbeckia bicolor*, Nutt. (Cone Flower.) College Station, Brazos county. (P.) Post oak openings. Nearly past flowering July 15th. Form with brown purple spots at base.

(108) *R. hirta*, L. College Station, Brazos county. Prairies.

(109) *R. alismæfolia*, Torr & Gray. (?). College Station, Brazos county. (P.) Prairies of central Texas; common, July 15th.

(110) *Lepachys columnaris*, T. & G. (?). Central Texas.

(111) *Helianthus annuus*, L. (Common Sunflower.) College Station, Brazos county. (P.) A common weed throughout central Texas, especially

in the black cretaceous soils of north central Texas. August 15th still in flower.

(112) *H. debilis*, Nutt., var. *cucumerifolius*, Gray. Grimes county, along Gulf Col. & St. Fe R. R. On black soil, July 15th, in full flower.

(113) *H. hirsutus*, Raf. Denison, Grayson county. In dry woods, July 20th, just coming in flower.

(114) *Coreopsis tinctoria*, Nutt. Melissa, Collin county.

(115) *C. palmata*, Nutt. Denison, Grayson county.

(116) *Thelesperma filifolium*, Gray. Denison, Grayson county. (P.) Dry hills in sandy soils; common.

(117) *Polypteris texana*, Gray. College Station, Brazos county. (P.) July 15 in full flower. Common in lower places, dry open prairies.

(118) *Helenium tenuifolium*, Nutt. College Station, Brazos county. (P.) A common weed in dry, open prairies. Has largely been extended since the cultivation of soils. Occurring with this weed is *Croton capitatus* var.

(119) *Lindheimerii*. "It is said that when cows feed on this weed milk takes on a bitter taste."—*Gulley*.

(120) *H. nudiflorum*, Nutt. Melissa, Collin county. (P.) In low grounds.

(121) *H. autumnale*, L. Mellissa, Collin county. A weed in low grounds.

(122) *Gaillardia pulchella*, Fong. (Gaillardia.) Denison, Grayson county. (P.) July 15 still in flower. Achenia also mature. On sandy soil. Common on the black waxy prairies of central Texas. Along Houston & Texas Central Railroad.

(123) *Dysodia chrysanthemoides*, Lag. (Fetid Marigold.) Navasota, Grimes county.

(124) *Cnicus undulatus*, Gray, var. *megacephalus*, Gray. Ennis, Ellis county. (P.) In woods.

(125) *Centaurea americana*, Nutt. (Star Thistle.) Ellis county. (P.) Common in black waxy soil throughout central northern Texas, also in Indian Territory south of McAllister, along M., K. & T. R. R. In full flower, July 1.

(126) *Pyrrhopappus carolinianus*, D. C. College Station, Brazos county. (P.) Still in flower July 15; achenes of early flowers have fallen. Common on the dry prairies and post oak openings.

ERICACEÆ.

(127) *Vaccinium arboreum*, Marshall. Clay Station, Burleson county. (P.) On the sides of a rocky bluff.

SAPATOCEÆ.

(128) *Bumelia lanuginosa*, Pers. Robertson and Collin counties. (P.) Low grounds; common.

EBENACEÆ.

(129) *Diospyrus virginiana*, L. (Common Persimmon). Grimes, Robertson, Denison, Collin counties.

(130) *D. texana*, Scheele. (Mexican Persimmon). Burnet county. (P.) In rocky soils.

OLEACEÆ.

(131) *Fraxinus viridis*, Michx. (Green Ash). College Station, Brazos county.

ASCLEPIADACEÆ.

(132) *Asclepiadora viridis*, Gray. Central Texas.

(133) *Asclepias vertiicllata*, L., var. *subverticillata*, Gray. College Station, Brazos county.

(134) *Gonolobus lævis*, Michx., var. *macrophyllus*. College Station, Brazos county; Gray, College Station, Brazos county. In woods.

(135) *Acerates viridiflora*, Ell. Central Texas. (P.)

GENTIANACEÆ.

(136) *Sabbatia campestris*, Ell. College Station, Brazos county (P). Prairies abundant.

(137) *Eustoma russellianum*, Griseb. (Prairie Lily.) Independence, Washington county. (P.) In low places; prairies.

POLEMONIACEÆ.

(138) *Phlox drummondii*, Hook. Hempstead, Waller county. (P.) Sandy barrens; common.

(139) *Gilia coronopifolia*, Pers. (Standing Cypress.) Common everywhere along post oak timbers and dry places. College Station, Brazos county (P). Corsicana, Ellis county; Dallas, Dallas county.

HYDROPHYLLACEÆ.

(144) *Hydrolea ovata*, Nutt. Hempstead, Waller county. Sandy barrens near pond; common.

CONVOLVULACEÆ.

(141) *Dichondra repens*, Forst. College Station, Brazos county. Common in prairies and woods.

(142) *Ipomœa purpurea*, Lam. Calvert, Robertson county.

SOLANACEÆ.

(143) *Solanum elæagnifolium*, Cav. College Station, Brazos county (P.); Independence, Washington county. Common weed everywhere along roadsides and in fields. Clay or black soil. Prairies.

(144) *S. torreyi*, Gray. White Hall, Grimes county. A weed in rich prairie soil.

(145) *S. carolinense*, L. (Horse Nettle.) Sherman, Grayson county. A weed in rich soil.

(146) *S. rostratum*, Dunal. (Spiny Nightshade.) Common throughout central Texas. College Station, Brazos county; Ennis, Ellis county; Sherman, Grayson county; White Hall, Grimes county; Dallas, Dallas county. It grows on sandy as well as "black waxy soils." In many places door yards and roadsides are covered with it. I am informed that this weed became generally diffused after the war.

(147) CAPSICUM FRUTESCEUS, L. San Marcos, Hays county. (P.) Frui ripe Aug. 15, 1888.

(148) *Physalis mollis*, Nutt., var., *cinerascens*, Gray. College Station, Brazos county. (P.)

(149) *P. philadelphica*, Lam. College Station, Brazos county. (P)

(150) LYCIUM VULGARE, Dunal. Dallas, Dallas county. Escaped from cultivation.

(160) Datura stramonium. Ennis, Ellis county. A weed in streets.

(161) *D. meteloides*, D. C. Ennis, Ellis county. Escaped from cultivation.

(162) Lycopersicum esculentum. Independence, Washington county. Volunteer tomatoes are not uncommon along the Brazos River.

SCROPHULARIACEÆ.

(163) *Castilleia indivisa*, Engelm. College Station, Brazos county. Common on prairies.

BIGNONIACEÆ.

(164) *Tecoma radicans*, Juss. (Trumpet-flower or Trumpet-creeper. Navasota, Grimes county. In bottoms along Brazos river. Calvert, Robertson county. Common.

ACANTHACEÆ.

(165) *Ruellia tuberosa*, L. College Station, Brazos county. In woods. Along streams.

VERBENACEÆ.

(166) *Verbena officinalis*, L. Navasota, Grimes county. Blackshear. (P.) College Station, Brazos county. (P.) Common in waste places, in fields and door yards.

(167) *V. bipinnatifida*, Nutt. College Station, Brazos county. (P.) Common on prairies of central Texas. July 10th, in flower. Seeds ripe.

(168) *Lippia nodiflora*, Michx. College Station, Brazos county. Common on dry prairies.

(169) *Lantana camara*, L. (?) San Marcos, Hays county.

(170) *Callicarpa americana*, L. (Mexican Mulberry.) College Station, Brazos county (P.) July 15, 1888, in flower. Fruit nearly ripe. Common in post oak woods, central Texas.

LABIATÆ.

(180) *Teucrium canadense*, L. College Station, Brazos county. (P.) In woods.

(181) *Pycnanthemum albescens*, Torr. & Gray. Hempstead, Waller county. (P.) Sandy barrens. Flowers about ready to open August 10.

(182) *Hedeoma drummondii*, Benthm. Burnet, Burnet county. (P.) Rocky woods and open grounds. Fruit ripe August 10, 1888.

(183) *H. ciliata*, Benthm. Hempstead, Waller county. (P.) Sandy barrens.

(184) *Salvia texana*, Torr. Burnet, Burnet county. (P.) Rocky grounds along railroad.

(185) *S. farinacea*, Bentham. Ennis, Ellis county. (P). Rich black soil; common. Also occurs on outcrops of rotten limestone.

(186) *S. azurea*, Lam. College Station. Brazos county. (P.) Common on prairies. Plant 2 to 3½ feet high.

(187) *Monarda punctata*, *L.*, var. *lasiodonta*, Gray. Clay Station. Sandy soil. In flower July 15, 1888.

(188) *Scutellaria cardiophylla*, Eng. & Gray. College Station, Brazos county. (P.) In deep, rich woods. In flower August 10, 1888.

(189) *S. parvula*, Michx. Central Texas. (P.)

(190) *Physostegia virginiana*, Benthm. Hempstead, Waller county Sandy barrens.

PLANTAGINACEÆ.

(191) *Plantago patagonica*, var. College Station, Brazos county. Common on dry prairies.

NYCTAGINACEÆ.

(192) *Axybaphus hirsutus*, Sweet.(?) Bryan, Brazos county. (P.) Sandy soils along roadsides.

(193) *Bœrhavia erecta*, L. Tyler, Smith county; Prof. Brunk, White Hall, Washington county.

ILLECEBRACEÆ.

(194) *Paronychia drummondii*, Torr & Gray. Hempstead, Waller county. (P.) Sandy barrens forming mats on ground.

AMARANTACEÆ.

(195) AMARANTUS SPINOSUS, L. Northern Texas.

(196) *Frœlichia floridana*, Moquin. (Cotton Plant.) Denison, Grayson county. (P.) A common weed in sandy places. Seeds scattered readily by the woolly down on calyx.

CHENOPODIACEÆ.

(197) CHENOPODIUM ALBUM. L.(?) College Station, Brazos county. (P.) This form, if it belongs to this species, has smaller leaves and is much more strict than the type. Occurs along roadsides.

PHYTOLACCACEÆ.

(198) *Phytolacca decandra* L, (Common Poke). Northern Texas.

POLYGONACEÆ.

(199) *Eriogonum longiflorum*, Nutt. Ennis, Ellis county. Limestone rocks.

(200) *Polygonum ramosissimum*, Michx. Navasota, Grimes county. R. D. Blackshear. (P.)

(201) *P. incarnatum*, Ell. College Station, Brazos county (P).

(202) *P. pennsylvanicum*, L. College Station, Brazos county (P).

(203) *P. hydropiperoides*, Michx. College Station, Brazos county (P).

(204) *P. dumetorum*, L. var. *scandens*, Gray. Ennis, Ellis county.

LAURACEÆ.

(205) *Sassafras officinale*, Nees. Tyler, Smith county. Prof. Brunk. (P.)

LORANTHACEÆ.

(206) *Phoradendron flavescens*, Nutt. College Station, Brazos county. On *Quercus obtusiloba. Ulmus crassifolia.* Common.

EUPHORBIACEÆ.

(207) *Euphorbia maculata*, L. College Station, Brazos county.

(208) *E. bicolor*, Engelm & Gray. Ennis, Ellis county. Common on black prairie soil.

(209) *E. corollota*, L. (P.) College Station, Brazos county. (P.) Common on dry prairies.

(210) *E. fendleri*, T. & G. Burnet county (P).

(211) *Jatropha stimulosa,* Michx. (Spurge Nettle). College Station, Brazos county (P.); Denison, Grayson county. A common weed occurring in sandy soil in isolated places.

(212) *Coyton glandulosus,* L. College Station, Brazos county.

(213) *C. capitatus,* Michx. var *lindheimerii,* Muell. College Station, Brazos county. A common weed on dry prairies throughout southern Texas.

(214) *C. monanthogynous,* Michx. Brenham, Washington county. Dry soil; common.

(215) *C. texensis,* Muell. Brenham, Washington county. Dry upland clay soil along fences.

(216) *Crotonopsis linearis,* Michx. College Station, Brazos county. Common in post oak woods.

(217) *Acalypha virginica* L. var. *gracilens,* Muell. College Station, Brazos county. (P.) Fields sandy.

(218) *Tragia nepetæfolia,* Cav. College Station, Brazos county. Dry soils.

(219) *Stillingia sylvatica,* L. College Station, Brazos county. Dry sandy soils in woods or border of the same; common.

URTICACEÆ.

(220) *Ulmus alata,* Michx. Denison, Grayson county.

(221) *U. crassifolia,* Nutt. Sherman, Grayson county (P). A large and beautiful tree, sometimes called Cedar Elm, because of its resemblance to the Red Cedar, especially so when Spanish moss hangs in long festoons from the tree. This is especially noticeable from a distance. It is abundant in swamps subject to overflow, also on higher black ground. In flower August 29, 1888.

(222) *Celtis Mississippiensis,* Bosc. Allen Farm, Brazos county; Dallas, Dallas county. Low grounds along streams.

(223) *Maclura aurantiaca,* Nutt. Melissa, Collin county. Large trees were observed in bottoms near Denison, about two feet in diameter at base. Timber especially durable when in ground; timber largely used for paving in the streets of Dallas; said to outlast Red Cedar several times.

(224) *Morus rubra,* L. Robertson and Collin counties .

(225) *Broussonetia papyrifera,* Vent. Plano. Dallas, Dallas county. Cultivated throughout central Texas and often escapes from cultivation, as in Dallas, Brenham and Sherman.

PLATANACEÆ

(226) *Platanus occidentalis,* L. Ellis, Grayson and Collin counties.

JUGLANDACEÆ,

(227) *Juglans nigra,* L. Denison, Grayson county. Allen Farm, Brazos county. A common tree everywhere in bottoms.

(228) *Hicoria pecan.* Allen farm, Brazos county; Sherman, Grayson county; Navasota, Grimes county. One of the largest trees in the bottoms. Persists for several years, *i. e.* young shoots constantly coming up. A great nuisance to the cotton planter. In Burnet county the trees are not so large. The nuts are largely collected in this place and sold to dealers.

(229) *Hicoria alba*, L. Britt Navasota, Grimes county. Clay uplands; common.

MYRICACEÆ.

(230) *Myrica cerifera*, L. Hempstead, Waller county. Sandy barrens.

CUPULIFERÆ.

(231) *Betula nigra*, L. Northern Texas.

(232) *Quercus obtusiloba*, Michx. (Post Oak.) College Station, Brazos county (P.); Independence, Washington county; Calvert, Robertson county; Sherman, Travis, Burnet, Hays, Grayson, Dallas counties. A common tree through Central Texas. A variable tree, usually growing on uplands. Soil may be sandy or a loam. Hard pan close to the surface, known as post oak soils.

(233) *Q. lyrata*, Walt.(?) Hays county; Collin county.

(234) *Q. priinoides*, Willd. Sherman. (P.) In bottom along streams, in rich soil, a good tree.

(235) *Q. durandii*, Buckley. Melissa, Collin county. Limestone bluffs. (P.)

(236) *Q. virens*, Ait. (Live Oak.) Independence, Washington county. Forming groves in black soil; a large tree.

(237) *Q. rubra*, L., var. *texana*, Buckley. Calvert, Robertson county. In low grounds.

(238) *Q. nigra*, L. (Black Jack, Jack Oak.) Denison, Grayson county. Red sandy soils. Common. Washington county, Brazos county, Collin county, Dallas county.

(239) *Q. falcata*, Michx. (Spanish Oak, Red Oak.) Yarborough, Grayson county; Grimes county (P.) A large tree. Common on sandy soil.

(240) *Q. aquatica*, Walter. (Water Oak, Punk Oak.) College Station, Bryan, Brazos county (P.); Washington county. In low grounds along streams. Not uncommon. Young leaves scurfy and sinuate pinnatifid.

(241.) *Q. imbricaria*, Michx. Denison, Grayson county.

(242.) *Q. phellos*, L. (Willow Oak.) Bryan, Brazos county. Common. Sandy, loamy soil; uplands.

(243.) *Q. palustris*, Du Rois. Calvert, Robertson county.

(244) *Q. emoryi*, Torrey (?). Burnet, Burnet county. In sandy, rocky woods. Low shrub.

SALICACEÆ.

(245) *Populus monilifera*, Ait. Denison, Grayson county; Calvert, Robertson county. In low grounds along streams.

CONIFERÆ.

(246) *Pinus tæda*, L. (Loblolly or Old-field Pine.) Yarborough, Grimes county. A few large trees, more common in Montgomery county.

(247) *Juniperus virginiana*, L. (Red Cedar.) Dallas, Dallas county; Austin, Travis county. Usually on sandy or light soils. Trees, large near Dallas. The species is abundant everywhere on the hills about Austin.

MONOCOTYLEDONOUS PLANTS.

BROMELIACEÆ.

(248) *Tillandsia usneoides*, L. (Spanish Moss.) A common species everywhere in southern Texas. It hangs in long festoons from various trees. Sometimes injurious to trees, as it prevents the growth of young branches and leaves.

COMMELIANCEÆ.

(249) *Commelina virginica*, L. College Station, Brazos county. Sandy soil. Common throughout central Texas. Denison south to Hempstead.

PALMÆ.

(250) *Sabal adansonii*, Guerns. Brenham, Washington county. Low grounds. Not common.

ARACEÆ.

(251) *Pistia stratiotes*, L., var. *spathulata*, Engelm. San Marcos, Hays county. Running water.

CYPERACEÆ.

(252) *Cyperus diandrus*, Torr. College Station, Brazos county.

(253) *C. rotundus*, L. (Nut Grass.) College Station, Brazos county.

(254) *C. ovularis*, Torr. College Station, Brazos county.

(255) *Dichromena leucocephala*, Michx. College Station, Brazos county.

GRAMINEÆ.

(256) *Paspalum floridanum*, Michx., var. *glabra*. College Station, Brazos county. (P.)

(257) *P. platicaule*. College Station, Brazos county. (P.)

(258) *P. læve*, Michx. College Station, Brazos county. (P.)

(259) *P. plicatulum*. College Station, Brazos county. (P.)

(260) *P. distichum*, L. College Station, Brazos county. (P.)

(261) *Panicum filiforme*, L. College Station, Brazos county. (P.)

(262) *P. glabrum*, Gaudin. Calvert, Robertson county.

(263) *P. sanguinale*, L. Calvert, Robertson county.

(264) *P. anceps*, Michx. College Station, Brazos county. (P.)

(265) *P. virgatum*, L. College Station, Brazos county (P.); Melissa, Collin county; Denison, Grayson county. Sandy soils.

(266) *P. dichotomum*, L. College Station, Brazos county. In woods common. (P.) Also a form with leaves 4 to 6 inches long and small spikelets—slender habit.

(267) *P. commutatum*, Schultes, var. *minor*. College Station, Brazos county.

(268) *P. muranthemum*. College Station, Brazos county. In woods.

(269) *P. texanum*, Buckley. Calvert, Robertson county. Introduced.

(270) *P. crus. galli*, L. form. College Station, Brazos county. Along roadsides in moist places.

(271) *Setaria glauca*, var. *lævigata*. College Station, Brazos county. Waste places.

(272) *Cenchrus echinatus.* College Station, Brazos county. Waste places.

(273) *Rottbœllia cylindrica.* College Station, Brazos county. Dry, sandy soils.

(274) *Andropogon furcatus,* Muhl. College Station, Brazos county; Melissa, Collin county. Common.

(275) *A. saccharoides.* College Station, Brazos county., Common in central Texas.

(276) SPOROBOLUS INDICUS. R. Br. College Station. Common.

(277) CYNODON DACTYLON, Pers. College Station, Brazos county; Calvert, Robertson county; Independence, Washington county; Dallas, Dallas county. Naturalized in many places, but always fails to produce seed.

(278) *Bouteloua racemosa,* Lag. Northern Texas.

(279) *Eleusine indica,* Gærtn. (Crow-foot grass.) College Station, Brazos county; Calvert, Robertson county. (P.) Common in cultivated fields in central Texas. Coming up in cornfields, where it yields abundant good forage.

(280) *Leptochloa mucronata,* Kunth. College Station, Brazos county; Calvert, Robertson county (P.); Sherman, Grayson county. Common in cultivated fields, yielding some forage.

(281) *Buchloë dactyloides,* Engelm. Melissa, Collin county. Escaped from cultivation. Grimes county.

(282) *Eragratis major,* Host. Slender form. College Station, Brazos county. (P.)

(283) E. *oxylepis.* Yarborough, Grimes county (P.); College Station, Brazos county. Common on dry prairies in waste places.

(284) *E. tenuis,* Gray. College Station, Brazos county. (P.) Prairies common.

(285) *Chloris verticillata,* Nutt. College Station, Brazos county. (P.) Dry places.

(286) *C. swartziana,* Doell. Central Texas. (P.)

(287) *Uniola gracilis,* Michx. College Station, Brazos county. In woods common.

(288) *Poa arachnifera,* Torr. Ennis, Ellis county. A valuable grass.

CRYPTOGAMOUS PLANTS.

FILICES.

(289) *Polypodium incanum,* Swartz. College Station, Brazos county; Montgomery county.

(290) *Adiantum capillus—veneris,* L. Denison, Grayson county.

MARSILIACEÆ.

(291) *Marsilia vestita.* Hook. & Grev. Clay Station. Dry soil.

THE RELATION OF FROST TO CERTAIN PLANTS.

BY L. H. PAMMEL.

Most persons are familiar with the fact that some plants are much more easily affected by frost than others. The slightest frost will affect plants like Pussly, young corn, beans, twitch grass, tomatoes, squashes, pumpkin, etc. I have watched many plants for some years, but the opportunity of recording temperature in close proximity to the plants have not heretofore been made here, though doubtless some observers have recorded facts, but the references are not at hand. Up to November 4 the following observations were made. In these tables dates and temperatures are recorded only at 32 degrees and below.

DATE.	Minimum.	9 A. M.	12 M.	5 P. M.
September 16	27	52	72	67
September 26	28.5	63.5	78	68.5
October 4	31	61	79	59
October 5	28.5	52	71	60
October 8	25	46	57	45
October 9	20	57	71	......
October 10	25	56	72	61
October 18	31	......	60	58
October 19	25	49	59.5	46
October 20	23.5	39.5	53	46
October 21	23	39	57.5	48
October 22	28	50	56	50
October 23	19.5	38	45.5	41.5
October 24	14	......	52	38.5
October 25	13	25.5	43	29
October 26	13	32	47	32
October 27	15	42	61	42
October 28	20	51	56	43
October 29	16.5	24	.....	38
October 30	14	.....	38.5	49.5
November 2	.....	......	33	34
November 3	24	37	47	44
November 4	35	35	33	31

THERMOMETER FIVE FEET FROM THE GROUND.

DATE.	Minimum.	9 A. M.	12 M.	5 P. M.
September 16	31	60	72	63
September 26	32	63.5	75	71
October 4	35	67.5	85.5	66
October 5	34	55	71.5	66
October 8	30	50	58.5	51
October 9	25	62	71	......
October 10	33	59	75	62
October 18	36	......	64	58
October 19	32	56	61	55
October 20	29	44	57.5	53
October 21	29	42	60	56
October 22	33.5	45	54	55
October 23	23	45	51	47
October 24	21	49	55	45
October 25	18	33	49	35.5
October 26	18	38.5	52	42
October 27	22	45	66	54
October 28	25.5	52	62	49
October 29	22	31	......	47
October 30	20	42	....	55
October 31	22	29	53.5	49
November 2	35	.....	37	40
November 3	32	37	51	51
November 4	41	41	38	36

The most striking difference is the lower temperature at the surface of the earth. The observations on the following plants may be of interest:

September 16: Corn, although young, was not affected close to thermometer. On creek bottom one mile from college leaves were frozen. Twitch grass *(Panicum capillare)* near the thermometer was not frozen. Common bean (*Phaseolus vulgaris*) leaves frozen near the thermometer. Pussly (*Portulaca oleracea*) affected in garden. Cucumbers (*Cumis sativus*) also affected. Cultivated balsams (*Impatiens balsamina*) also affected. Frost on October 8th and 9th entirely killed garden beans; tomatoes seriously affected. Four o'clock (*Mirabalis jalapa)*, balsam, corn, beans, cucumbers, squashes, pumpkins, melons, tomatoes, pussly, Pigweed (*Amarantus blitoides, Zinia coleus*, Morning Glory (*Ipomœa purpurea*), Unicorn plant (*Martynia proboscidea*) seriously affected.

Of the partially affected I will enumerate a few: Red Clover (*Trifolium pratense*). *Dolichos lablab*, Castor Oil Bean (*Ricinus communis*), Cotton (*Gossypium*) *herbaceum*) and *Cassia marylandica.*

Not affected at all: *Phlox drummondii*, Mexican poppy (*Argemone mexicana*), Sage (*Salvia pratensis*), Bachelor's Button (*Centaurea cyanus)*, Golden Rod (*Solidago rigida*), Aster (*Aster multiflorus*), Scabios (*Scabiosa atropurpurea*), Artichoke (*Helianthus tuberosus*), Beet (*Beta vulgaris*), Fleabane (*Erigeron annuus*), Tansy (*Tanacetum vulgare*).

Up to this time frost had in no way affected the flowering of *Phlox drummondii, Salvia pratensis, Melissa, Argemone mexicana, Eschscholtzia californica*, Borage (*Borrago officinalis*), *Collinsia bicolor*, *Erigeron annuum*. One of the curious things in connection with some plants is that in plants like the Castor Oil bean only the lower leaves were frost bitten, while the others were still green and fresh on October 18th.

The following plants were entirely killed between October 18th and November, 4th: *Dolichos lablab, Ipomœa purpurea, Datura wrightii, Gossypium herbaceum, Quamoclit vulgaris, Phaseolas multiflorus, Hibiscus trionum, Calendula officinalis.*

Partially affected: *Ricinus communis, Helianthus debilis, Borrago officinalis, Trifolium pratense, T. incarnatum, Polanisia graveolens, Soja hispida.*

On October 24th the following were slightly affected: *Cosmos, Solanum nigrum, Chrysantheum corinarium, Argemone mexicana, Cassia marylandica, Trifolium pratense, Eschscholtzia californica, Melilotus officinale.*

Not affected by frost on 23d and 24th: *Euphorbia cyparissias, Pelargonium zonale, Medicago sativa, Symphytum officinale, Solidago rigida, S. canadensis, Aster novæ-angliæ, Scrophularia nodosa*, var. *marylandica. Erodium cicutaria, Phlox drummondii, Dipsacus sylvestris, Chrysanthemum indicum, Silphium lacinatum, Scabiosa atropurpurea, Nepeta cataria, Acalypha virginica, Marrubium vulgare, Potentilla norvegica, Tanacetum vulgare, Centaurea cyanus, Iris versicolor, Triosteum perfoliatum, Poterium sanguisorba, Collinsia bicolor, Arctium major, Saponaria officinalis, Beta vulgaris, Daucus carota, Brassica campestris, Salvia pratensis, Scabiosa atropurpurea, Nepeta cataria, Fragaria virginiana.*

The leaves of trees of the following species were affected somewhat: *Prunus americana, Eleagnus angustifolia, Acer saccharinum, Betula alba, Populus alba, P. tremula.*

Leaves of shrubbery plants killed by frost on October 25: *Ulmus fulva, Ulmus americana, Acer negundo, Vitis riparia, V. labruscœ,* various cultivated forms, of *Prunus cerasus, P. avium, Fraxinus viridis, Pyrus malus.*

Not affected: *Prunus persica, Berberis vulgaris, B. thumbergii, Pyrus communis, Ligustrum vulgare.*

Herbaceous plants not affected on November 4: *Marrubium vulgare*, *Dianthus chinensis*, *Dipsacus sylvestris*, *Centaurea cyanus* (slightly), *Calendula officinalis*, *Eschscholtzia californica* (slightly), *Tanacetum vulgare*, *Triosteum perfoliatum*.

None of the perennial grasses were affected by frost up to November 4th. This was also true of some of the annuals—*Phleum pratense*, *Bromus inermis*, *B. breviaristatus*, *Dactylis glomerata*, *Agropyrum repens*, *A. glaucum*, *Agrostis alba*, Var. *vulgaris*, *Chrysopogon nutans*, *Andropogon furcatus*, *A. scoporius* (the leaves of these last three are turning brown); *Spartina cynosuroides* (yellow), *Poa pratensis* and *Avena sativa*.

Trees with green leaves on November 4th: *Ligustrum vulgare*, *Eleagnus angustifolia* (some affected), *Prunus* (*Amygdalus*) *persica*, *P. simoni*, *Quercus robur*, *Acer saccharinum* (a few trees), *Quercus rubra* (few), *Q. macrocarpa* (few), *Syringa vulgaris*, *S. persica* (some few yellow leaves).

The following notes on the flowering of a few plants may be of interest:

October 27th: *Scabiosa atropurpurea*, *Calendula officinalis*, *Melilotus officinalis*, *Leonurus cardiaca*, *Phlox drummondii*, *Trifolium pratense* (sheltered place), *Collinsia bicolor*.

October 23d: *Reseda odorata*, *Erodium cicutarium*, *Marrubium vulgare*, *Potentilla norvegica*, *Sonchus asper*, *Cassia marylandica*, *Erigeron annuum*, *Chrysanthemum coronarium*, *Lathyrus odoratus*, *Nepeta cataria*, *Solidago canadensis*, *Argemone mexicana*, *Maruta cotula*, *Cryptotænia canadensis*, *Polanisia graveolens*, *Borrago officinalis*, *Saponaria officinalis*.

October 21st: *Helianthus debilis*, *Gossypium herbaceum*, *Ricinus communis*, *Ipomœa purpurea*, *Salvia pratensis*.

NOTES ON THE POLLINATION OF CUCURBITS.

ABSTRACT BY L. H. PAMMEL.

Little attention has been given to a study of the pollination of cucurbits. The European *Bryonia dioica* was studied by Hermann Müller and Mr. T. C. Gentry has studied *Cucurbita ovifera* and *C pepo*, but his account is quite inaccurate in some important particulars. Mr. Gentry assumes that they are pollinated by the wind. Insects, especially *Hymenoptera*, are the important pollinators. *Coleoptera*, especially *Diabrotica vittata*, *D. longicornis*, *D. punctata*, are frequently found in flowers and incidentally carry the pollen. Some of the Syrphus flies also assist in the pollination of *Citrullus vulgaris*. Nectar is secreted in considerable quantity especially by the flowers of *Cucurbita pepo* and *C. maxima*. So large was the amount of nectar in some of the covered flowers of *C. maxima* that a half spoonful might have been collected. The odor of the flowers of *C. maxima* is quite pleasant and agreeable. Concerning the sexes, *Cucurbita maxima* and *C. pepo* and *Cucumis sativus* are monœcious. In *Cucumis melo* some varieties have perfect flowers, *e. g.*, they are polygamo-monœcious. Some varieties of *Citrullus vulgaris* also are polygamo-monœcious. Before 12 M. seems to be the proper time for pollination in *Cucurbita pepo* and *C. maxima*, while *Citrullus vulgaris* may be pollinated in the afternoon.

THE STOMATA AND PALISADE CELLS OF LEAVES.

BY F. C. STEWART.

The name stomata (sing. stoma) has been applied to the elliptical apertures in the epidermis of leaves and other green parts of plants. The stoma is a modified epidermal cell and consists of a rift and guradian cells (usually two in number). The guardian cells are rightly named for it is their function to regulate the amount of evaporation from the leaf by opening and closing the rift. Unlike ordinary epidermal cells, the guardian cells contain chlorophyll, and for that reason they were once thought to belong to the parenchyma.

Goodale[1] says, "Stomata belong especially to green organs exposed to the air, but they have been detected on all superficial parts of the plant with the exception of roots." As authority he cites De Bary, who found stomata on the tubers of the potato, on the perianth and anthers of *Lilium bulbiferum* and on the pistil and seed coat of the Canna. In the higher plants they occur for the most part on the leaves. In the majority of Monocotyledons[2] they are found on both sides of the leaf, but in Dicotyledons they are seldom found on the upper surface except in leaves which present both sides to the sun. In some *Coniferæ*[3] there are more stomata on the upper than on the under surface. They are entirely absent from the leaves of submerged water-plants, and appear only on the upper surface of floating leaves.

In regard to arrangement, there seems to be no general law except in a few orders, viz: in *Equisetaceæ*, *Coniferæ* and *Gramineæ*. Since the object of the stomata is to bring the interior of the leaf into communication with the outside they world, are so placed as to communicate directly with the intercellular passages. Their arrangement, therefore, depends upon the internal structure of the leaf. The rift is a narrow ellipse whose major axis is generally the major axis of the stoma as a whole. (*Portulacca oleracea* is an exception.) Outside of the orders above named, the stomata are found scattered irregularly over the surface of the leaf, and with their axes pointing in every conceivable direction.

Being together with the lenticels, the aerators of plants, their number and size are thought to bear an important relation to the behavior of plants. In general, the plants of arid regions have few and small stomata, while water plants and plants native to moist climates have numerous and large stomata. This rule has a great many preplexing exceptions, and we are forced to acknowledge that we

1 Goodale's Physiological Botany. p. 70.

2 Thome's Struct. and Phys. Bot., Eng. Translation, Bennett, p. 61.

3 Gray's Struct. Bot., p. 90.

really have but little exact knowledge of these curious little plant valves. The number of stomata on a square inch of leaf surface is surprising. It varies all the way from a few thousands up to hundreds of thousands. However, all computations of stomata are only approximations. The number varies on different portions of the same leaf, and the difference is often great. To get even an approximation it is necessary to take sections from different portions of several leaves and get an average. For an example of this variation take the Duchess apple. Counts were made on different parts of three leaves with the following results:

LEAF I....	29 stomata in field of microscope.
	26 " " "
	20 " " "
	34 " " "
LEAF II...	30 stomata in field of microscope.
	30 " " "
	27 " " "
	28 " " "
LEAF III..	26 stomata in field of microscope.
	38 " " "

A difference of one stoma in the field makes a difference of over 5000 on a square inch. Thus it is seen that the number in the Oldenburg (Duchess of Oldenburg) varies from about 120,000 to 200,000, while we get as an average 150 000 per square inch. From the table below it will be seen that this is about the average number in the varieties of apples examined by me. Prof. Bessey[4] found from 150.000 to 200,000 and Mr. Wellman[5] observed about the same number, while Lindley[6] gives but 24,000.

To obtain accurate measurements of stomata is even more difficult than to obtain their number. They are so very small and it is so difficult to get them always under the same conditions. In this work, also, we must make a large number of measurements and take the average. Stomata on the same leaf vary considerably in size and somewhat in shape. While the majority are elliptical in outline, some circular ones will be found. In some species they are rectangular. To show how stomata vary in size in leaves of the same tree we will again take the Oldenburg apple. Stomata were measured on three leaves.

The largest, the smallest and intermediate sizes were taken. L. stands for length and W. for width:

4Iowa Hort. Report, 1879, p. 131.

5Iowa Hort. Report, 1873, p. 117.

6In his Introduction to Botany, p. 145, Lindley gives the number of stomata in thirty-six species of plants, twenty-eight of which were computed by Thomson.

Leaf	Stoma	Dimension	Measurement
LEAF I	Stoma 1	L.	.00109 inches.
		W.	.00094 "
	Stoma 2	L.	.00109 "
		W.	.00078 "
	Stoma 3	L.	.00109 "
		W.	.00086 "
	Stoma 4	L.	.00125 "
		W.	.00078 "
LEAF II	Sto ma 1	L.	.00156 "
		W.	.0C094 "
	Stoma 2	L.	.00125 "
		W.	.00094 "
	Stoma 3	L.	.00094 "
		W.	.00094 "
	Stoma 4	L.	.00125 "
		W.	.00094 "
LEAF III	Stoma 1	L.	.00139 "
		W.	.00109 "
	Stoma 2	L.	.00094 "
		W.	.00078 "
	Stoma 3	L.	.00139 "
		W.	.00109 "
	Stoma 4	L.	.00125 "
		W.	.00109 "

The variation indifferent species may be seen in the table. Weiss[7] gives the length and breadth of the stomata in forty species. The least length in his table is .00047 in., the length of the stomata in *Amarantus caudatus;* the least width is .00031 in., in *Morus alba;* the greatest length is .00279 in., in *Lilium bulbiferum;* and the greatest width is .00197 in., in *Avena sativa.* The average length of the stomata in the forty species is .00126 in., and the average breadth is .00091 in.

While studying stomata I also made some observations on palisade cells. The number of rows of palisade cells in each species is given in the table. The number varies from one to four, two being the most common number. Prof. Bessey[8] found from two to four rows in the various varieties of the apple. Except in vertical leaves, palisade tissue is seldom found on the under surface of the leaf. Stomata

[7] Goodale's Phys. Bot., p. 171.

[8] Iowa Hort. Rep't, 1879, p. 132.

are confined mainly to the under surface and palisade cells to the upper surface. The nature ot the palisade tissue depends largely upon the amount of light the leaf receives during its growth. Frequently the innermost layer of palisade cells will be incomplete, that is, in places it will be absent, or the cells may be but little different from the ordinary parenchyma cells. In the table, incomplete layers are indicated by the sign +.

The following table gives the results of some observations made during the past summer. It gives the number of rows of palisade cells, the number of stomata per square inch, and the size of the stomata in the species and varieties named. For the species given in the latter part of the table the size of the stomata is not given. Partly dry and partly alcoholic material was used and in these conditions measure ments of stomata would be unreliable, and hence are omitted:

TABLE.

SPECIES.	STOMATA PER SQ. INCH.		SIZE OF STOMATA IN INCHES.		PALISADE LAYERS.	
	Upper surface.	Under surface.	Upper surface.	Under surface.	Upper surface.	Under surface.
Sugar pear (*Pyrus communis*)...... ..	0	·6,768	0	L. .00151 W. .00119	2+	0
Rutabaga (*Brassica compestris*)......	9,024	12,690	0	L. .00119 W. .00079	......	.....
Portulacca oleracea....................	21,150	8,460	L. .00085 W. .00075	L. .00070 W. .00092	3	0
Salix laurifolia..........	0	135,000	0	L. .00150 W. .00143	2+	0
Prunus pennsylvanica............	0	215,000	0	L. .00107 W. .00059	3	0
Polygonum cuspidatum	0	62,500	0	L. .00381 W. .00261	2	0
Pontederia cordata.....	91,000	118,332	L. .00429 W. .00285	L. .00579 W. .00266	3	1
Apple (Canada Baldwin) *Pyrus malus*.	0	290,000	0	L. .00125 W. .00094	3	0
Apple (Peffer No. 1) *Pyrus malus*.....	0	123,332	0	L. .00128 W. .00086	3	0
Apple (978) *Pyrus malus*................	0	32,500	0	L. .00115 W. .00093	2+	0
Nymphæa reniformis	458,332	0	L. .00094 W. .00078	0	3	0
Acer nigrum.................	0	350,000	0	L. .00078 W. .00073	1	
Pyrus coronaria	0	300,000	0	L. .00100 W. .00062	3+	0
Cratægus tomentosa, var. *mollis*........	.. ....	....	0	L. .00162 W. .00084	......	.....
Apple (Oldenburg) *Pyrus malus*......	0	150,000	0	L. .00124 W. .00095	2+	0
Sagittaria variabilis.....................	32,500	37,500	L. .00182 W. .00130	L. .00192 W. .00156	.....	......
Virginia Crab.............	0	153,750	0	L. .00138 W. .00101	2+	0
6 M (Russian cherry) *Prunus cerasus*.	0	160,000	0	L. .00127 W. .00106	2+	0
12 M (Russian cherry) *Prunus cerasus*.	0	142,500	0	L. .00146 W. .00098	2+	0
Silphium laciniatum..................	45,000	50,000	L. .00192 W. .00172	L. .00198 W. .00156	2	2
Lactuca scariola....................	120,000	122,000	L. .00101 W. .00068	L. .00101 W. .00078	2	2
Populus certinensis.	43,750	109,000	L. .00130 W. .00081	L. .00114 W. .00070	2	0
Populus tremula.................	....	....	....	....	2	0

TABLE—CONTINUED.

SPECIES.	STOMATA PER SQ. INCH.		SIZE OF STOMATA IN INCHES.		PALISADE LAYERS.	
	Upper surface.	Under surface.	Upper surface.	Under surface.	Upper surface.	Under surface.
Acer dasycarpum	0	210,000	0	L. .00057 W. .00044	1	0
Medicago sativa	105,000	91,000	L. .00088 W. .00070	L. .00102 W. .00070	2+	0
Russian Oak (*Quercus robur*, var. *pedunculata*)	0	315,000	0	L. .00119 W. .00091		0
Mongolian Pear (*Pyrus sinensis*)	0	82.500	0	L. .00177 W. .00135	2	0
Prunus serotina	0	235,000	0	L. .00115 W. .00075	2	0
Populus alba	....	....	....	....	2	0
Lutovka (cherry) *Prunus cerasus*	0	109,165	....	....	1+	0
Rosa rugosa	....	....	....	....	2+	0
Prunus angustifolia	0	150,000	....	....	2	2(?)
Celtis occidentalis	....	....	....	....	1	0
Prunus pumila	0	55,000	....	....	....	....
Apricot (Nichol's) *Prunus armeniaca*	0	253,500	....	....	2	0
12 M (Pear) *Pyrus communis*	0	33,000	....	....	2	0
327 (Apple) *Pyrus malus*	0	90,000	....	....	2	0
75 M (Apple) *Pyrus malus*	0	88,000	....	....	2	0
Wythe (Apple) *Pyrus malus*	0	197,000	....	....	3	0
413 (Apple) *Pyrus malus*	0	150,000	....	....	2	0
15 M (Apple) *Pyrus malus*	0	167,500	....	....	3	0
Fluke's Wild Crab (*Pyrus Ioensis*)	0	155,000	....	....	2	0
Talman Sweet (*Pyrus malus*)	0	220,000	....	....	3	0
Rawle's Janet (*Pyrus malus*)	0	170,000	....	....	2	0
Pyrus toringo	....	....	....	....	2	0

A KEY FOR THE IDENTIFICATION OF THE WEED SEEDS FOUND IN CLOVER SEED.[1]

BY. F C. STEWART.

The identification of weed seeds, though an important matter, is not an easy one. The average person knows Fox-tail, and probably that is about all. Even botanists, who have not given the subject special attention, will be surprised to find how small a number of weed seeds they are able to identify without study.

Outside of systematic works[2] but little has been written on seed characters. What has been written is scattered through Experiment Station Bulletins and Agricultural Reports, and is not in an available form. However, the Germans have done some good work in this line, notably Harz[3] and Nobbe.[4]

A good key for the identification of American weed seeds would be of great

1Part of a thesis on THE IMPURITIES OF CLOVER SEED, written for the degree of Bachelor of Science, Iowa Agricultural College.

2Gray's Manual of the Botany of the Northern U. S., Chapman's Flora of the Southern States, Coulter's Rocky Mountain Botany, etc.

Landwirtschaftliche Samenkunde, two volumes, Berlin 1885, Paul Parey.

Handbuch der Samenkunde, Berlin, Wilgandt, Hempel and Parey, 1876.

value to our botanists and seedsmen. The key of Dr. Harz is good, but it is too general in its nature for our purpose. Below is offered a key designed especially for the identification of weed seeds commonly found in clover seed. Though rude and incomplete, it may be of some service.

KEY.

A. Fruit not enclosed by a glume and palet; not a caryopsis.

I. Achenes, sharply triangular.

1. Black and shiny; sides concave; length, 1″.
   Polygonum acre, H. B. K.
2. Black, but not shiny; usually enveloped by the close fitting calyx; sides not concave; length, $1\frac{1}{3}$–2″.
   Polygonum convolvulus, L.
3. Brown and shiny; embryo peripheral.
   a Not enveloped by calyx; length, 1″.
   Rumex... { *Crispus*, L. / *Altissimus*, Wood. }
   b Usually closely enveloped by calyx; length, about ½″.
   Rumex acetosella, L.
4. Brown or light colored not shining; embryo central.
   Carex.
5. Reddish black; not shiny; pointed; length, $1\frac{1}{3}$″.
   Polygonum aviculare, L.

II. Achenes or nutlets, slightly triangular.

1. An achene, nearly flat; one angle very obtuse and rounded; somewhat ovate; dull black; length, $1\frac{1}{3}$″.
   [5]*Polygonum hydropiper*, L.
2. Nutlet; brown; narrowly ovate; length, 1′; one face flat, the other two meeting in an obtuse angle which is bordered on each side by a line of darker brown; very smooth.
   Brunella vulgaris, L.

III. Achenes, lenticular or ovate and flattened.

1. Usually black; embryo[6] coiled in a ring around the albumen; never more than 1″ in length; not pointed at apex; sides convex.
   a Shiny black; without utricle.
   * Orbicular; ½–⅔″ broad.
   Amarantus albus, L.
   ** Somewhat ovate; length ½–⅔″.
   Amarantus retroflexus, L.
   *** Less shiny; orbicular; ¾–1″ broad.
   Amarantus blitoides, Watson.
   b Dull grayish black; orbicular; utricle frequently present; ¾″ broad.
   Chenopodium album, L.

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[5] In the genera *Polygonum* and *Rumex* many achenes are found from which the pericarp has been removed in threshing. Such are flesh colored and of the same shape as the achenes before mutilation.

[6] The pericarp is often partially removed in *Amarantus* and *Chenopodium* showing the flesh colored seed. The coiled embryo can be readily seen with a hand lens. Usually enough of the pericarp remains to identify the genus.

2. Black and shiny; 1″ or more broad; abruptly tipped with a short point.

a Gibbons flattened, sometimes slightly triangular; orbicular to slightly ovate; $1\text{–}1\frac{1}{4}$″ broad.

Polygonum persicaria, L.

b Concave on both sides; orbicular; $1\frac{1}{3}\text{–}1\frac{3}{4}$″ broad.

Polygonum pennsylvanicum, L.

IV. Seeds sharply angled in various ways, but not triangular; not achenes.

1. Dull black or brown seeds with one convex face which is more or less rough. Angles not winged except in *Verbena hastata*.

a Nearly uniform in size throughout the entire length of the seed; length, $2\frac{1}{2}\text{–}3$ times the thickness; 3-faced, one convex, the other two plane and meeting in a moderately sharp angle; light brown.

Verbena.

* Convex face prominently 4-ridged longitudinally; upper half transversely wrinkled.

f Length, $1\text{–}1\frac{1}{5}$″; plane faces with whitish roughening.

V. bracteosa, Michx.

ff Length, $1\text{–}1\frac{1}{5}$″; little or no whitish roughening on plane faces.

V. angustifolia, Michx.

fff Length, $1\frac{1}{3}\text{–}1\frac{1}{2}$″; otherwise same as in *V. angustifolia.*

V. stricta, Vent.

** Not prominently ridged nor wrinkled.

f Length, $\frac{3}{4}\text{–}1$″; angles not winged.

V. urticæfolia, L.

ff Length, 1″; angles between the convex face and the plane faces slightly winged.

V. hastata, L.

b Seeds flattish; angled in various ways; smaller at the ends than in the middle.

f Dark brown, nearly black; length, $\frac{3}{4}\text{–}1\frac{1}{4}$″.

Plantago rugelii, Decaisne.

ff Light brown; length, $\frac{1}{2}$″.

Plantago major, L.

2. Seeds irregular and winged on the angles, giving them a shriveled appearance; light brown; length, $\frac{3}{4}$″.

Œnothera biennis, L.

V. Obconical achenes; longitudinally ribbed; light colored.

1. Ribs beset with tubercles; light brown; length, $\frac{3}{4}$″.

Anthemis cotula, D. C.

2. Not tubercled; truncate at apex; length, $\frac{3}{4}$″; lighter colored than last.

Anthemis arvensis, L.

3. More slender; stripes of black between the ribs; $\frac{3}{4}$″ long.

Chrysanthemum leucanthemum, L.

VI. Boat shaped seeds, oblonged and hollowed on one face.

1. Shiny brown; about twice as long as broad. Light colored line running lengthwise the convex face; length, $1\frac{1}{5}''$.

   Plantago lanceolata, L.

2. Brown but not shiny; a slight transverse depression running across the middle of the convex face; length, 1-$1\frac{1}{2}''$; the hollow white lined; two white rimmed depressions at the bottom of the hollow.

   Plantago patagonica var. *aristata*, Gray.

VII. Seeds globose or nearly ovoid.

1. Greenish, oily, naked seed; nearly ovoid; pointed; length, 1″.

   [7]*Ambrosia* { *artemisiæfolia*, L.
   { *psilostachya*, D. C.

2. Gray black; globose; $\frac{1}{3}''$ in diameter; surface irregularly roughened.

   Cuscuta epithymum, Murr.

B. Fruit enclosed by glume and palet; a caryopsis.

I. Flowering glume and palet smooth, shiny and coriaceous.

1. One side flat, the other with a prominent hump; shiny green.

   a Orbicular; 1″ broad.

   Paspalum læve, Michx.

   b Ovate, tapering to an acute point; length, $1\frac{1}{2}$–2″.

   [8]*Panicum crus-galli*, L.

2. One side somewhat flattened, but the other not prominently humped.

   a Ovoid; very dark green; length about $\frac{3}{4}''$.

   Panicum capillare, L.

   b Narrowly oblong; light green; length about $1\frac{1}{5}''$.

   Panicum proliferum, Lam.

   c Linear oblong; pointed slightly at both ends; the second sterile glume and the imperfect flower generally closely enveloping the perfect flower.

   * Perfect flower usually black; first sterile glume almost wanting, second one equaling the flower; length, 1″.

   Panicum glabrum, Gaudin.

   ** Perfect flower greenish; first sterile glume small, second not more than half the length of the flower; length, $1\frac{1}{2}''$.

   Panicum sanguinale, L.

II. Flowering glume and palet roughened, but coriaceous; ovate.

1. Length about 1″; greenish, light colored or dark brown; flowers striate lengthwise and dotted.

   Setaria viridis, Beauv.

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[7] Seeds of these two species generally appear naked and in this condition. I know of no characters by which they can be separated. But when found with the involucre intact they are easily separated. *A. artemisiæfolia* has a crown of 6-8 stout tubercles while *A. psilostachya* is smooth.

[8] Frequently the sterile glumes and the imperfect flower remain attached. In such cases the species is easily distinguished by the stiff bristles on the second sterile glume and the glume of the imperfect flower. The glume of the imperfect flower is also awned.

2. Length, $1\frac{1}{4}$–$1\frac{3}{4}''$; tawny yellow, brown or nearly black; transversely wrinkled.

[9] *Setaria glauca*, Beauv.

II. Flowering glume and palet membranaceous, glume truncate; palet 2-nerved; length of flowering glume about $\frac{3}{4}''$.

[10] *Phleum pratense*, L.

EXPLANATION OF PLATE.

1. *Setaria viridis* (upper surface).
2. *Setaria viridis* (under surface).
3. *Setaria viridis* (with glumes removed).
4. *Setaria glauca* (upper surface).
5. *Setaria glauca* (under surface).
6. *Setaria glauca* (glumes removed).
7. *Panicum glabrum.*
8. *Panicum sanguinale.*
9. *Panicum crus-galli.*
10. *Panicum crus-galli* (glumes removed).
11. *Plantago lanceolata* (convex face).
12. *Plantago lanceolata* (concave face).
13. *Plantago rugelii.*
14. *Amarantus retroflexus.*
15. *Amarantus albus.*
16. *Amarantus blitoides.*
17. *Polygonum aviculare.*
18. *Chenopodium album* (without utricle).
19. *Polygonum persicaria,*
20. *Polygonum hydropiper.*
21. *Chenopodium album* (with utricle).
22. *Polygonum aere.*
24. *Rumex acetosella.*
25. *Ambrosia artemisiæfolia* (naked).
27. *Rumex crispus.*
28. *Anthemis cotula.*
29. *Verbena bracteosa.*
30. *Chrysanthemum leucanthemum.*

NATURAL SIZE DRAWINGS.

31. *Setaria viridis.*
32. *Setaria glauca.*
33. *Panicum glabrum.*
34. *Panicum sanguinale.*
35. *Panicum crus-galli.*
36. *Plantago lanceolata.*
37. *Plantago rugelii.*

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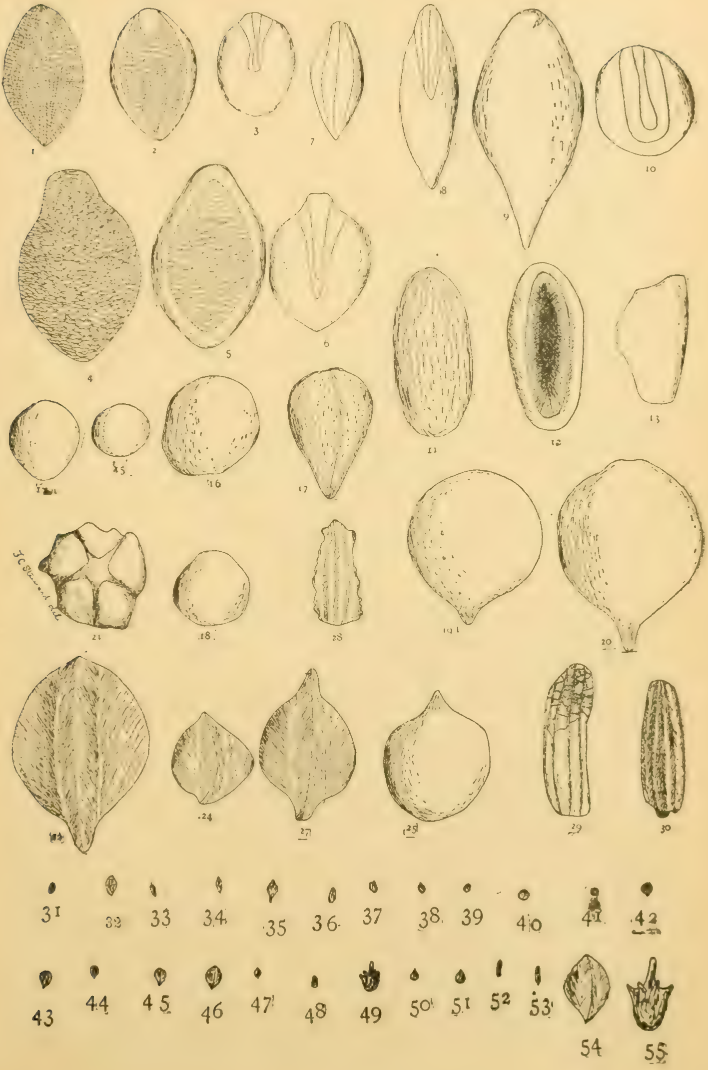
[9] *S. glauca. S. viridis* and *P. crus-galli* frequently appear naked; *P. crus-galli* and *S. glauca* are orbicular, flat on one side, well rounded on the other, and are quite difficult to separate. *S. viridis* is oblong ovoid. All these are light green in color.

[10] This very frequently occurs naked. Then it is light brown, ovoid, ½″ long.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38. *Amarantus retroflexus.*
39. *Amarantus albus.*
40. *Amarantus blitoides.*
41. *Chenopodium album* (without utricle).
42. *Polygonum persicaria.*
43. *Polygonum hydropiper.*
44. *Polygonum aviculare.*
45. *Polygonum acre.*
46. *Polygonum convolvulus.*
47. *Rumex acetosella.*
48. *Anthenus cotula.*
49. *Ambrosia artemisiæfolia* (with utricle).
50. *Rumex crispus.*
51. *Ambrosia artemisiæfolia* (naked).
52. *Verbenia bracteosa.*
53. *Chrysanthemum leucanthemum.*
54. *Polygonum convolvulus* (enlarged three times).
55. *Ambrosia artemisiæfolia* (enlarged, with involucre).

PRELIMINARY OBSERVATIONS ON A CATTLE DISEASE FREQUENTLY OCCURRING IN IOWA.

BY W. B. NILES.

This disease is called hydrophobia by the people at large in a majority of cases. By veterinarians it is diagnosed as rabies, cerebro-meningitis, enteritis and impaction of the third stomach.

As regards its distribution, it may be said to occur most frequently north of a line drawn east and west separating the State into halves. In the extreme southern part cases are rarely reported.

Nature, Symptoms and Course of the Disease.—In some outbreaks the cattle are reported to have been bitten by a dog, but seldom has the owner been able to positively say that such is the case. In a majority of cases no dog is mentioned in connection with them, and no strangely acting dog has been reported in the neighborhood.

In all outbreaks the disease runs a lingering course in the herd. Several cases occur and the time elapsing between the first and last case extends over several weeks; in some outbreaks over five or six months. The symptoms observed in the different outbreaks are very uniform. So uniform that it is easy in most instances to recognize the trouble from descriptions written by the owner of the cattle.

At first the animal appears uneasy, is alert, taking more notice than common of everything taking place about it, is very attentive if a strange man or dog appears, and a slight switching of the tail is often observed. The eyes soon become staring and wild, and eventually reddened. The animal early refuses food and drink, and as a consequence becomes very gaunt in appearanee. Early in the course of the disease saliva dribbles from the mouth and continues to a greater or less extent until death occurs. Soon after the appearance of the first symptoms the animal begins to bellow or low very much like an animal lost from its fellows. This is continued with intermissions of quiet until the animal dies, and is the most characteristic feature of the disease. Some become quite "mad" or furious and chase anything that comes in their way, man as well as beast; many have been reported to me as having chased their attendants, and I have myself been charged at by a steer which at first sight appeared to be inoffensive. At other times the sick animal has a desire to follow one about—to start after and follow other cattle in the herd without any desire to injure them. Within a short time after the first symptoms appear the animal shows weakness in the hind limbs with a tendency to knuckle over at the fetlocks. This is also often seen in the fore extremities, and as the disease advances becomes more marked until in some cases the animal will when trotting along suddenly go down by first going over on the fetlocks and then down on the knees, chest and abdomen. The animal will get up perhaps to repeat the act again shortly. This, I think, is due to a loss of the co-ordination powers more than to weakness. In many cases during the trouble severe straining occurs, as if the animal were trying to pass dry fæces. Nothing except a small quantity of dark fæces is passed however.

Death occurs in from four to eight days, most cases living about one week. The disease is uniformly fatal. I have yet to hear of the first recovery. In some outbreaks about fifty per cent of the cattle become affected. In a majority of cases, however, the loss is not above ten per cent.

Post mortem examination shows almost uniformly an absence of what are usually called fatal lesions. The liver, spleen, kidney, heart and intestinal tract are usually normal. In a few cases I have found the folds of the abomasum reddened and œdematous, and again the capsule of the kidney has been observed in some cases to detach easily, and on sections of the organ a congested condition of the vessels have been noted, together with several small calculi in the pelvis. The blood, if at all changed from normal, is lighter in color and clots more quickly. The brain and surrounding membranes show the greatest change. On incising the dura mater there is usually an escape of considerable clear serum. On removal of the dura an intense black color of the pia mater covering a large part of the organ is sometimes observed. At other times this dark color is not so marked, and is confined to the anterior portion of the cerebral lobes. A small piece of the membrane placed under the microscope shows the dark color to be due to a great number of minute dark bodies resembling micrococci, situated on the underside of the pia mater. (This black condition I have found in apparently healthy animals slaughtered for food, but present only to a slight extent.) The vessels of the brain are much congested, ecpecially those of the choroid plexus, and those in the region of the fourth ventricle. This condition is even well marked after the animal has been destroyed by bleeding. A section of the organ shows no apparent change in the brain tissue.

What is the disease and what is its cause? Is it rabies, communicated to cattle by the bite of some rabid animal, or is it something very similar to it, contracted in some other way? These are questions not easily answered. It mnst be admitted that the symptoms are very much like those shown by rabid cattle, yet, when we observe that hydrophobia in man is very rarely met with; that but few rabid dogs are seen; that the disease seems to be a *cattle* disease, and that it extends over such a long period of time and rarely exists on but one farm in a neighborhood, we are loth to accept the diagnosis of rabies.

Thinking it was possibly a bacterial disease, I have made quite a thorough bacteriological study of the trouble. I have made cultures from the liver, spleen, kidneys, blood, brain substance and brain serum. Some of them have been made in the field and others in the laboratory from tissues carefully removed for that purpose. For culture media, agar-agar, nutrient gelatine, blood serum, bouillon and potato have been used.

Culture tubes inoculated from the spleen, liver, blood and kidneys often remain sterile. In some instances organisms have been obtained from these organs, but no one of these has been met with in a majority of the cases examined. From the brain and brain serum, several chromogenic varieties have been isolated, some of which have been obtained from more than one animal. Rabbits and calves have been inoculated with bouillon cultures of those organizing with negative results.

An organism not chromogenic has appeared in one or more of the culture tubes from four different outbreaks. It has been obtained from the brain, spleen and liver. From its frequency of occurrence it would seem possible that it may have a casual relation to the trouble. Rabbits, calves and one dog have been inoculated subcutaneously and intravenously with bouillon cultures with negative results, and no organism so far observed has proven pathogenic.

The organism last referred to is a micrococcus, considerably larger than the most micrococci. In agar-agar stab-culture it develops slightly along the track of the needle and extends slowly over the surface, forming a raised, soft, tenacious mass. At first white, the growth gradually becomes dirty white or cream colored, bordering on brown. On blood serum the growth does not form a circular confluent mass, but development occurs on the surface in lines extending in different directions from the seat of puncture. It grows better in bouillon than in solid media, and does not produce gas in ordinary media. In bouillon no film forms on the surface, but a sediment forms at the bottom of the flask which in time becomes quite abundant. It grows at the ordinary room temperature, but faster in thermostat at about 37°. In agar-agar I have observed in a few instances individual colonies develop along the track of needle, which eventually became very dark colored, almost black.

Recently an outbreak of the disease near Greene, Iowa, furnished some material for more experiments, and with the assistance of Drs. Moore and Kilborne from the Bureau of Animal Industry, a yearling heifer was inoculated under the dura mater—a piece of bone having first been removed with a trephine—with an emulsion of brain matter from an animal which died from the effects of the disease On the nineteenth day after the inoculation the inoculated animal began showing symptoms similar to those described heretofore. Death occurred on the sixth day after the first symptoms were observed. A post mortem examination showed much the same conditions met with in regular outbreaks. Before the death of the animal, saliva was collected and a rabbit inoculuted inside the thigh under the skin. This rabbit died in nine days. Inoculations have been made from both the calf and rabbit brains, and it is hoped we will now be in a position to say whether the disease is rabies or something else.

PELLÆA ATROPURPUREA, LINK., ON SANDSTONE LEDGES IN MUSCATINE COUNTY, IOWA.

BY F. REPPERT, MUSCATINE, IOWA.

There are in Muscatine county two localities where this fern occurs. These stations are sandstone ledges belonging to the carboniferous formation. This seems to be an exceptional and as yet unrecorded habitat for this fern. These localities are both along the Mississippi river, the one at Wyoming hills, seven miles, the other at Montpelier, fourteen miles above Muscatine City.

The sandstone composing these ledges is soft, more or less shaley, particularly that at Montpelier. That these ledges are natural drainage points is evidenced by the facts that at both are found living springs and a more or less wet condition along nearly the full length of their exposure. In places, at the base of each of these ledges, tufa is found in limited quantity. These evidences indicate the presence of lime, which is confirmed by chemical tests, both the water and the stone showing the presence of a considerable per cent of this base. The lime may not be an original constituent of the rock, but a secondary addition, resulting from the lime-charged waters which filtrate into these ledges, supplying the necessary lime and moisture which make these sandstone ledges congenial to this fern.

In "Ferns of North America," by D. T. Eaton, it is stated that "this fern was collected by John Clayton about 1736, on the shore of the river Rappahannock, in a shady place by the root of a juniper."

It may be worthy of mention that at both of the Muscatine stations for this fern the red cedar (*Juniperus virginiana*, L.) is found on the brinks of the ledges. These are the only known places in the county where the juniper is found native.

LIST OF IOWA CLOVER INSECTS AND OBSERVATION ON SOME OF THEM.

The following list of Iowa clover insects comprises those species enumerated by Profs. J. A. Lintner and C. M. Weed as clover feeders which are known to occur in the State with such additions as personal observation or accepted authority will permit. All insects listed occur in the collections of the Iowa Agricultural College, and the notes in connection with any individual insect refer only to its occurrence on clover.

A few doubtful determinations were referred to Prof. Herbert Osborn, of Ames, Iowa.

ORDER LEPIDOPTERA.

FAMILY PAPILIONDÆ.

Callidryas eubule, Linn., var. sennæ, L.
Colias cæsonia, Stoll. Common.
Colias eurytheme, Bd. Common.
Colias philodice, Godt. Plentiful.

FAMILY LYCÆNIDÆ.

Lycæna comyntas, Godt. Common.

FAMILY HESPERIDÆ.

Eudamus pylades, Scudd.

FAMILY BOMBYCIDÆ.

Spilosoma isabella, Sm-Abb.
Hyphantria cunea, Drury.
Hyperchiria io, Fabr.

FAMILY NOCTUIDÆ.

Agrotis fennica, Tausch.
Agrotis annexa, Treitsch.
Agrotis saucia, Hübn.
Mamestra trifolii, Esp.
Mamestra renigera, Steph.
Mamestra picta, Harr.
Prodenia commelinæ, Guen.
Nephelodes violans, Guen.
Leucania unipuncta, Haw.

Plusia brassicœ, Riley.

Heliothis armigera, Hübn. Very common.

Drasteria erechtea, Cram. Very plentiful. Exceptionally injurious the past season.

FAMILY GEOMERTIDÆ.

Hæmatopis grataria, Fabr. Plentiful.

Aspilates dissimilaria, Hübn.

FAMILY PRALIDÆ.

Asopia farinalis, Linn.

Asopia costalis, Fabr. Reported as very destructive to stacked clover, in some of the southern counties of the State.

FAMILY TORTRICIDÆ.

Cacœcia rosacæna, Harr.

Dichelia sulphureana, Clem. Common at times.

Grapholitha interstinctana, Clem. Our most destructive moth. Have seen it damage the clover seed crop more than fifty per cent in some fields.

FAMILY TINEIDÆ.

Gelechia roseosuffusella, Clem. Common.

ORDER DIPTERA.

FAMILY CECIDOMYIDÆ

Cecidomyia leguminicola, Lint. Our most formidable clover insect. Widely distributed over the State.

ORDER COLEOPTERA.

FAMILY EROTYLIDÆ.

Languria mozardi, Latr. Not plentiful.

FAMILY CHRYSOMELIDÆ.

Colapsis brunnea, Fabr.

Diabrotica longicoruis, Say. Common.

Diabrotica 12-punctata, Oliv. Common.

FAMILY TENEBRIONIDÆ.

Tenebrio molitor, Fitch.

FAMILY MELOIDÆ.

Macrobasis unicolor, Kirby. Plentiful.

FAMILY OTIORHYNCHIDÆ.

Epicærus imbricatus, Say.

FAMILY CURCULIONIDÆ.

Sitones flavescens, Marsh. Plentiful and very serious at times.

FAMILY CALANDRIDÆ.

Sphenophorus placidus, Say.

ORDER HEMIPTERA.

FAMILY CAPSIDÆ.

Pæcilocapsus lineatus, Fabr. Very plentiful.

FAMILY COCCIDÆ

Pulvinaria innumerabilis, Rathvon.

FAMILY THRIPIDÆ.

Thrips tritici, Fitch.

ORDER ORTHOPTERA.

FAMILY ACRIDIDÆ.

Caloptenus femur-rubrum, De G. Very plentiful.
Caloptenus bivittatus, Say. Common.
Caloptenus differentialis, Thos. Plentiful.

ORDER THYSANURA.

FAMILY PODURIDÆ

Smynthurus arvalis, Fitch. Swarms in clover in May and June. Cannot be found in late summer and autumn. Perhaps not very injurious.

ORDER ACARINA

Bryobia pratensis, Garman. Very plentiful, and doubtless injurious in the spring.

Additional list of known and doubtful feeders.

ORDER LEPIDOPTERA.

FAMILY NOCTUIDÆ.

Plusia precationis, Guen. Adults very abundant in clover in September. Doubtless an injurious insect.

FAMILY DELTOIDES.

Hypena humuli, Harr. Adults captured in clover in September. Doubtful.

FAMILY PYRALIDÆ.

Nomophila noctuella, S-V. Adults very abundant in clover in September. Very doubtful.

ORDER COLEOPTERA.

FAMILY CHRYSOMELIDÆ.

Diachus auratus, Fabr. (Authority of Osborn.)
Disonycha triangularis, Say. Swept from clover and very probably feeds upon it.
Psylliodes punctulata, Welsh. Plentiful in May.
Pachybrachys othonus, Say. Taken sweeping.
Pachybrachys infaustus, Hald. Taken sweeping.

FAMILY MELOIDÆ.

Epicauta pennsylvanica, De G. Not often taken in clover.

FAMILY OTIORHYNCHIDÆ.

Tanymecus confertus, Gyll. One specimen taken. A probable foe.

FAMILY PHILACRIDÆ.

Alibrus consimilis, Marsh.

Alibrus nitidus, Welsh.

These two species are common on the flowers upon which they doubtless feed, though it is questionable if they do any noticeable injury.

ORDER HEMIPTERA.

FAMILY COREIDÆ.

Alydus eurinus, Say. Fairly common (authority of Osborn).

FAMILY COREIEÆ.

Coriyus hyalinus, Fab. Common.

FAMILY CAPSIDÆ.

Lygus pratensis, Linn. (Recorded by Osborn.) Abundant and injurious.

Calacoris rapidus, Say. (Recorded by Osborn.) Plentiful.

FAMILY JASSIDÆ.

Agallia sanguinolenta, Prov. Abundant and serious.

Tettigonia hieroglyphica, Say. May have been an accidental occurrence.

Empoa albipicta, Forbes. The most serious Jassid at Ames last season.

Cicadula 4-lineata, Forbes. One specimen taken by sweeping.

Phlepsius irroratus, Say. Not common, perhaps not normal.

Thamnotettiex melanogaster, Prov. Not plentiful; perhaps not common.

Platymetopius acutus, Say. Not uncommon.

Chloroteltix viridis, Van Duzee. One specimen taken in sweeping.

FAMILY FULGORIDÆ.

Amphiscepa bivitatta, Say. One specimen taken in sweeping. Probably accidental on clover, and its normal food plant some of the fruil trees.

FAMILY MEMBRACIDÆ.

Campylenchia curvata, Fabr. (Authority of Osborn.) Larvæ collected on clover by Miss Alice M. Beach.

FAMILY APHIDÆ.

Aphis medicaginis, Koch. (?) (Rare. Authority of Osborn.)

Callipterus trifolii, Monell. (Recorded by Monell and for Iowa. Authority Osborn.)

Siphonophora sp. Extremely abundant and serious the past season.

FAMILY THRIPIDÆ.

Phlœothrips nigra, Osborn. (Recorded by Osborn.) Very abundant in the heads.

ORDER ORTHOPTERA.

Tragocephala viridifasciata, Han. So common in spring that it seems worthy of special mention, with the three species listed by Weed.

NOTES ON APHIDIDÆ

HERBERT OSBORN AND F. A. SIRRINE.

A list of the Aphididæ of the State as far as collected was published in the proceedings of this Academy for 1890-91 as part of the catalogue of Iowa Hemiptera. It was known at the time to be very incomplete, but it was considered best to include only such species as had been actually observed. As the past season was favorable, especially during autumn, for collecting in this family, considerable more material has been added. We present, therefore, a supplemental list with notes on habits and references to host plants.

Siphonophora erigeronensis Thos. On Erigeron canadensis. (Common "Horse Weed.") This is one of the most common species, occurring on a number of common weeds besides the above, and also on greenhouse plants.

Siphonophora sp. Apparently identical with S. Geranii Oestl. On leaves of Ostrya virginica (Hop Hornbeam).

Siphonophora tiliæ Monell. On Tilia americana (Basswood).

Siphonophora granaria Kby. On volunteer oats and has been abundant in different parts of the State. Was overlooked in making up the previous list.

Siphonophora sp. On Trifolium pratense (Red Clover).

Siphonophora sp. On Scrophularia nodosa.

Siphonophora sp. On Cicuta maculata (Poison Hemlock).

Siphonophora sp. On Polygonum Hartwrightii.

Phorodon humuli Schrank, on Hop. Collected on Des Moines river in Boone county, and on Squaw creek in Story county.

Phorodon sp. On Monarda punctata (Horse Mint). This species is probably identical with the Phorodon which Mr. T. A. Williams lists without description as Phorodon monardæ n. sp. on Monarda fistulosa.

Siphocoryne xanthii Oestland. On Xnathium canadense (Cocklebur). This pretty species was quite abundant on the above plant during the latter part of the summer.

Rhopalosiphum nymphaeæ L. On Nymphæa odorata (Pond Lily). What is apparently the same species occurred also on the Arrow leaf Sagittaria variabilis.

Rhopalosiphum rhois Monell. (?) On Rhus glabra (Sumach).

Rhopalosiphum serotinæ Oestl. (?) On apple leaves.

Aphis maidis Fitch. Abundant on corn, Broom corn and Sorghum. Given in previous list but not from this locality.

Aphis monardi Oestl. On Monarda punctata (Horse Mint).

Aphis mimuli Oestl. On Mimulus ringens (Monkey Flower).

Aphis helianthi Monell. (?) On Helianthus gross-serratus. Taken in Tama county and at Ames.

Aphis sp. On Amaratus albus (?) (Tumble Weed).

Aphis cardui L. On Thistle.

Aphis sp. Probably A. Asclepiadis Fitch, on Asclepias cornutum (Milkweed). Perhaps the same as S. asclepiadis of last list

Aphis setariæ Thos. On Panicum crus-galli (Barnyard grass).

Aphis eupatorii Oestl. (?) On Eupatorium perfoliatum (Boneset).

Aphis ageratoides Oestl. On Eupatorium Ageratoides.

Aphis sp. Probably Aphis lonicera Monell. On cultivated Honey suckles.

Aphis œnotheræ Oestl. On Œneothera biennis (Evening Primrose).

Aphis marutæ Oestl. (?) On Cratægus coccinea (Hawthorn).

Aphis frondosæ Oestl. On Bidens frondosa (Burr Marigold).

Aphis euonymi Fab. On Euonymus atropurpurus (Wahoo). Included in prevous list under A. rumicis but now considered distinct. It agrees more closely with A. viburni but is given as a distinct species by Buckton.

Aphis cratægifoliæ Fitch. On Cratægus tomentosa (Thorn).

Hyalopterus pruni Fab. On Plum and Choke cherry.

Hyalopterus arundinis Fab. Pruni Fab. (?) On Phramites communis. At first only the winged form of Hyalopterus pruni was found on the plum, and in no case was the apterous viviparous form found. The blades of Phragmites showed that the Aphids had been there for some time and probably for most of the summer. Pupæ of both the viviparous females and of the males were found in the colonies on Phragmites. There is no difference in structural characters of the winged viviparous forms found on plum and those found on Phragmites. Slight differences may be noted in color evidently due to age. Hence it seemed more than probable that this aphid migrated from the grass to leaves of some of the plum family to deposit the oviparous females; these latter depositing their eggs around the buds.

Winged forms were taken from the grass and confined on leaves of plum. These winged forms established colonies of oviparous individuals, and these deposited eggs around the buds.

Monellia caryella Fitch. On Hicoria alba and amara. One specimen listed in previous list, a single specimen from a small colony having been secured a few years ago (1889). The species was rather common this season, a point of interest, since this species was for some thirty years after its description by Fitch unrecognized by any other entomologist, but was a few years ago recorded in Minnesota by Mr. Oestlund about the same time our speciman was taken here.

Callipterus bellus Walsh. On Quercus coccinea. (?) In markings this resembles Monellia.

Callipterus asclepiadis Monell. On Asclepias cornutum.

Callipterus discolor Monell. On Oak. This and the preceding seem to be identical so far as descriptive characters go even when compared side by side in fresh specimens. It seemed possible that they move from Milkweed to Oak in autumn, but egg-laying broods and eggs were found on both plants.

Callipterus sp. On Quercus macrocarpa, and coccinea.

Callipterus sp. Probably the same as Chaitophorus spinosa Oestlund. On Quercus macrocarpa.

Callipterus trifolii Monell. Abundant in autumn on Trifolium pratense Red Clover). Mentioned in previous list as Callipterus. On Clover. Monell's descriptions in Canadian Entomologist had been overlooked.

Chaitophorus populifoliæ Fitch. On Populus monilifera.

Chaitophorus populicola Thos. (?) On Populus tremuloides. Aspen.

Chaitophorus sp. On Populus tremuloides (Aspen).

Chaitophorus nigra Oestl. On Salix nigra. (?) (Willow).

Chaitophorus sp. On Salix longifolia. (?)

Melanoxanthus sp. Apparently undescribed. Occurs at the base of willow bushes, and the secretion covering them is of such a color as to give the bushes the appearance of being covered with the sediment of high water. Usually hidden in rubbish or loose leaves. Only apterous forms have been taken.

Cryptosiphum sp. On Artemisia frigida. Probably C. Artemisiæ Buckton, but only apterous forms taken.

Schizoneura lanigera Hauss. Not abundant on Pyrus coronaria. Since previous list was published this species has been taken at Ames on Wild crab.

Tetraneura graminis Monell. On Leersia virginica.

Tetraneura ulmi L. On Ulmus americana winged forms of Tetraneura graminis were found flying from Leersia virginica, and at the same time winged specimens of Tetraneura ulmi were observed alighting and hiding under rough bark of the elm, where afterward the peculiar males and females of the latter were found as also the single egg of the female.

Colopha ulmicola Fitch. Included under Glyphina in previous list. Specimens this season were taken on the bark of Cork elm in October.

Colopha eragrostidis Middleton. On Eragrostis Frankii and Purshii. Not compared with the original description. So far as descriptive characters go there is no difference between this species and the one occuring on elm.

Pemphigus attenuatus n. sp. On Smilax rotundifoliæ. They accumulate in colonies extending for a foot or more along the vine and give it the appearance of being two or three times its normal diameter and of a grayish woolly surface, or as if covered with some abnormal growth. The lice hang by their beaks with the end of the body held at right angles to the vine so that the outer surface is quite uniform. Some specimens nearly the same if not identical with the winged forms of Smilax were taken in August, 1889. These were covered with an extremely long white excretion. In flight the dense cottony mass made them appear like large flakes of snow.

Description.—Body robust purple black. Head broad. Antannæ wide apart nearly as long as body, dusky throughout. Wings narrow, attenuate at tip, veins very slender, legs black, tibiæ slightly pale toward apex. Described at time of collecting.

Alate viviparous female form: Length of body 1.8 to 2 mm. of antenna, 1.33 to 1.34 (I 0.5; m. II 0.12 mm.; III 0. 22 mm.; IV 0.25 mm.; V 0.30 mm.; VI including nail 0.30 mm.) Width of body 0.7 mm.; length of wing, 3.6 to 3.9 mm.; width, 1 mm. Rostrum reaching beyond second pair of caxæ. Wings narrow, pointed, from which the name is derived. Third discoidal obsolete at base; the first and second discoidals approximate at point of issue. The same is true of the discoidals of hind wings. Stigma long and narrow; stigmal vein nearly straight and running nearly to apex of wing, approaching in this respect some species of Lachnus. Cauda and cornicles obsolete. Antennæ not annulate, third joint with a few enlarged sensoria, remaining joints slightly rough or irregularly rugose. From specimens in balsam.

Apterous viviparous form: Length of body 3.50 to 3.90 mm.; width 1.80 to 2 mm.; length of anntenna 130 to 140 mm. (Joint I 0.10 mm.; II 0.15 mm.; III 0.32 mm.; IV 0.25 mm.; V 0.27 mm.; VI 0.30 mm.) Antennæ slightly roughened and with a few hairs. Rostrum reaching second pair of coxæ, stout. Body walls and appendages brown, the fluids of the body give a dark olive green background, while the whole surface is covered with a gray flocculent secretion. In balsam the color changes to a purple black. Cauda obsolete Cornicles barely indicated.

Apterous males or larvæ: Length of body 1 mm width 0.4 to 0.5 mm.; Rostrum reaching nearly to end of abdomen, stout. Antennæ length 0.7 mm.; Only five joints visible. Eyes small, red.

LIFE HISTORIES OF JASSIDÆ.

BY HERBERT OSBORN.

Observations upon the grass feeding species of *Jassidæ* have been directed particularly throughout the season to learning important steps in their life history The first point which we tried to determine was the stage in which the winter is passed. Adults of *Deltocephalus inimicus*, *D. debilis*, *Agallia sanguineolenta* and many other species had been taken in sheltered locations last season up to the time when actual winter commenced, and with the opening of spring search was at once begun for them in places where it seemed most likely that they might be found, viz: sunny spots of lawn on the south side of buildings, south slopes of sodded hills in the woods, under debris and weeds, and in such other places as seemed to afford any promise of shelter for them. The only distinctively grass feeders found were *Agallia sanguineolenta* and *Tettigonia hieroglyphica*, the former in a variety of situations, the latter only in the woods. No specimens whatever of *Deltocephalus*, *Diedrocephala* or other conspicuous grass feeding genera were found. Search for adults began March 8th and continued at short intervals till larvæ appeared all over grass land, and had adults been present they could hardly have escaped notice. This seemed to show pretty certainly that the eggs must be deposited in the fall and that the adults perish during winter if not in late autumn. To determine more accurately the place of deposition of the eggs and to secure additional evidence as to whether it was necessary for adults to survive the winter to oviposit, a pen about 6x10 feet was built, enclosing a patch of bluegrass lawn, the sides consisting of tightly fitting boards. The bottom edges were set nto the ground and all cracks and openings carefully stopped; the pen was open, however, at the top to sun and rain. This enclosed patch was carefully examined to make sure that no adults were present and both it and the outside territory were examined carefully at very freqent intervals to determine the first appearance of insects. Larvæ from without could not possibly enter, a leap of two feet being far beyond their powers, a few inches being the most that they can rise. The probability of the adults entering the enclosure, even if any had been found elsewhere, was very slight indeed. As soon, however, as larvæ appeared over grass land in general, and they appeared in millions within a few days of the time that the first larvæ were found, this pen also contained larvæ in numbers, showing, we believe, that the eggs must have been deposited within that particular area the fall preceding. This observation coupled with the fact that the eggs of the summer broods have been found inserted under the epidermis of grass blades seems to give conclusive proof that the spring brood of larvæ hatch from eggs that have been deposited in the grass in the autumn or early winter preceding.

The first larvæ were seen April 23d, in grass, on the south side of one of the college buildings, but were not to be found elsewhere, nor did they appear in great numbers till May 12th, evidently being retarded by the cold wet weather. The larvæ taken April 23d were nearly black in color and developed into *Deltocephalus inimicus*, one adult being obtained June 29th. Larvæ of the same species, belonging to later broods, are usually much lighter colored, almost whitish, with occasional individuals of darker color, and after first or second moult all present a characteristic marking, consisting of a black lateral margin to thorax and abdomen. Larvæ of *D. inimicus* and *D. debilis*, though very similar when first hatched, are readily separated after the first or second moult by this character, *debilis* being uniformly light, through the first two or three moults which have been observed.

Deltocephalus inimicus has been pretty carefully studied and its life history is quite complete. The eggs have been found inserted beneath the epidermis of blue grass blades, forming minute blister-like swellings near the tips, the end of the tips beyond the point of oviposition turning yellow and dying in all the cases examined. By pressing the blisters the incubating insects can sometimes be extruded through the slot made by the ovipositor, and the young insects have been reared from such blades when put in breeding jars.

July 8th some adults were caged on growing bluegrass and had all died by the 15th of July. July 25th larvæ appeared in the cage. The period of incubation, therefore, when subjected to breeding jar conditions, would not be less than ten nor more than seventeen days.

Five distinct stages of growth are known, young larvæ, first, second and third moults, the last producing the pupa stage, and lastly the imago. Moults occur at intervals of seven or eight days depending somewhat upon temperature, and some insects that hatched July 25, matured August 26. When ready to moult the insect ascends some blade of grass, fastens its legs to the edge of the blade, and so far as observed with the head invariably upward. The old skin splits along the median line of the head and back and the soft creature struggles out, grasshopper fashion, leaving its cast clinging to the grass. When first moulted it is very soft and transparent, the heart showing as a reddish streak along the back. The dark lateral stripes do not characterize the specimen until about an hour after the moult occurs.

Deltocephalus debilis. We captured the first specimens of adult *debilis* June 2d, ten days or two weeks before any adults of *inimicus* were taken, though as before stated the first larvæ found developed into *inimicus* at a later date, June 29th. By July 7th the first brood of *debilis* had nearly disappeared. Adults of *debilis* confined in breeding jars June 3d, died in about ten days, and larvæ hatched in these jars July 5th, so the period of incubation of this generation and with breeding jar conditions would be between three and four weeks. The bulk of the second generation disappeared about the middle of August, and if an incubation period of four weeks be accepted as something near an average, the larvæ of the third brood should have appeared shortly before the middle of September and would mature about the middle of October. That the mature brood appears before this calculated date, we have noted both in 1891 and in 1892, though we have no record as to the time when the larvæ appeared.

Deltocephalus inimicus Say had very nearly reached its maximum and was well gone by the end of the month. The larvæ of the second brood were very conspicuous during the early part of August and were maturing in the latter part of the month and early September. As an adult brood is known to be present about the middle of October it seems that there must be three broods of this insect also. *D. inimicus* seems to differ from *debilis* in its life history only in being about two weeks later in maturing its respective broods. It is possible that some of the very latest individuals of *debilis* represent a fourth brood as a few scattering specimens may be taken as late if not later than *inimicus*.

These insects have such a vastly important economic relation that some practical deductions from these studies will, I trust, not be considered out of place here. I have in earlier publications called attention to burning as a means of preventing the increase of these pests and some observations that showed advantage where this was practiced. Now that it is determined that the eggs of the most destructive species of the grass leaf-hoppers are deposited in the blades of grass during late autumn it is evident that there is a substantial basis for practical results from burning either in late fall or early spring and where the old growth of grass is too short to allow of ready burning it may be excellent policy to spread a thin layer of straw to assist the spread of flames or even to take stock from pasture early enough in fall to permit a growth of grass that will burn readily the following spring.

ADDITIONS AND CORRECTIONS TO CATALOGUE OF HEMIPTERA.

HERBERT OSBORN.

I desire here to make a few additions and corrections to the list of Hemiptera presented in last report.

Anasa tristis, DeG. The common squash bug reads *Banasa* tristis, and as there is a genus *Banasa* in a preceding family the correction is important.

The family *Berytidæ* is made to include the species of *Corizus* and *Leptocorisa*, but should include only *Jalysus spinosus*, Say. This arrangement follows Uhlers Check list, but there the sub family Rhopalina is made to include *Corizus*, etc., all these being included with *Coreidæ* in the super family *Coreoidea*. It would probably better the arrangement and still preserve the super family and the sub family distinctions which have some desirable features to transfer *Berytidæ* to the end of the *Coreoidea* bringing the sub family *Rhopalina* next to *Pseudophlœina*.

The previous list includes *Cymodema tabida* which should probably be omitted from the list entirely. The name was inserted in a preceding list from specimens from an excellent authority on Hemiptera, who has, however, since stated the determinations were incorrectly given to him, the species so named being *Cymus claviculus*, and I find my specimens to agree with European specimens of this species. I am unable at present, however, to find any Iowa specimens of this species and fear that the former record was inadvertently made from other specimens.

Gypona flavilineata, Fitch. After a careful comparison of a large number of specimens of this form with Fitch's descriptions and with typical *octolineata* I am satisfied that it is a distinct form.

The entry of *Acocephalus sp.* was made from an early generic determination from Mr. Van Duzee who has since described the species as *Anthysanus comma.* and the species should so stand.

Grypotes unicolor, Fitch, is now made the type of Van Duzee's new genus *Chlorotettix.*

Chlorotettix tergatus, Fitch. This is a rather common species, having somewhat similar form and habits as *unicolor*, but of a tawny color

Phlepsius strobi, Fitch. This is a common species, and occurs commonly on the undersurface of the leaves of Pigweed, *(Chenopodium)* causing them to turn purple in spots. Its name—*strobi*—could hardly have been given with reference to its food habits, as it appears here to be quite constantly confined to Pigweed in larval stages and pretty generally, also, in the adult form.

Paramesus twiningii, Uhl., is the form entered in preceding list as *Paramesus, sp.* Mr. Van Duzee having reached this conclusion after careful comparison with the type of the species.

Telamona acclivata and *fagi* should be referred to the genus *Heliria*, Stal.

Enchenopa curvata is now included in *Campylenchia*, Stal.

Pachypsylla c-minuta Riley, is entered in previous list as *Pachypsylla sp.*

Pachypsylla c asteriscus, Riley, is another form occurring on the Hackberry.

In another paper will be found additions to the list of Aphididæ.

I am indebted to Mr. E. P. Van Duzee for a number of these corrections.

THE FISHES OF THE CEDAR RIVER BASIN*.

BY SETH E. MEEK, PH. D.

The Cedar river is the second largest river within the State of Iowa, and one of the most picturesque. It, together with its northern tributaries, rises in southern Minnesota. Its general course is southeast to Moscow, about fifteen miles from the Mississippi river; at this point it turns almost at right angles, and flowing southwest about thirty miles it empties into the Iowa river.

Above Moscow the current is rather swift, and its bottom sandy with few rocky places and occasional stretches of mud. The Cedar basin is, for the most part, an undulating prairie, with considerable timber along the banks of the streams, especially the eastern tributaries of the Cedar river. There are a large number of ponds and bayous along the river, especially the lower third of its course, which are always connected with the river in times of high water. In these ponds there is much swamp vegetation and always an abundance of sunfishes, pickerel and bullheads. The slough near Cedar Rapids is one of the largest of these bayous. It is the great fishing ground for the small boys of Cedar Rapids. If attended by a fair degree of luck they may be seen on their homeward trips with a string of small bullheads and sunfishes as long as the average boy himself.

The Cedar is, in my judgment, the finest stream in Iowa. It is only exceeded in size by the Des Moines, which it excels in swiftness of current, in being bordered to a greater extent by timber, and being fed by larger supply of springs and spring brooks. I do not think it has been more thoroughly explored than the Des Moines and its tributaries, yet I have recorded from it a larger nnmber of species of fishes. As to which has or affords the larger quantity of fishes for the market I have not the data to judge. I find anglers complain of the scarcity of game fishes, or at least the remark is often made that fishing with hook and line is not as good as it used to be. Yet during the months of June and July it is good enough to entice men day after day into the water waist deep just below the dam at Cedar Rapids. These men seldon fail to come out except with a respectable string of Black Bass, Wall-eyed Pike, or Channel Cat.

The streams of Iowa have undoubtedly changed much in character since the country has become so thickly settled. The soil, since loosed with the plow, is much more easily washed into the streams than when it was covered with the stiff native sod. The more thorough underdraining and the surface ditches enables the

* This paper, presented at Sixth Annual Meeting, was too late for insertion in last report.

water, after heavy rains, to find its way at once into the large creeks and rivers. Thus the water in the streams is muddier than formerly; in wet weather is deeper, and in dry weather is more shallow. These features, together with the fact that the rivers are becoming, to some extent, the sewers for the large cities, is a probable cause for a dimunition of some of the food fishes.

The natural features of the Cedar river make it an excellent stream for fishes, and it is sure to be many years before angling will cease to be an enjoyable and profitable pastime for those who are fortunate enough to reside along its banks. To all such I will say, you have in the Cedar a beautiful stream, and in it are some excellent game and food fishes. Protect your stream as far as possible from pollution, and protect your fishes from wholesale slaughter by the use of dynamite or any other barbarous methods used for their capture, and you will be amply rewarded.

During my four years' residence in Cedar Rapids as a teacher in Coe College, I utilized some spare time in making a study of the fish fauna of the State. The result of my studies is being published in the present bulletin of the United States Fish Commission. The larger share of the work done in the Cedar basin was under the direction and by the aid of the United States Fish Commission. I wish to acknowledge the services of my students who, from time to time, assisted me in making collections near Cedar Rapids, of which Mr. W. T. Jackson and Mr. E. P. Boynton and Mr. B. Bailey, deserve especial mention. I was also assisted by Prof. P. B. Burnet, of Lincoln, Nebraska, in making most of the collections from the upper part of the river basin.

I have given, in foot notes, other species not found in Cedar Basin, but which belong to the Iowa fauna.

This makes the paper also serve as a preliminary catalogue of the fishes of Iowa. No doubt other forms will be added when a more thorough survey of the State is made.

The Cedar river and its tributaries were examined as follows:

The Cedar river at West Liberty, Mt. Vernon, Cedar Rapids, Palo, Waverly and Austin (Minnesota.)

Turtle river and Rose creek, Austin (Minnesota.)

West Fork and Hartgraves creek at Dumont.

Shell Rock river and Quarter Section Run, near Waverly.

Dry creek, near Palo.

Prairie creek, near Beverly.

Indian creek, near Marion.

*Excellent food fishes.
‖Good food fishes.
—Poor food fishes.
†Very good food for larger fishes.
Those unmarked are of little or no economic value.

ORDER I, HYPEROARTIA.

FAMILY 1, PETROMYZONTIDÆ (THE LAMPREYS.)

1. *Ammocœtes branchialis* (Linnæus). Mud Lamprey. This small lamprey ascends clear brooks in the spring for the purpose of spawning, during which time large numbers can easily be captured. At Cedar Rapids they spawn about the middle of April, the season lasting about two weeks. They are seldom taken except during this season. The species is small, specimens seldom reaching a length of more than 6½ inches. It would be an easy matter to destroy large numbers of

these lampreys in the spring if thought expedient, in view of the injury which they are supposed to inflict on some of the food fishes. They undoubtedly do some destruction, but how much is difficult to say. From an economical standpoint the lampreys in the Cedar basin are of no importance.

2. *Petromyzon concolor* (Kirtland). Brook Lamprey. Prof. F. Starr collected this species in the Cedar River a few years ago. I have never seen them spawning although I have searched more carefully for them than for the preceding species. This species is quite frequently taken with large food fishes by fishermen on the Mississippi river.

ORDER II, SELACHOSTOMI.

FAMILY 2, POLYODONTIDÆ (THE PADDLE-FISHES).

3. [1]*Polyodon spatula* (Walbaum). Paddle-Fish, Spoon-Bill, Duck-Billed Cat, Cedar Rapids, rare, one specimen taken from the Cedar river in November, 1861, is in Coe College Museum. The snouts of a few individuals taken during the past ten years are in the same museum.

ORDER III, GLANIOSTOMI.

FAMILY 3, ACIPENSERIDÆ.

4. *Scaphirhynchus platyrrhynchus* (Rafinesque). Shovel-nosed Sturgeon. An occasional specimen is taken from the Cedar river with hook baited for suckers.

ORDER IV, GINGLYMODI.

FAMILY 4, LEPIDOSTEIDÆ (THE GAR FISHES).

5. *Lepidosteus osseus* (Linnæus). Common gar-pike, Long-nosed Gar. Common in the spring in the river at Cedar Rapids. They, with the following, may be frequently seen from First Avenue bridge. Specimens sometimes reach a length of four or five feet. Of no economical value whatever:

6. *Lepidosteus platystomus*, (Rafinesque). Short-nosed gar-pike. Occasionally seen in the river at Cedar Rapids. Scarce.

ORDER V, HALECOMORPHI.

FAMILY 5, AMIDÆ (THE BOWFINS).

7. *Amia calva* (Linnæus). Dog-fish, Mud-fish, John A. Gundle.

Very abundant in the slough, and occasionally taken from the Cedar river. Of no value except to the biologist. This species, together with the preceding, are much studied and are of much interest from their relation to earlier forms and for the light they throw upon the subject of evolution.

ORDER VI, NEMATOGNATHI.

FAMILY 6, SILURIDÆ (THE CAT-FISHES).

8. ‖*Ictalurus punctatus* (Rafinesque). Channel cat, White cat, Silver cat. Common, during the months of June and July; many specimens of this species are taken from the Cedar river with hook and line. The best bait seems to be clotted

‖*Acipenser rubicundus* (Le Sueur). Lake sturgeon. A resident of the Mississippi Valley, and no doubt inhabits the lower part of the Cedar river, as specimens have been frequently taken from the Iowa river at Iowa City.

‖ *Ictalurus furcatus* (Cuv. & Val.) Chuckle headed cat. A resident of the Mississippi river. Not recorded from the Cedar basin.

blood from swine. The favorite fishing places are just below the dam and below T. M. Sinclair's packing house. The latter being the best, although the water is less pure and clear than below the dam.

9. ‖*Ameiurus natalis* (Le Sueur). Yellow cat. Scarce.

10. ‖*Ameiurus nebulosus* (Le Sueur). Common bull-head. Apparently scarce.

11. —*Ameiurus melas* (Rafinesque). Bull-head. Common in all streams of Iowa. This and the two preceding constitute the common bullhead in Iowa, the latter being by far the most abundant.

12. * *Leptos olivaris* (Rafinesque). Mud cat, Flathead cat. Specimens weighing twenty pounds are occasionally taken from the Cedar river a short distance below the dam in the early summer. Some of these large specimens may be *A. nigricans*.

13. *Noturus flavus* (Rafinesque). Stone cat. Cedar Rapids. Rare.

14. *Noturus gyrinus*, (Mitchell). Stone cat. Common.

ORDER VII EVENTOGNATHI.

FAMILY 7, CATOSTOMIDÆ. (THE SUCKERS).

15. † *Carpiodes velifer* (Rafinesque). Quillback, crap sucker. Very common in the larger streams of the entire basin. Different individuals show considerable variation. I have been unable to find any constant characters by which to separate it in two or more species.

16. —*Catostomus teres* (Mitchell). Common white sucker.

17. —*Catostomus nigricans* (Le Sueur). Hog sucker. Stone-roller. Hog Mullet. Found usually with the preceding, and nearly as abundant.

18. —*Erimyzon sucetta* (Lacepede). Chub sucker. This species seems rare in Iowa. I have found it only in the Cedar river near West Liberty.

19. —*Moxostoma anisurum* (Rafinesque). White-nosed sucker. Rare in Iowa. In Cedar basin known only from Austin, Minnesota, and from Waverly.

20. —*Moxostoma duquesnei* (Le Sueur). Common red-horse. The most abundant of Iowa suckers.

21. *Minytremia melanops* (Rafinesque). Striped sucker. Scarce.

FAMILY 8, CYPRINIDÆ (THE MINNOWS).

22. †*Compostoma anomalum* (Rafinesque). Stone-lugger. Stone-roller. Common, especially in spring brooks.

23. †*Chrosomus erythrogaster* (Rafinesque). Red-bellied minnow. Not common. An inhabitant of clear, cool water.

‖ *Ameiurus nigricans*, (Le Sueur). Great cat fish. Mississippi cat. A resident of the Mississippi river.

Noturus exilis (Nelson). Des Moines and Skunk rivers. Rare.

Noturus miurus (Jordan). An inhabitant of Minnesota. Not yet recorded from Iowa.

Ictiobus cyprinella (Cuv. & Val.). Red-mouthed buffalo. Common buffalo fish. Mississippi river. Usually taken from the bayous. Common.

Ictiobus urus (Agassiz). Big-mouthed buffalo. Mississippi river. Common.

Ictiobus bubalus (Rafinesque). Small-mouthed buffalo. Common.

There are one or more of the buffalo fishes found in the Cedar river, but which I am unable to say.

‖*Cycleptus elongatus* (Le Sueur). Missouri sucker. Mississippi river, scarce.

—*Moxostoma aureolum* (Le Sueur). Skunk river, rare.

—*Placopharynx carinatus* (Cope). Very abundant in western Iowa. This species resembles *M. duquesnei*, and it is not at all unlikely that many of the large suckers caught in the Cedar in the spring may belong to this species. It is quite abundant in the Des Moines river at Des Moines.

24. †*Hybognathus nuchalis* (Agassiz). Silvery minnow. One of the most abundant of the minnows.

25. †*Hybognathus nubila* (Forbes). Waverly and Austin (Minn.) Not common.

26. †*Pimephales promelas* (Rafinesque). Flathead. Abundant in sluggish and stagnant water.

27. †*Pimephales notatus* (Rafinesque). Blunt-nosed minnow. Very common, prefers clear, running water.

28. †*Cliola vigilax* (Baird & Girard). Bullhead minnow. Palo and Cedar Rapids, scarce.

29. †*Notropis anogenus* (Forbes). Austin, Minnesota. Rare.

30. †*Notropis heterodon* (Cope). Not common.

31. †*Notropis cayuga* (Meek). This and the two preceding species very much resemble each other. They are usually found near the shore and in small bayous, where there is plenty of vegetation. They are the most feeble and insignificant of the fresh water fishes of Iowa.

32. †*Notropis deliciosus* (Girard). Not common.

33. †*Notropis topeka* (Gilbert). Waverly. Rare. Similar to the preceding, but has much smaller eyes, and a more compressed body.

34. †*Notropis gilberti* (Jordan and Meek). Inhabits clear, running water Abundant.

35. †*Notropis whipplei* (Girard). Common.

36. †*Notropis megalops* (Rafinesque). Common Shiner. An abundant and variable minnow.

37. †*Notropis jejunus* (Forbes). Cedar Rapids. Rare.

38. †*Notropis ardens* (Cope). Red fin. Not common. Very variable.

39. †*Notropis dilecius* (Girard). Emerald minnow. Common.

40. †*Notropis atherinoides* (Rafinesque). Not common. Seldom taken except in river currents.

41. †*Phenacobius mirabilis* (Girard). Not common.

42. †*Rhinichthys atronasus* (Mitchill). Black-nosed Dace. Palo and Mt. Vernon. Scarce.

43. † *Hybopsis dissimilis* (Girard). Not common.

44. † *Hybopsis storerianus* (Kirtland). Scarce.

45. † *Hybopsis kentuckiensis* (Rafinesque). Horny-head. River chub. Common.

46. † *Semotilus atromaculatus* (Mitchill). Scarce.

47. † *Phoxinus elongatus* (Kirtland). Palo (Dry creek). Scarce. The identification of this species somewat doubtful.

48. † *Notmigonus chrysolucus* (Mitchill). Golden shiner. Bream. Not common.

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†*Hybognathus nuchalis placita* (Girard). Scarce, Des Moines river.

†*Notropis boops* (Gilbert). Southwest Iowa. Scarce.

†*Notropis hudsonius* (De Witte Clinton). Spawn eater. Clear and Spirit lakes and Sioux river. Locally abundant.

†*Notropis lutrensis* (Baird and Girard). Very abundant in western Iowa.

†*Rhinichthys cataractae* (Cuv. and Val.) Long. Upper Iowa river. Scarce.

†*Hybopsis gelidus* (Girard). Common in the Missouri river.

†*Hybopsis hyostomus* (Gilbert). Southwest Iowa. Scarce.

†*Platygobia gracilis* (Richardson). Flat-headed chub. Missouri river. Scarce.

ORDER VIII, ISOPONDYLI.

FAMILY 9, HIODONTIDÆ (THE MOON EYES).

49. †*Hiodon tergisus* (Le Sueur). Moon-eye. Silver bass. Cedar Rapids. Scarce.

FAMILY 10, CLUPEIDÆ (THE HERRINGS).

50. †*Clupea chrysochloris* (Rafinesque). Skip-jack. Cedar Rapids. Scarce.

51. †*Dorosoma cepedianum* (Le Sueur). Gizzard shad. Hickory shad. Not common.

FAMILY 11, SALMONIDÆ (THE SALMON).

52. **Salvelinus fontinalis* (Mitchell). A few specimens are occasionally taken from McLeod's run, near Cedar Rapids. This species was originally placed here by Mr. Shaw, formerly State Fish Commissioner of Iowa. Mr. Minott, a trapper and fisherman, Mt. Vernon, Iowa, informs me that he has seen this species in small tributaries of the Cedar river near Mt. Vernon.

FAMILY 12, CYPRINODONTIDÆ (THE KILLIFISHES).

53. †*Fundulus zebrinus* (Jordan and Gilbert). Not common in the Cedar basin. More abundant in the lakes.

54. †*Zygonectes notatus* (Rafinesque). Top minnow. Usually found in small numbers.

55. *Zygonectes dispar* (Agassiz). West Liberty. Taken from a large bayou.

FAMILY 13, UMBRIDÆ (THE MUD MINNOWS).

56. *Umbra limi* (Kirtland). Mud minnow. Rather scarce; taken only in small grassy ponds.

FAMILY 14, LUCIIDÆ (THE PIKES).

57. —*Lucius vermiculatus* (Le Sueur). Little pickerel. Common in the grassy bayous.

58. **Lucius lucius* (Linnæus). Pike. Northern pickerel. Common. It loiters in grassy and weedy places. This species is known as pickerel in Iowa. It is the true pike. The name pike is erroneously given to the wall-eyed pike.

ORDER IX, APODES (THE EELS).

FAMILY 15, ANGUILLIDÆ

59. **Anguilla crysypha* (Rafinesque). The common eel. Cedar Rapids and Waterloo. Not common.

ORDER X, HEMIBRANCHII.

FAMILY 16, GASTEROSTEIDÆ.

60. *Eucalia inconstans* (Kirtland). Brook stickleback. Scarce. Found only n small brooks.

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†*Hiodon alosoides* (Rafinesque). Missouri river. Scarce.

FAMILY PERCOPSIDÆ (THE TROUT PERCHES).

†*Percopsis guttatus* (Agassiz). Trout perch. This species is very abundant in the tributaries of the Missouri river.

†*Fundulus diaphanus* (Le Sueur). Not recorded from Iowa. Evidently belongs to her fauna.

†*Zygonectes sciadicus* (Cope). Le Mars. Scarce.

**Lucius masquinongy* (Mitchell). Muskallunge. Scarce. Known from Mississippi river, also the Skunk river near Ames. The largest and most voracious fish in Iowa waters.

ORDER XI, PERCESOCES.

FAMILY 17, ATHERINIDÆ (THE SILVERSIDES).

61. †*Labidesthes sicculus* (Cope). Brook silverside. Not common.

ORDER XII, ACANTHOPTERII.

FAMILY 18, CENTRARCHIDÆ (THE SUNFISHES).

62. ‖ *Pomoxys sparoides* (Lacepede). Calico bass. Strawberry bass. Common.

63. ‖ *Pomoxys annularis* (Rafinesque). Crappie. Less common than the preceding.

64. ‖ *Ambloplites rupestris* (Rafinesque). Rock bass. Red eye. Goggle eye. Common.

65. ‖ *Chœnobryttus gulosus* (Cuv. & Val.) War mouth. Common in grassy ponds.

66. ‖ *Lepomis cyanellus* (Rafinesque). Green sun-fish. Very common. The small boy's game fish.

67. *Lepomis machrochirus* (Rafinesque). Waverly & Dumont. Scarce.

68. *Lepomis humilis* (Girard). Scarce in eastern Iowa. Abundant in the western part of the State.

69. ‖ *Lepomis pallidus* (Mitchill). Blue sun-fish. Very common.

70. ‖ *Lepomis megalotis* (Rafinesque). Long eared sun fish. Scarce.

71. *Lepomis holbrooki* (Cuv. & Val.) Scarce.

72. ‖ *Lepomis gibbosus* (Linnæus). Pumpkin-seed. Common in slough, scarce in the rivers.

73. * *Macropterus dolomieu* (Lacepede). Small mouthed black base.

74. * *Macropterus salmoides* (Lacepede). Large mouthed black bass. Common.

FAMILY 19, PERCIDÆ (THE PERCHES).

75. *Etheostoma clarum* (Jordan & Meek). Sand darter. Scarce.

76. *Etheostoma nigrum* (Rafinesque). Johnny darter. The most abundant of Iowa darters.

77. *Etheostoma caprodes* (Rafinesque). Log-perch. Scarce.

78. *Etheostoma aspro* (Cope and Jordan). Black-sided darter. Common.

79. *Etheostoma phoxocephalum* (Nelson). Scarce.

79*a* *Etheostoma evides* (Jordon & Copeland). Scarce.

80. *Etheostoma zonale* (Cope). Common.

81. *Etheostoma flabellare* (Rafinesque). Not common.

82. *Etheostoma cœruleum* (Storer). Rainbow darter. Soldier-fish. Common.

83. *Etheostoma jessiæ* (Jordon & Brayton). Scarce.

84. *Etheostoma Iowæ* (Jordan & Meek). Very common.

85. *Etheostoma microperca* (Jordan & Gilbert). Least darter. Scarce.

86. ‖*Perca lutea* (Rafinesque). Yellow perch. Not common in rivers, abundant in lakes.

87. **Stizostedion vitreum* (Mitchill). Wall-eyed Pike. Jack salmon. Not common in rivers. Very common in the lakes where it is erroneously called pike.

88. **Stizostedion canadense* (C. H. Smith). Sauger. Sand pike. Not always distinguished from the preceding by fishermen.

Enneacanthus eriarchus (Jordan). A very rare species. At present not recorded from Iowa

Etheostoma blennoides (Rafinesque). Green sided darter. A doubtful resident.

Etheostoma shumardi (Girard). Mississippi river, at Muscatine. Scarce.

FAMILY 20, SCIENIDÆ.

89. —*Aploidonotus grunniens* (Rafinesque). Fresh-water drum. Common in the spring.

FAMILY 21, COTIDÆ.

90. *Cottus ba'rdi* (Agassiz). Millers thumb. Common in spring brooks.

FAMILY SERRANIDÆ.

‖*Roccus charysops* (Rafinesque). White Bass. Not common.
‖*Murone interrupta* (Gill). Yellow bass. Scarce.

FAMILY GADIDÆ.

—*Lota lota* (Linnæus). Lawyer. Ling, Aleky trout. Mississippi river. Scarce

According to the foregoing list, there are in the Cedar Basin, 90 species of fishes; in Iowa, 121 species. Those of the Cedar Basin are distributed among 12 orders, 21 families, and 48 genera; in the State, 12 orders, 24 families, and 58 genera.

Fishes known from Mississippi river	62
Fishes known from Cedar river basin	90
Fishes known from Des Moines river basin	66
Fishes known from Skunk river basin	49
Fishes known from Iowa river basin	52
Fishes known from Wapsipinicon river basin	42
Fishes known from Maquoketa river basin	31
Fishes known from Turkey river basin	31
Fishes known from Yellow river basin	17
Fishes known from Upper Iowa river basin	18
Fishes known from Missouri river	11
Fishes known from Big Sioux river basin	33
Fishes known from Floyd river basin	35
Fishes known from Soldier river basin	6
Fishes known from Boyer river basin	15
Fishes known from Chariton river basin	13
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PROCEEDINGS

OF THE

Iowa Academy of Sciences,

FOR 1893.

VOLUME 1, PART IV.

EDITED BY THE SECRETARY,

HERBERT OSBORN, AMES, IOWA.

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PROCEEDINGS

OF THE

EIGHTH ANNUAL MEETING

OF THE

IOWA ACADEMY OF SCIENCES.

The eighth annual session of the Iowa Academy of Sciences was held in Des Moines, December 26 and 27, 1893.

The following papers, read in full or by title, were, by action of the Executive Committee, referred to the Secretary for publication:

L. W. Andrews—On the Assumption of a Special "Nascent State." Some Peculiarities of Solutions of Sulpho-cyanate.

A. A. Bennett—Work in the Chemical Laboratory of the Iowa Agricultural College.

W. S. Hendrixson—The Electrolysis of Silver: Some Laboratory Apparatus.

G. W. Bissell—Experimental Engineering at the Iowa Agricultural College.

S. Calvin—On the Geological Position of *Benettites dacotensis* Macbride, with Observations on the Stratigraphy of the Region in which the Species was Discovered.

Wm. H. Norton—Some Preliminary Notes on the Lower Devonian Strata of Iowa.

C. R. Keyes—Relations of the Cretaceous Formations in Northwestern Iowa. Derivation of the Unione Fauna of the Northwest. Process of Formation of Certain Quartzites.

J. L. Tilton—Origin of the Present Drainage System of Warren County

H. Foster Bain—Structure of the Mystic Coal Basin. The Deep Well at Sigourney.

E. H. LONSDALE—Southern Extension of the Cretaceous in Iowa. Topography of the Granite and Porphyry Areas in Missouri.

A. G. LEONARD—Zinc Deposits in Northeastern Iowa. Satin Spar from Dubuque.

A. C. SPENCER—Occurrence in Iowa of Fossiliferous Concretions Similar to those of Mazon Creek.

F. M. FULTZ—Evidences of Disturbances During the Deposition of the Burlington Limestones.

A. J. JONES—The Coal Measures of Poweshiek County. On the Occurrence of *Cardiocarpus* in Iowa.

T. H. MCBRIDE—Notes on the North American Cycads. The Distribution of *Rhus typhina*.

L. H. PAMMEL—Presidential Address—Bacteria, Their Relation to Modern Medicine, the Arts and Industries. Powdery Mildew of the Apple. Further notes on *Cladosporium carpophilum*.

MARY ALICE NICHOLS—Observations on the Pollination of some of the *Compositæ*.

B FINK—Some Additions to the Flora of Iowa.

H. W. NORRIS—The Paraffine Method Applied to the Study of the Embryology of the flowering Plants. The Development of the Auditory Vesicle in *Necturus*. An instance of the Persistence of the Ductus Venosus in the Domestic Cat.

B. SHIMEK—Additional Notes on Iowa Mollusca. Variations in the *Succinidæ* of the Loess.

WM. S. WINDLE—Work at the Johns Hopkins Marine Biological Laboratory.

C. C. NUTTING—The Vascular Supply of the Teeth of the Domestic Cat. The Homology of the Inca Bone. An Informal Report on the Practicability of Dredging in Deep Water Without the Use of Steam.

HERBERT OSBORN—On the Distribution of Certain Hemiptera. Laboratory Notes in Zoology.

ALICE M. BEACH—Additions to the Known Species of Iowa *Ichneumonidæ.*

F. A. SIRRINE—A New Species of *Pemphigus* Occurring on Thorn.

C. W. MALLY—Hackberry *Psyllidæ* found at Ames, Iowa.

The following resolution was adopted in business session:

WHEREAS, The State has begun the good work of a Geological Survey of the State, a much needed investigation, and

WHEREAS, This work has been prosecuted for two years with vigor and success; therefore, be it

Resolved, That we, the Academy of Sciences, do most heartily commend the Geological Survey to the liberality of the General Assembly, with the hope that the Survey may receive all liberal encouragement and the support of such appropriations as may enable it to carry forward the various lines of its most excellent work.

A resolution was also passed and a committee appointed with reference to securing a better representation of scientific works in our State library and in other libraries of the State.

ON THE ASSUMPTION OF A SPECIAL "NASCENT STATE."

BY LAUNCELOT ANDREWS, PH. D.

The assumption frequently appears in chemical literature that elements at the moment of being set free from their compounds exhibit properties which the same elements do not ordinarily possess. This alleged specific condition is designated as the "nascent state" or *status nascendi.* The hypothesis of such a condition dates back to the time when the dualistic theory held sway and, so far as I am aware, has not been subjected to criticism in the light of modern views.

It is my purpose in the present paper to consider the following pertinent questions concerning this hypothesis:

First. Is it necessary to our understanding of any known facts?

Second. Does it offer a simpler explanation of any facts than can be given without its aid?

Third. Is it inconsistent with known facts?

Fourth. Can it be consistently applied to any class of phenomena without the aid of additional auxiliary assumptions?

One of the classes of chemical reactions which is most often explained by the assumption of a nascent state is that in which reduction is effected by metallic zinc in acid solutions or by sodium amalgam in aqueous neutral alkaline or acid solution or by other oxydizable metals. Here the metal is said to act upon the water or the acid, setting free hydrogen which in turn, by virtue of the peculiar properties it is supposed to possess in the nascent state, effects the reduction.

Thus the reducing of ferric chloride to ferrous chloride by zinc in acid solutions would be represented by the following two equations:

$$Zn+2H\,Cl=Zn\,Cl_2+H_2 \qquad [1$$

$$2H+2Fe\,Cl_3=2Fe\,Cl_2+2H\,Cl \qquad [2$$

The reduction of a copper sulphate solution would be represented thus:

$$H_2SO_4+Cu=Cu\,SO_4+2H \qquad [3$$

$$2H+Cu\,SO_4=Cu+H_2\,SO_4 \qquad [4$$

And in the same way the reduction of metallic Cu at the negative electrode during the electrolysis of a Cu SO_4 solution would be represented as *secondary* and due to the nascent hydrogen appearing there. In the familiar process of preparing sulphurous anhydride by the action of copper on concentrated hot sulphuric acid we find it assumed that hydrogen is first produced as in equation 3 and then in *statu nascendi* immediately reacts on the sulphuric acid,

$$Cu+H_2SO_4=Cu\ SO_4+H_2 \qquad [5$$
$$2H+H_2SO_4=2H_2O+SO_2 \qquad [6$$

forming water and sulphurous anhydride.

Many other cases might be cited of simple reactions in which it is considered necessary by some authors to employ the nascent hypothesis, but I shall, for the present, confine myself to these and in the light of the facts seek an answer to our four crucial questions. If we dispense with the hypothesis we must assume in each case a direct action of the metal on the salt; thus zinc and ferric chloride would give zinc chloride and ferrous chloride.

$$Zn+2Fe\ Cl_3=Zn\ Cl_2+2Fe\ Cl_2 \qquad [7$$

Zinc and copper sulphate would simply present a case of direct interchange of metals.

$$Zn+Cu\ SO_4=Zn\ SO_4+Cu \qquad [8$$

The reduction of copper by electrolysis would be primary not secondary.

$$Cu \xleftarrow{\text{To negative pole.}} Cu\ SO_4 \xrightarrow{\text{To positive pole.}} SO_3+O \qquad [9$$

This view in the latter case will not be seriously questioned by any student of the recent work of Arrhenius and Ostwald and their followers.

Lastly, we can simply represent the reduction of hot concentrated sulphuric acid as consisting in the first stage in an oxidation of the copper at the expense of the acid.

$$Cu+H_2SO_4=Cu\ O+\underbrace{H_2\ SO_3}_{H_2O\ SO_2} \qquad [10$$

The sulphurous acid becoming dehydrated of course at the high temperature of the reaction; and the copper oxide being soon converted into copper sulphate.

In the cases named it is clear that the nascent state hypothesis is not necessary and does not lead to a simpler explanation of the facts than can be had without it. Is it inconsistent with any of the facts? Considering first the reduction of sulphuric acid by copper, the following phenomena may be observed: When metallic copper, carefully cleaned, is heated gradually with concentrated sulphuric acid until sulphurous anhydride begins to be evolved, the surface of the copper becomes coated with a black crust. If the metal is now removed from the acid, then washed and placed in hydrochloric acid, the coating dissolves, forming a solution of copper chloride. In fact, this crust consists of copper oxide. Its formation is not explained by the hypothesis in question (eqs. 5-6) but is a direct confirmation of eq. 10. If the acid is reduced by hydrogen some of the hydrogen might be expected to escape unoxidized. In order to test this point pure sulphuric acid was heated with copper which was obtained by electrolysis from a recrystalized specimen of copper sulphate and subsequently ignited in an atmosphere of carbon monoxide. The gases evolved were collected over mercury and about 50 c. c. were treated with caustic potash. All was absorbed except a small bubble, which consisted essentially of oxygen. No hydrogen could be detected.

In order to demonstrate, however, that none had been formed it was necessary to show that if formed it would not be wholly oxidized by the hot acid. To get direct evidence upon this point, a quantity of nearly pure zinc was heated with the same acid that had served for the copper experiment and in the same way. Fifty c. c. of the evolved gas was only partly absorbed by potash, a residue of about 3 c. c. being left. This residue consisted essentially of hydrogen.

The chain of evidence now appeared complete, for unless there were two kinds of nascent hydrogen it would be all oxidized in both cases *if in either*. the conditions being the same, and the fact that none was found in the copper experiment must be taken for valid proof that none was formed.

In reality the correct view would appear to be that at the temperature of the reaction the acid is for the greater part dissociated into H_2O and SO_3, the copper being oxidized by the latter only. The zinc acts upon the SO_3 forming SO_2, and also upon the undissociated part of the acid, setting free hydrogen which escapes.

Further light may be thrown upon this matter by a consideration of the reduction of the sulphuric acid by carbon. This reaction takes place at about the same temperature as that with copper, in accordance with the equation

$$C+2H_2SO_4=2H_2O+CO_2+2SO_2 \qquad [11$$

Here there can be no question of nascent hydrogen unless by assuming the existence of a sulphate of carbon, thus

$$C+2H_2SO_4=C(SO_4)_2+4H \qquad [12$$

which is wholly unwarranted, and there is no ground for supposing the mechanism of the action of carbon on sulphuric acid to be entirely different from that of copper on the same compound.

A favorite field in which nascent hydrogen often disports itself lies in the extremely complex reactions between nitric acid on the one hand and various metals on the other. Here the nitric acid may be reduced to ammonia, hydroxylamine, free nitrogen, nitrous acid, any of the oxides of nitrogen, and possibly still other products. Often many of them are simultaneously formed. Of these, ammonia and laughing gas and N_2 are never formed by the action of mercury, Bi., Cu. and Ag.[1] Iron, on the other hand, may reduce the whole of the nitric acid to ammonia. Montemartini, who has made a special study of this group of reactions[2], and others have shown that the various metals reduce nitric acid in various ways, giving reaction products in different proportions and of different kinds. The bearing of this upon the subject of the present paper is evident. If, for example, iron, zinc and copper all reduce nitric acid indirectly through the primary formation of nascent hydrogen, we would expect the ultimate products to be the same in kind and in relative amount, the absolute amount depending simply upon the quantity of hydrogen formed. Since this is not so, the conclusion is inevitable that the nascent hydrogen is not the reducing agent but the action of each metal is immediate and specific, removing oxygen from the acid and forming unstable intermediate products which elude direct observation but which, by their reactions, give rise to the products characteristic of each case.

I have endeavored, in this discussion, to select the fairest instances of the application of the nascent condition hypothesis and find myself forced to the conclusion that it is the survival of an obsolete doctrine; that it explains nothing which cannot be as well or better explained without it; that it cannot be reconciled in certain cases with known facts, and that,

[1] *Ber.* 92, 616, 898 f.

[2] *Loc. cit.*

therefore, we are not at present justified in the assumption that elements at the moment of formation or liberation from their compounds possess properties in any way different from those they commonly exhibit.

SOME PECULIARITIES OF SOLUTIONS OF FERRIC SULPHOCYANATE

BY LAUNCELOT ANDREWS, PH. D.

The deep blood-red color of solutions of ferric sulphocyanate has frequently been taken advantage of for the determination of small quantities of iron in river or spring water, in blood, in alloys, in alumcake, etc.

The earliest method of this kind, so far as I have been able to ascertain, is due to T. L. Herapath, who proposed to determine minute quantities of iron by the addition of potassium sulphocyanate to the acidified solution containing an unknown amount of iron, and also to a standard iron solution of known strength, the latter being then diluted until both showed the same tint.

Very similar methods have been employed or devised by A. Thomsen (*Ch. Soc. Jour.*, 47, 493), Ad. Joles (*Arch. f. Hygiene, XIII*, 402), L. Lapique (*Bull Soc. Chim.*, 2, 295, and by R. R. Tatlock (*Jour. Soc. Ch. Ind.* 6, 276).

Vierordt (*Quant.*, *Spektralanalyse*), suggested a fundamental modification of Herapath's colorimetric method, in that he dispensed wholly with a standard comparison solution, substituting for it a direct spectrophotometric determination of the amount of light of given wave length, transmitted by a layer of the ferric sulphocyanate solution one c. m. thick. In this method the assumption, based upon analogy, is made that the light absorbing power of the solution is directly proportional to the amount of iron contained therein; or in other words, *that the negative logarithm of the fraction of light transmitted is proportional to the concentration of the solution*, and the assumption seems to be confirmed by Vierordt's observations.

Subsequent investigations by Krüss and Moraht (*Lieb. Ann.*, 260, 193; *Kalorimetrie, u. Spektral analyse*, 1891, *p.* 125), and by Magnanini (*Zeit· phys. Ch.* 8,1) have shown the assumed proportionality to be non-existent in fact. If aqueous solution of ferric sulphocyanate be diluted its color fades away in a much more rapid ratio than corresponds to the diminishing concentration of the solution. The depth of color is much enhanced by an excess of either generatrix, *i. e.*, of KSCN or of $Fe\ Cl_3$, and as Magnanini has shown the change follows the laws of mass action qualitatively and quantitatively.

Magnanini dismisses the affair at this point as a *res adjudicata* assuming that the sulphocyanate is subject, in its solution in water, to a progressive electrolytic dissociation in the ions, Fe and S C N. In accordance with well known principles this dissociation must become more complete with increasing dilution, and of course the formation of colorless ions from the colored salt must result in a diminution of the intensity of the color.

There is, however, another explanation not only possible, but probable. Ostwald has shown that other salts of ferric iron undergo in dilute solution more or less complete hydrolysis into colloidal ferric hydrate and free acid. If this hydrolysis also occurs in solutions, as we have no reason to doubt, of the sulphocyanate, in accordance with the equation.

$$Fe(SCN)_3+3\ H_2O=Fe(OH)_3+3\ HSCN,$$

It would offer a complete explanation of the phenomena hitherto observed.

II. EXPERIMENTAL PART.

In order to obtain further insight into the nature of the changes occurring upon dilution of solutions of ferric sulphocyanate, and indirectly of solutions in general, it seemed advisable to operate in solutions containing no water.

In such solutions the hydrolysis called for by the second theory given above could not occur and the electrolytic dissociation called for by the first theory could occur only in a subordinate degree. Hence both theories would lead us to expect that a solution of stated concentration of $Fe(SCN)_3$ in ether or in amyl alcohol or in absolute ethyl alcohol would have a much more intense color than a solution of the same strength in water, and second that the color would be proportional to the strength.

My observations have confirmed the first prediction, but not the second.

A solution in ether was first prepared containing 4.7 m. g. $Fe(SCN)_3$ per cu. cm., both the iron and sulphocyanogen being directly determined and found in accordance. From this solution, which was kept in the dark, the other solutions were prepared and their absorbtion coefficients determined by repeated observations in a Vierordt spectroscope with double symmetrical slit.

First.—Comparison of absorbtive power in amyl alcohol and water solutions. A solution containing .0625 m. g. $Fe(SCN)_3$ per c. c. of amyl alcohol transmitted 42 per cent of light of wave length 587, or about the same amount as an aqueous solution containing .247 m. g. per c. c., or nearly four times as strong.

I. Amyl alcohol containing .05 m. g. $Fe(SCN)_3$ per c. c., T=15°.

MIDDLE OF REGION.	PER CENT TRANSMITTED LIGHT.	EXTINCTION COEF.	ABSORBTION RATIO K.
617	84.0	.076	
589	56.2	.250	.200
564	42.5	.372	.134
517	19.1	.719	
501	16.0	.796	

II. Amyl alcohol containing .1 m. g. Fe $(SCN)_3$ per c. c. T=15°.

MIDDLE OF REGION.	PER CENT TRANSMITTED LIGHT.	EXTINCTION COEF.	ABSORBTION RATIO K.
617	41.0	.377	
589	14.8	.830	.120
564	6.8	1.167	

III. Amyl alcohol containing .094 m. g. Fe $(SCN)_3$ per c. c. T=18°. Older solution, stood 48 hours.

MIDDLE OF REGION.	PER CENT TRANSMITTED LIGHT.	EXTINCTION COEF.	ABSORBTION RATIO K.
622	61.0	.215	.436
599	42.9	.367	.263
568	12.2	.914	.104
556	9.0	1.045	.090

IV. Ethyl alcohol .094 m. g. Fe $(SCN)_3$ per c. c. T=18°.

MIDDLE OF REGION.	PER CENT TRANSMITTED LIGHT.	EXTINCTION COEF.	ABSORBTION RATIO K.
568	21.6	.665	
556	12.7	.896	

Other series of experiments with ethyl alcohol, amyl alcohol and ether, demonstrated that the absorbent power of solutions of ferric sulphocyanate in these menstrua diminishes more rapidly than the concentration. The amyl alcohol was distilled from phosphoric acid to remove traces of organic bases and then thoroughly dried. Hydrolysis of the ferric salt can therefor not occur.

If electrolytic dissociation occurs, the molecular conductivity of these solutions must increase with diminishing concentration and in proportion to the diminishing light-absorbing power.

The electrical resistance of the same solutions which had been examined optically was therefore determined in a resistance cell of the form described by Arrhenius, by Ostwald's method with Kohlrausch-Wheatstone bridge and telephone. The specific resistance of the amyl alcohol employed was about 100,000,000 ohms per m. m. cube.

All the measurements showed that the molecular conductivity of the non-aqueous solutions examined diminished with increasing dilution and in about the same ratio as the reciprocal of the absorbtion coefficient, whereas the molecular conductivity should be greater at high dilutions than at low if the tapering off of the color of the former is due to electrolytic dissociation.

I am not prepared to present final quantitative results at present because my apparatus is not perfectly adapted to the measurements of such high resistances, but there is no reason to question the qualitative results nor the general character of the numerical data. A cell now in course of construction having a much smaller resistance constant than that heretofore in use is expected to furnish results of the desired accuracy.

Ivan Klobukoff (Zeit. Phys. Chem. IV, 429,) has observed that solutions of hydrochloric acid in ether and in amyl alcohol exhibit a diminution of molecular conductivity with increasing dilution of the solutions and has shown that it is not due to any chemical action of the acid upon the alcohol. This phenomenon evidently belongs in the same class with that which I have observed in the case of ferric sulphocyanate solutions.

Neither of the theories as yet advanced seems capable of explaining all the facts and more extended studies of the spectroscopic and electrical behavior of other colored salts in non-aqueous solvents must be made before any theory can be advanced with profit.

ELECTROLYSIS OF SILVER—LABORATORY NOTES.

W. S. HENDRIXSON.

(Abstract.)

The author exhibited some pieces of apparatus devised in connection with his work on the atomic weight of tin, and also a quantity of pure silver prepared by electrolysis of the pure silver of Stas in strong nitric acid solution. The method of electrolysis was essentially that of Abrahall* as modified by Richards†. By using a strong acid solution containing fifteen per cent of silver and a battery consisting of sixteen gravity cells the silver was obtained in large crystals and no peroxide was formed at the positive pole. Separate experiments showed that silver deposited under these conditions, from a solution to which copper had been added, contained no trace of the latter metal.

The apparatus exhibited included:

1. A platinum condenser for the preparation in pure condition of such substances as attack glass or metals other than platinum, viz, water, hydrochloric, hydrobromic and nitric acids. Cork or other connections are avoided by selecting a retort into the neck of which the condenser tube fits closely. The first portion of the vapor condenses between the glass and platinum and forms a seal. The condenser tube is bent so that the neck of the retort or flask may be inclined upward to secure a back flow and to avoid the mechanical carrying over of substances by the spray.

2. A separatory funnel having a doubly-bored stop-cock like that in the well-known Lunge's nitrometer. On turning the cock to arrest the flow of the liquid the column in the stem, which in the ordinary funnel remains in the stem, being held by atmospheric pressure, falls at once since it is replaced by air which enters the stem through the second hole in the stop-cock.

* Journal Chem. Soc., 1892, p. 660.

† Proc. Amer. Academy, Vol. XXVIII, p. 22.

3. An adjustable attachment for a Bunsen burner, having three upright posts for the support of dishes, and a platinum triangle, made of wire, passing through holes near the tops of the posts, to support a crucible, watch-glass or small dish. The attachment permits the use of a "crown top" if it is desired to evaporate a liquid rapidly without boiling, and it is provided with supports for a cylindrical chimney which encircles the posts and protects the flame from drafts of air.

4. An apparatus for electrolysis, consisting of a dessicator containing a platinum triangle to support a platinum dish. A wire of the same metal is connected with the triangle and passes through the side of the dessicator. To prevent loss by spray, the dish is covered by a large watch-glass, in which is sealed a large platinum wire ending in a spiral below to serve as the positive electrode. The wire extends through a very small cork fitted in the top of the dessicator, and thus can be raised, lowered or supported in any position.

EXPERIMENTAL ENGINEERING AT THE IOWA AGRICULTURAL COLLEGE.

BY G. W. BISSELL, PROFESSOR OF MECHANICAL ENGINEERING.

Experimental engineering at the Iowa Agricultural College is of two kinds. The first kind has for its object the instruction of the student in the use of and calibration of the instruments employed, and in the performance by improved methods of a series of graded experiments whose variety and selection are such as experience has shown to be productive of the best results attainable with the facilities of the laboratory.

The experiments under this head which are conducted by the students in mechanical engineering are: Tension, transverse and compression tests of the materials of construction, properties of lubricants, measurements of power by absorption and transmission dynamometers, steam gauge and indicator spring calibration, cement testing, fan-blower tests, calorimetry, weir and water-meter calibration, efficiency tests of steam engines, boilers, injectors, air compressor and steam heating, electric lighting and pumping plants, and the thermal analysis of the steam engine.

Owing to the number of experiments and students and the lack of duplicate apparatus, it is necessary as well as advisable to maintain all apparatus in working order, so that the student is not obliged to lose time and patience and courage in looking for things. While the experience obtained in arranging apparatus might be useful as instruction, such preliminaries are apt to discourage the beginner. Moreover, the practice, if followed with large classes, would cause confusion and sacrifice discipline. System is necessary in this particular.

The actual performance of the above or any other set of experiments is secondary to another feature of the work, which consists in the writing of a satisfactory report of the experiments. This report includes several distinct things, and is generally arranged under heads as follows:

1. Object of the experiment.

2. Method to be employed in attaining it. Under this head is placed the derivation of the fundamental formulae for the experiment.

3. Description of apparatus. This includes all apparatus, principal or accessory. The description is often assisted by sketches.

4. Describe the experiment. Every operation having direct or indirect bearing on the results.

5. Give numerical data. These are usually taken on printed blanks and afterward copied on similar blanks for pasting in the note books.

6. Derive results.

7. Draw conclusions.

When the student has the results obtained from the above experiments upon the pages of his note book he has a valuable store of knowledge to draw upon in his future work. For the tests of the materials of construction he finds certain constants. Experimenting with lubricants shows him that the value of an oil for lubrication depends upon many properties. Testing the transmission of power by various devices opens his eyes to the extent of the friction losses, resistance of the air, etc. The calibration of instruments, calorimetry, flue-gas analysis are essential in establishing the value of the efficiency tests; and from these efficiency tests, he learns, above all, the value of accuracy in each and every step and the importance of perfect honesty in the recording of observations.

With the exceptions of the tests upon materials, the numerical results of much of this work are far from correct because of the inexperience of the experimenters and because also of the variability of conditions peculiar to engineering problems. The exactness of the physical and chemical laboratories are unusual in the engineering laboratory. But education and not figures is the result sought by the instructors. Professor Carpenter, in charge of experimental engineering at Sibley College, Cornell University, says "The undergraduate laboratory should be equipped so as to demonstrate in a practical and convincing way the principal laws or facts that the student must master in order to finish his course. Its course of instruction should be such as to require systematic work of the student, teach him how to observe, how to use apparatus, how to deduce conclusions from his mass of data and finally how to make a neat and systematic report of his work."*

Having completed, or nearly so, the above outlined work, the student takes up the second kind of experimental work which is offered to him chiefly in the form of thesis work. That "there's nothing new under the sun" cannot be said of man's knowledge. And in engineering there are countless problems still unsolved for the lack of evidence which those actively engaged in professional work have not the time to gather and the technical schools are expected to help by contributing facts. Hence the necessity for original work in the technical schools. This can almost always be accomplished by assigning it to students as thesis work and the results of so doing when the instructor can give personal supervision to the work are good. Educationally, the results are good because the student is thrown largely upon his own resources and because in opening the gates to the new

*Engineering Laboratories, R. C. Carpenter. *Science*, November 3, 1893.

fields of knowledge thus brought to view he has new experiences and new thoughts and is taught the increased importance of application, reasoning and preliminary training. In short we aim to benefit first the student and next the profession by the second kind of experimental work.

The time spent on thesis investigation and writing ranges in amount from one hundred to two hundred hours of actual work.

The scope of the original work in experimental engineering for the past two years is indicated by the following subjects chosen from the whole number assigned:

The force exerted in cutting cast iron, wrought iron and steel in the lathe.— For cast iron the force is proportional to the amount of metal removed. For wrought iron and steel the force does not increase as rapidly as the amount ot metal removed.

Determination of the point pressure and twisting moment exerted by twist drills in cast iron, steel and brass.—A collection of data useful in the design of drill presses.

The resistance of swing check valves in the return pipes of steam heating systems.—Found to be very slight, indeed--not over one-quarter of a pound.

Some of those projected for the coming year are:

Friction of cylinder oils.

Variation of stress in the punching of metals.

Variation of economy of the steam engine with change of load.

Experiments with small venturi meters.

In the other departments of the engineering, electrical, civil and mining, the experimental work plays an important part and is prosecuted with vigor by the instructors and students.

Ames, Iowa, December 26, 1893.

ON THE GEOLOGICAL POSITION OF BENNETTITES DACOTENSIS MACBRIDE, WITH REMARKS ON THE STRATIGRAPHY OF THE REGION IN WHICH THE SPECIES WAS DISCOVERED.

BY SAMUEL CALVIN, IOWA CITY.

Since Professor Macbride's paper on *Bennettites dacotensis* was published in the *American Geologist* for October, 1893, there have been numerous inquiries respecting the exact geological horizon from which the cycads were derived. The close resemblance and the intimate relationship indicated between the Dakota fossil and *Tysonia marylandica* Fontaine, while not conclusive, would point toward a common horizon for the two species, and so make it possible to correlate the Potomac formation with a definite Mesozoic horizon in the northwest. Prosessor Macbride's paper left the stratigraphical position of his species undecided. To settle, if possible, the question definitely, the writer recently made a visit to the locality that furnished the types of Macbride's species.

Specimens of Bennettites are not very numerous in the Black Hills of South Dakota. At all events not very many have yet been brought to light. All the individuals at present known have been found in a rather limited area around Minnekahta, a small station on the Deadwood branch of the B & M. railway. By far the greater number, some forty or fifty altogether, were discovered on an area of only a few acres, about four or five miles southwest of Minnekahta. They all lay partly imbedded in the soil on the southern slope of one of the low, rounded, grassy hills that characterize the marginal portion of the Black Hills uplift. Separating the cycad hill from the next on the south is a comparatively shallow, but steep sided cañon, supporting a moderately dense growth of *Pinus ponderosa* Douglass. The walls of the cañon reveal the edges of gently folded and tilted beds of sandstone. Sandstones—yellow, brown or red, sometimes in massive, and sometimes in thinner layers—often project above the grassy surface on the gentler slopes above the cañon walls; while here and there are high buttes rising two or three hundred feet above the general level, and composed of conformable beds of sandstone throughout their entire elevation. A single sandstone formation therefore, extends from the bottom of the small secondary canyons of the region to the top of the buttes; and, though no cycads were seen in place, there is no reason to doubt that it was in this sandstone, at some level, that they were originally imbedded. The sandstone exhibits the characteristics of the Dakota group of the Black Hills as described by Hayden, Winchell and Newton; still it was thought best not to decide the question of its age on lithological grounds alone. Diligent search during the time at our disposal failed to disclose the remains of recognizable plants or animals belonging to the sandstone in place. Fragments of silicified trunks, probably of deciduous trees, lay loose on the surface. Some of these were mingled with the cycad trunks, and, since the condition of mineralization was the same in both, it was inferred that the silicified trunks of both types had been imbedded under the same conditions, and that they probably came from the same horizon. A short distance east of the cycad field a gray shale, supposed to be the Jurassic of the geologists who have written on the Black Hills, was revealed by an upward arching fold in the bottom of the canyon, but as it contained no fossils judgment was for a time reserved. Three or four miles west of the main group of cycads the ash colored shales, recognized beyond a doubt by *Belemnites densus*, M. and H., and other characteristic fossils as the Black Hills "Jurassic" are exposed in full force in the east side of Big Horn basin. The whole thickness of the Jurassic, two hundred feet or more, is thus revealed; while beneath the Jurassic shales, at the bottom of the basin-like valley, there is an exposure of Red Beds having a thickness of twenty or thirty feet. The rim of Big Horn basin, on the east side at least, exhibits ten or twelve feet of heavy, cross bedded sandstone resting directly on the Jurassic shales. These cross bedded layers constitute the base of the great sandstone formation, to which reference has already been made. The formation extends from the Jurassic shales to the summits of the adjacent buttes. On stratigraphical evidence we are now prepared to recognize it as the Dakota sandstone. The cycad beds are therefore Cretaceous and belong to Meek and Hayden's Cretaceous No. 1.

A considerable thickness of the sandstone at the top of all the higher buttes of the region has been converted into a very hard, brittle quartzite. The process of vitrification has in some instances almost completely obliterated the original structure; in other cases the original grains are seen imbedded in a a secondary deposit of silica. Contrary to the opinion of some observers, I believe the vitrification to be due to conditions that existed in the sea at the time the beds were deposited. The waters were charged with an unusal amount of soluble silica, which was not only precipitated among the sand grains, converting the whole mass into a homogeneous quartzite, but some of it was substituted for the molecules of wood and other tissues in the stems of cycads and deciduous trees, that by accident were floated in from adjacent lands. The silicified trunks of ordinary trees now found on the lower slopes occupied by the sandstone are very much broken and weathered and polished by long exposure. On the shoulder of one of the buttes a mile or two west of the main cycad field, not far below the level of the vitrified bed, there was noted a silicified log two feet in diameter at the base, twelve feet of the basal part unbroken, with a train of fragments of varying dimensions extending from the smaller end far enough to indicate an original length of seventy or eighty feet The fresh appearance of this specimen, with its fractures all sharp angled and its parts of considerable length all in their natural relative positions, was in striking contrast with the short, polished, worn, disassociated fragments found in the residual soil on surfaces two or three hundred feet lower. The differences in condition and appearance indicate enormous differences in the length of time the specimens have been exposed. The effects on the better preserved specimen, of rain and frost and wind driven sands, with frequent falls from undermining cliffs, during the years necessary to reduce the hill on which it lies to the level now occupied by the fragments with which it is compared, will not be left to conjecture so long as the worn and dismembered fragments lying at lower levels remain to furnish objective illustrations of what those effects have been in the past. These are reasons for the conclusion that all the silicified trunks, including those of Bennettites, came from the same horizon, and that that horizon was the vitrified beds near the summit of the Dakota sandstone.

East of the valley followed in this vicinity by the B. & M. railway, rises Arnold's peak, a high butte, the summit eight hundred feet above the valley, and like the other high points of the region, capped with vitrified sandstone. The geological structure at the base is concealed, but a mile or two farther north, almost directly east of Minnekahta, the high ridge of which Arnold's peak is simply the most prominent part, reveals at its base the belemnite-bearing beds of the Jurassic. The plain on which Minnekahta stands is some scores of feet below the top of the Jurassic, and not less than six hundred feet below the vitrified sandstone near the summit of the Dakota group. On this plain a few specimens of Bennettites have been found, but in most cases they were so far decomposed as to fall to pieces when attempts were made to remove them. Again we find some relation between the abrasion and decomposition that the fossils have undergone and the vertical distance they lie beneath the level of the vitrified beds. Assuming that all the fossils were imbedded at essentially the same horizon, then those that now occupy the lowest level have been longest exposed to atmospheric and aqueous agencies.

At Hot Springs, about twenty miles as one has to travel from the principal group of cycads, the valley of Fall river has been cut down through the entire thickness of the Dakota sandstone, through all the Jurassic, and down into the purple limestone and gypsiferous red clays of the Red Beds. Battle Mountain, east of the town of Hot Springs, has an elevation of about a thousand feet above the valley. The upper part of the mountain is composed of the Dakota sandstone, and away up at the summit is the quartzite seen on the higher eminences around Minnekahta. Fall river, formerly known as Minnekahta creek, flows off toward the southeast to join the south fork of the Cheyenne river. About four miles from Hot Springs, the stream emerges from the sandstone hills in a series of cascades which constitute the falls of Fall river. At the falls, as previously observed by Newton, the sandstone is inclined at a high angle and passes beneath the dark colored shales of the Fort Benton group. Crossing the nearly level plain that separates the last of the sandstone hills from a high escarpment that curves around nearly parallel to the margin of the uplift, we find ourselves on calcareous beds of the Niobrara group. These are charged with *Inoceramus problematicus* Schlotheim, with occasional colonies of *Ostrea congesta*, the whole aspect of the formation resembling closely the Inoceramus bearing beds near Sioux City, Iowa, and Ponca, Nebraska. The similarity of the Sioux City deposits to Niobrara beds on French creek, a locality probably thirty miles northeast of the point just noted, was remarked by Prof. N. H. Winchell in 1874.

Over on the Cheyenne river, about six miles east of Fall River Falls, is an exposure of Niobrara that reminds one of the massive chalk beds at St. Helena, Nebraska. The resemblance is not complete, for at St. Helena the beds are for the most part white, only occasionally portions are bluish in color owing to the presence of organic matter. On the Cheyenne the beds are all bluish. They give out a strong fœtid odor when struck with the hammer. There are indications of the presence of organic matter in unusual amount. But the massive bedding of the soft, calcareous material, the manner in which the layers break down, the huge blocks of talus, the occasional small colonies of *Ostrea congesta*, the vertebræ and scales of fishes, are each and all perfectly duplicated at the two points mentioned; namely, on the Missouri at St. Helena, and on the south fork of the Cheyenne southeast of Hot Springs.

Around Edgemont, south of the hills, the country for some distance is occupied by the Fort Benton shales. A steep escarpment which constitutes the vertical face of the first terrace south of Cheyenne, reveals with their usual characteristics, the Inoceramus beds of the Niobrara; but passing on southwest over the hills toward the valley of Cottonwood creek, the Fort Benton is again exposed. Erosion of the shales has formed a series of Bad Lands on a diminutive scale. It has at the same time made prominent certain beds of impure limestone, from which we obtained numerous fossils. Among the collections here were specimens of *Prionocyclus wyomingensis* Meek, *Scaphites warreni* Meek, *Lunatia concinna* M. and H., *Inoceramus pseudo-mytiloides* Scheil, two or three other species of Inoceramus, a Pteria or two, and many other less obtrusive forms that have not yet been identified.

At the town of Hot Springs some portions of the valley are occupied by horizontal beds of a very coarse conglomerate that lies unconformably on the folded and tilted Red Beds. The thickness of the conglomerate is about forty feet. It is composed of fragments of all the harder formations from the crystalline rocks at the center of the uplift to the purple limestone of the Red Beds and the quartzite of the Cretaceous. When the conglomerate was deposited the valley had essentially its present depth. In some places the streams have just fairly completed the work of cutting through the conglomerate, in other places they have cut twenty or thirty feet below its base. This conglomerate is probably the equivalent of that lying at the base of the White river Miocene. If so it would indicate an enormous amount of erosion between the beginning and middle of the Tertiary as compared with the amount accomplished since.

Returning finally to the main object for which these observations were undertaken, it is clear that *Bennettites dacotensis* Macbride, belongs to the Cretaceous period, and the evidence is practically conclusive that the exact horizon at which the individuals of the species were imbedded is represented by the uppermost layers of the Dakota sandstone.

NOTES ON THE LOWER STRATA OF THE DEVONIAN SERIES IN IOWA.

BY WILLIAM HARMON NORTON.

In a report recently made to the State Geological Survey, the writer communicates in detail some facts regarding the brecciated zone of the Devonian in Linn county, Iowa, and the terranes subjacent. The following is in part a brief summary of this report:

In the breccia which occupies the same horizon from Davenport to Fayette, and which has been termed by McGee the Fayette breccia, four stages are discriminated.

The fourth, or upper stage, involves in Linn county to a greater or less extent several life-zones of the Cedar Valley limestone, including the horizons of *Acervularia davidsoni* (E. and H.), *Phillipsastrea gigas* (Owen), *Spirifera pennata* (Owen), and *Spirifera dimesialis* (Hall). Matrix and fragments are alike being fossiliferous and shaly, and the fragments are usually large and often but slightly disturbed.

The third stage is distinguished by the predominance of fragmental masses, often large and rectangular, of a tough, grey, crystalline or semicrystalline, heavily bedded limestone, containing a distinct fauna, of which a large *Gyroceras* and *Rhynchonella intermedia* (Barris) are the most characteristic fossils, and *Gypidula occidentalis* (Hall) and *Orthis macfarlandi* (Meek), the most common. The limestone of which these fragments is composed is not found in place in Linn county.

The second stage is defined by the abundance of fragments, usually small, of a hard, drab, unfossiliferous limestone of finest grain, often thinly bedded, often finely laminated, the laminæ frequently being flexed or contorted. This limestone also is not found undisturbed in Linn county.

The first stage is characterized by an abundant buff or brown matrix, the fragments being sparse and small. Some of them are quartzose, belonging like the matrix to the subjacent terrane.

This subjacent terrane, locally called the Kenwood beds, consists of massive argillaceous and ferruginous buff and reddish-brown limestones, irregularly bedded, often flexed and arched and passing horizontally and vertically beneath into buff thinly laminated or shaly limestone, weathering into slopes of marly clay. In these beds nodules of crystalline quartz with calcite and angular fragments of the same are common. Beneath the buff shales which constitute the bulk of the Kenwood beds lies a layer of greenish or bluish fissile shale from a few inches to five feet thick. The upper limestones are usually involved, more or less in the Fayette breccia. The total thickness of the Kenwood beds is nearly forty feet. The basal blue shale in especial is believed to represent the horizon of the Independence shales. The latter term, originally designating some sixteen feet of dark carbonaceous and grey fossiliferous shale pierced by a well near Independence, may readily be extended, however, to include all the limestone and shale of the Kenwood. The latter term is, therefore, used only as a local synonym for the Independence shales, of which it offers many natural sections, the first discovered.

Beneath the Kenwood beds in Linn county lies a Devonian terrane not hitherto known, termed the Otis beds. Like the Kenwood beds, from which it is somewhat sharply divided, the Otis limestone is remarkably constant and uniform in its lithological features, some layers with special characteristics being traced across the county. It consists of nearly pure non-magnesian limestones, some macro-crystalline and some non-crystalline and compacted of impalpable calcareous silt, often heterogeneous in texture, often lying in heavy lenticular masses, passing into thin calcareous plates. In all the numerous exposures of these beds from the Cedar River above and below Cedar Rapids to near the Jones county line southeast of Springville, *Spirifera subumbona* (Hall) is found gregarious in a typical form distinct from the varietal form found in the Independence shales at Independence. On the Buffalo and Wapsipinnicon rivers the numerous sections of the Otis limestone are unfossiliferous. The Otis beds, whose total thickness is thirty feet, include hard thinly-bedded magnesian limestone basal layers by which they pass without unconformity into softer heavily bedded dolomitic limestones, probably Silurian in age, provisionally called the Coggan beds.

It is believed that the Devonian succession in Linn county will be found to obtain elsewhere in the State where the lower strata of the system are exposed.

At Davenport, for example, the lower limestone out-cropping along the Mississippi river from the city northward to Gilbertsville, thinly bedded, arched and partially brecciated, is identical in appearance with the fragments of the second stage of the Fayette breccia from Fayette to Cedar Rapids. Under the saddles of its folds there emerges a brown ferruginous limestone indistinguishable from the Upper Kenwood, whose horizon it seems to occupy. Lithologically and paleontologically the fossiliferous beds resting on these limestones at Davenport, referred by Barris to the Corniferous, are believed to be equivalent to the *Gypidula occidentalis* and *Rhynchonella intermedia* limestone, whose presence defines the third stage of the breccia in Linn county, and which in Buchanan county has been named the Gyroceras beds. At Davenport, as in the counties to the northwest, the Gyroceras beds are succeeded by a soft, shaly limestone with a characteristic fauna.

The writer has felt the need of definite terms to designate these beds, and therefore suggests for the consideration of workers in this field the name, *Lower Davenport beds* for the lower unfossiliferous limestone at Davenport, the limestone which furnished the fragments for the second stage of the Fayette breccia. If a geographical as well a paleontological term should be found convenient for the fossiliferous limestone overlying these lower beds, the term Upper Davenport beds could be appropriately used as a synonym of the Gyroceras beds.

The change in fauna is so distinct at the summit of the Gyroceras beds that it seems to the writer that they should be separated from the Cedar Valley limestones, as the Independence shales have been.

If the inferences we have drawn are correct, the "Upper Helderberg" of Hall, and the "Corniferous" of Barris, at Davenport, are superior to the horizon of the Independence shales. They must therefore be included in that broad biotic unity whose termini are the Independence shales and the Lime creek shales, whose fauna have been shown by Calvin to be so similar.

It is an interesting fact that the new Devonian terrane, the Otis beds, found beneath the Independence shales, contains, as we have stated, as its characteristic fossil a Hamilton and Chemung species, and carries no species, so far as known, allied to pre-Hamilton faunas in other states.

Geological Laboratory of Cornell College, December 28, 1893.

CRETACEOUS FORMATIONS OF NORTHWESTERN IOWA.

BY CHARLES R. KEYES.

(*Abstract.*)

Until recently little definite information has been accessible concerning the distribution and subdivisions of the Cretaceous deposits of Northwestern Iowa. Strata of Cretaceous age have been recognized from time to time at various points, but, as a rule, little detailed information has been recorded. As early as 1840 Nicollet called attention to certain sections near the mouth of the Sioux river which he regarded as Cretaceous in age. Since that time Cappellini, Marcou, Meek, Hayden, White and others have been through this region. In all these cases the rocks noted were in the immediate vicinity of the Missouri river. White gave more attention, perhaps, to the Iowa strata than any of the other writers mentioned, and recognized outliers as far east as Guthrie county and as far south as Montgomery county.

Recently numerous deep well records and field observations have shown that the Cretaceous deposits cover a much larger area than has hitherto been recorded. The northwestern fourth or fifth of the State may now be regarded as occupied by deposits of Cretaceous age. White, in considering the Iowa Cretaceous, divided the beds as found in the Sioux river region into the Woodbury shales and sandstones and the Inoceramus beds. As recently shown by Calvin the Woodbury shales are equivalent to the Dakota sandstone and the Fort Benton shales of Meek and Hayden and the Inoceramus beds are the same as the Niobrara of the same authors. Thus three of the formations differentiated by Meek and Hayden are known to be well represented in Iowa. During the past season another formation of the Cretaceous age has been found to extend into Iowa. This is the Fort Pierre shale. It was first noticed in the State by Mr. H. F. Bain, who found it well developed in the vicinity of Hawarden, in Sioux county, where it attains a considerable thickness. The easternmost location heretofore known showing the Fort Pierre beds has been Yankton, South Dakota, at which place the deposits are used largely in the manufacture of Portland cement.

There is another division of the Cretaceous of the upper Missouri valley which Meek and Hayden have recognized, This is the Fox Hills group. It will be seen, therefore, that four out of the five Cretaceous formations of the region are now known to extend into the State of Iowa.

Incidentally it may be mentioned that the Niobrara chalks have been recently recognized as far east as Auburn in the southeastern part of Sac county, eighty miles east of any hiterto reported locality. The Cretaceous deposits have also been extended southward by Mr. E. H. Lonsdale nearly to the Missouri line. The gypsum deposits of Webster county, Iowa, are also thought to belong to this age. It may not be out of place here to mention the fact that in the drift of northwestern Iowa boulders have been found consisting of soft friable ferruginous sandstone, highly fossiliferous, the organic remains being characteristic Fox Hills forms. As remarked by White the presence of the friable sandstone blocks indicates that they are not far removed from their original localities. It would not, therefore, be wholly unexpected should outliers of the Fox Hills group yet be found within the limits of Iowa.

DERIVATION OF THE UNIONE FAUNA OF THE NORTHWEST.

BY CHARLES R. KEYES.

One of the most striking features in the zoological history of the Mississippi basin is the exceedingly rich and varied moluscan fauna, which is characterized particularly by the Unio family, including all the common river mussels. The great abundance of individuals, the large number of forms and the wide geographic range of many of the varieties has perhaps no parallel elsewhere. The first of these statements requires no further proof to one who has worked anywhere within the limits of the region under consideration. The second proposition finds ample evidence in collections of more than sixty different kinds of these mollusks from a single locality. Altogether more than seven hundred species of the family Unionidæ have been described from North America—over four-fifths of the entire number known to exist in the world. Having such a large number of closely related forms to deal with, it has become very convenient, and indeed very necessary, to separate the chief genus into a number of subordinate groups, naming each after its leading species; thus the sections are known as the "gibbosus," "undulatus" groups, etc.

The distribution in space of the uniones of the continental interior has been shown to be in many respects very peculiar. As the problem finds no satisfactory solution in an ordinary zoological treatment, an inquiry has naturally been made in regard to how far the present regional disposition of the various groups may have been determined by the conditions of former geological epochs. This involves by far the most important factor in the consideration of the present geographic distribution of organisms, and one which continually assumes greater and greater prominence in dealing with facts pertaining to that subject.

It has also been clearly shown in other zoological families that the range of many genera and species in time is very much more extended than has been generally regarded, and that some of the living types have a high antiquity. The recent discoveries of rich land and freshwater faunæ in the Mesozoic and later deposits of the Northwest have done much toward elucidating the early history of American fluviatile mollusks. White* has already intimated in a general way the probable close genetic relationship of these fossil uniones and the forms now living in the waters tributary to the Mississippi river, but no specific references were made to the mollusks now existing. Later† it was incidentally mentioned that among the Laramie Unionidæ were found the prototypes of *Unio ligamentinus*, *U. undulatus* and other groups.

In the upper Mississippi region the Unionidæ are easily separable into three grand sections which are commonly ranked as genera: Anodonta, Margaritana and Unio. The generic distinctions are based entirely upon the characters of the hinge "teeth;" but there are also other good structural features to support this separation; and the transitions are few and not well marked. The leading North American groups of Unio may be typified by the following species: *Unio ligamentinus* Lam., *U. undulatus* Barnes, *U. ellipsis* Lea, *U. gibbosus* Barnes, *U. tuberculatus* Barnes, *U. pustulosus* Lea and *U. parvus* Lea, besides others which have no bearing in the present connection. Of these at least five groups are known to have fossil representations in some portion of the western Cretaceous or Tertiary strata. In the present consideration no forms from rocks earlier than the Mesozoic age are considered, for the reason that so much doubt at present exists concerning the shells referred to the Unionidæ from the Devonian and Carboniferous of this country. As regards the Tertiary forms described under Anodonta and

*U. S. Geol. Sur., 3rd Ann. Rep., 1883.

†Keyes: Annot. Cat. Iowa Mol., Bul. Essex Inst., vol. xx, 1889.

Margaritana considerable confusion also prevails; and it is quite certain that some of the species have been wrongly referred to these genera.

It has been stated by Binney and others that among the living land mollusks a wide geographic distribution is indicative of a high antiquity for the group. This observation has lately* been extended to certain Carboniferous mollusks. By carefully reviewing the American Unionidæ it will be found that the generalization is applicable to this family also. Those (subgeneric) groups having the widest geographical range at the present time in the basin of the Mississippi river are the ones which are best represented in the Mesozoic strata of the upper Missouri region. As examples, *Unio ligamentinus, U. ellipsis, U. undulatus* and *U. rectus* are the most prominent, perhaps These four species range from Ottawa, Canada, and western New York, to southwestern Kansas and Texas, and from Alabama to northern Minnesota and Dakota. All four groups, along with others, are present in considerable numbers in the freshwater Laramie deposits of the Northwest.

Of the group typified by the first species mentioned—*Unio ligamentinus*—there are a number of forms now known among the fossil Uniones. The shell of the living representative is exceedingly variable, as might naturally be expected of a species occurring under the many diverse conditions of environment such as are imposed by its wide geographical distribution. Throughout its range many specific terms have been applied to the various varietal forms. In some localities this species has a very thin and fragile shell; in others the shell is very thick and massive, with large, heavy hinge-teeth, and rough, deep, muscular impressions, resembling in many respects the early described *Unio crassidens* of Lamarck. To the latter category the majority of the Laramie forms of the group appear most closely to approach, particularly such shells as *Unio vetustus* Meek, from southwestern Wyoming. *U. priscus* M. and H., seems also to belong to the group. The type continued through the Eocene as *U. shoshonensis* White.

Unio ellipsis is the type of a rather large and variable group of shells. The beaks in this species are far forward, even extending beyond the anterior margin of the shell. It is thus a representative of a series having but few examples among the forms at present living, but which was almost universal among the Laramie species, as was first pointed out by White. The most nearly related of the fossil species now known is perhaps *U. proavitus* W., but in the former the "teeth" are somewhat heavier and the outline more rotund. Other forms of this type are are found in *U. cryptorhynchus* and *U. propheticus*.

Unio gonionotis White, is evidently one of the "undulatus" group; but it more closely resembles some other members of this section rather than the leading species itself. *U. belliplicatus*, while differing considerably from the type of the group, is believed to have a close relationship with other members of the section, particularly certain forms that have recently been noted from Kansas.

The *Unio rectus* group is characterized by rather large, elongate forms, having heavy shells, rounded in front, and more or less attenuated behind. The Laramie representatives are best known under *U. couesi* W., and perhaps also *U. danæ* M. and H. In the Eocene *U. clinopisthus* appears to have flourished as the descendant of the early "gibbosus," or "rectus" type.

*Proc. Acad. Nat. Sci., Phila., 1888, p. 245.

Among the fossils already alluded to are a number of Anodontæ, the most prominent of which is *A. prepatoris*, a member of the "grandis" group. Margaritana has been reported from the Cretaceous, but at present there is much doubt as to the correct reference of the form to this genus.

At present the oldest American form of Unio is *U. cristonensis* Meek. It was described from a horizon doubtfully referable to the Triassic, and was first figured by White. The type specimens are imperfect, but show distinctly the generic characters.

White* has expressly called attention to the fact of the extreme shortening of the Laramie Uniones in front of the beaks, or rather the forward position of the umbones as compared with the modern shells. This fact is of great interest in its bearing upon the phylogeny of the group, as it is an important consideration in support of Neumayr's recently advanced suggestion concerning the derivation of the Uniones from the Trigonidæ. Should this near relationship of the two families be established it is very probable that the view just mentioned would require some slight modification. For the two families had already, in the Cretaceous, become very much differentiated, so that the two types were probably derived from a common, but rather remote ancestor, rather than one from the other.

A most remarkable feature concerning the Unione fauna of North America is the striking individuality of the forms of each drainage basin, however limited it may be. This peculiarity is so marked that one acquainted with the American species of the family has little difficulty in telling from which particular portion of the country, or indeed the stream, a given series of shells was taken, even when the most widely distributed species are under consideration. It was probably this fact more than any other that occasioned the vast multiplication of species by Lea whose wide familiarity with these bivalves enabled him from the external characters alone to readily determine the locality of the various forms of Unionidæ brought to his notice. It is, perhaps, one of the best known examples showing how persistent, how exclusive, how united a particular fauna of a limited geographic area may be, when the physical conditions are seemingly quite diverse. It also illustrates how well the peculiarities of two contiguous basins may be fully preserved even when the conditions of environment are presumably the same. A hint towards a partial explanation of these phenomena is derived from geological data concerning the permanency of river basins; for it has been satisfactorily shown that the water courses are among the longest lived of all the topographical features of a region. This being the case the Unionidæ would be admirably adapted to flourish through long periods of time and undergo but slight structural modifications, and this certainly seems true of these bivalves in the Missouri basin, for they have come down from Mesozoic times almost unchanged.

The distinctness of unione faunæ in separate drainage basins has some striking illustrations in the upper Mississippi valley. One in particular has recently been brought into notice in the case of the Des Moines and Iowa rivers, which flow parallel to one another southeastward across the State of Iowa. The peculiar distribution of the lamellibranchs in the eastern and western portions of the State was pointed out some time ago in an annotated catalogue of the Mollusca of Iowa. Of the species found in

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*U. S. Geol. Sur., 3rd Ann. Rep., p. 431, 1884.

the Des Moines river there are seven that do not occur in the Iowa, while in the latter stream there are twenty-one forms that are not found in the former; twenty-six species are common to both rivers. Of the latter, four are rare in the Iowa but abundant in the Des Moines, while two are rare in the last mentioned water course and common in the eastern stream.

Now the molluscan fauna of the Iowa is identical with that of the Minnesota river, suggesting that an intimate connection may have existed, at a period not very remote, between the latter stream with some one of the drainage basins of eastern Iowa. That the connection was probably of a comparatively recent date is shown by the distribution of the living Unionidæ in the upper Mississippi valley which points strongly to the widespread influence of certain peculiar agencies during glacial times which modified the former range of the mollusks of the region. The present topography, however, of southern Minnesota, does not seem to exhibit any direct indications of such a relation as is above alluded to, except in the central part. But it is probable, as has been urged by Chamberlain, McGee and others, that during the glacial period the elevation above the sea level of the region under consideration was very different from that of the present time. The objection raised by the previous statement therefore loses most of its force.

The persistence, with such slight structural modifications, of the members of the Unionidæ for the long period of time that must have elapsed since the close of the Cretaceous appears to indicate a high antiquity for this type of molluscan life. But since so very little or nothing is known concerning the internal characters of the shells of the Paleozoic lamellibranchs, it is very probable that a number of other Unio representatives will be found among forms already described under genera not at all related. On the other hand future research will doubtless bring to light new types connecting more closely the family with others. In this connection it is of interest to note that Whiteaves has lately described some lamellibranchs from the Coal Measures of Nova Scotia which with little doubt possess characters which would cause great difficulty in the attempt to separate the forms from typical Unio.

PROCESS OF FORMATION OF CERTAIN QUARTZITES.

BY CHARLES R. KEYES.

(*Abstract.*)

In the extreme northwestern corner of Iowa there is a small area of very hard, thoroughly vitreous rock, which has been known for more than a quarter of a century as the Sioux quartzite. The mass is also well exposed in the adjoining portions of Minnesota and South Dakota. The Sioux "granite," as it is now locally called among quarrymen, is of considerable interest for the reason that it has long been the only altered formation known within the limits of Iowa. The apparent metamorphic characters of the quartzite beds is all the more remarkable from the fact that the rocks of the State are so horizontal in their position, so undisturbed by mountain making forces, and so unchanged in lithological characters that it is commonly supposed that all the strata of the State are essentially the same as when deposited in the quiet waters of the great interior sea which once occupied the heart of the American continent.

Although so thoroughly crystalline and so closely resembling quartzitic rocks altered from sand beds through regional or contact metamorphism no massive crystallines have been mentioned in connection with the Sioux quartzite until quite lately when a large mass of diabase was discovered in the midst of the quartzite of southeastern Dakota. Still more recent borings in northwestern Iowa have revealed no great distance below the surface other rocks of undoubted eruptive origin among which may be mentioned quartz-porphyry.

The Sioux quartzite formation has received considerable attention from time to time, but for the most part the observations have been somewhat cursory; incidental to other examinations rather than special examinations.

Irving's description of the lithological features of this formation essentially agrees with observations made during the past few months. It is as follows:

"Loose sandstone to the hardest and most complete vitreous quartzite, the prevalent phase being a distinctly quartzitic one. The loosest and most completely indurated portions are arranged in the most irregular relations to one another. Occasionally they will be interstratified. At times the exposed parts will be completely vitrified, while below artificial openings will display an entirely loose sandstone, suggesting an induration of the exposed portions by weathering. In other cases, however, exactly the reverse of this will be met with, while very often the more and less indurated phases pass into each other laterally by rapid graduations, the two phases traversing the layers and dovetailing into each other in the most irregular manner. The prevalent color of the formation is red, but the loosest varieties are often very pale colored, while the most vitreous kinds frequently present a very dark purple hue. In western Minnesota and again in certain points of Dakota, there is associated with the quartzite the fine clayey rocks known as pipestone, or catlinite. Intermediate between this pipestone and the purely silicious quartzite are clayey sandstones and quartzites, often of a blotched appearance, and not a little resembling externally certain of the Keweenawan sandstones of Lake Superior. So far as the microscope studies have gone these rocks are in the main mixtures of red clay and quartz. Conglomeritic phases of the quartzite are met with at a number of points, but no other rocks but those already mentioned have been recognized in this great formation."

Thin sections under the microscope show that the great sandstone beds have become consolidated and rendered quartzitic through the secondary enlargement of the sand grains, by additions of silica, the added parts being oriented optically with the internal grains they surround. In South Dakota a few miles northeast of Carson station on the Sioux City & Northern Railroad, there is exposed in the railroad cut some sections which show an alternation of thin layers of the hardest quartzite and soft incoherent sands. In places the alternating quartzitic layers are only one or two inches in thickness, and are each separated by several inches of loose sand. By selecting the sand grains near the quartzite and examining them carefully under a microscope, the grains may be found abundantly showing secondary enlargement. In many cases the crystalographic faces are well defined, and the common hexagonal pyramid of typical quartz is found perfectly reproduced, each with a sand grain inside. In many instances the sand grain is especially well defined for the reason that red oxide of iron has filled the irregularities in the surface. It appears, then, that in these enlargements there is a more or less rounded irregular grain, thickly coated with iron oxide, and around this has been deposited secondary quartz with crystal faces often well defined. As the secondary enlargement goes on the contiguous grains become closely interlocked, forming the compact vitreous quartzite which is so well known.

ORIGIN OF THE PRESENT DRAINAGE SYSTEM OF WARREN COUNTY.

J. L. TILTON.

SYNOPSIS: *First.*—In Warren county the drift is of uneven depth. As in other drift areas, this unevenness is not dependent entirely on the pre-glacial surface. In the unconformity of the drift on this pre-glacial surface a relation is seen indicating a similarity between the present drainage system and the pre-glacial drainage system.

Second.—The present river valleys and larger ravines are larger than present streams require. They fit into the pre-glacial valleys.

Third.—In the smaller ravines only do we find erosion without regard to the pre-glacial configuration of the county.

In connection with field geology work in the northern part of Warren county and the adjacent townships of Madison county, a question of constantly increasing interest to me has been this: To what is the present drainage system of the county due? I will endeavor to make clear an answer to this query, without too much detail, leaving other questions to be presented at some future time.

It is generally understood that the drift is laid in irregular deposits, here thick on the hill-tops, there thick in the valleys. Are we to expect, then, that the present drainage system has been marked out since the "Ice Age," with little regard for the previously existing systems? It is true, that in the county referred to there is no regularity in the depth of the drift deposit. At times the drift rests on sandstone, at times on limestone, at times on shale.

Two-thirds way from Indianola to Spring Hill is a valley; its sides with equal pitch. The road down the east side shows Carboniferous outcrops very prominently, while by the road down the west side is a drain, cutting deep into loess, without a trace of Carboniferous strata. A little east of this ravine is another ravine crossing the road, cutting through loess and various Carboniferous strata; here is an excellent illustration of unconformity, for within a hundred feet the surface of the Carboniferous strata slopes northward, in the direction of the present drainage, allowing the loess to rest successively on clay shale, coal, fireclay and shale.

Indianola is built on a hill thickly capped with drift, while a hill east of Carlisle has shale, clay, and coal out-cropping in the road, even near the top of the hill.

To see the bearing of these illustrations of unconformity, let it be remembered that the old surface was exposed to erosion during untold centuries from the close of the Carboniferous Age till the "Ice Age." In that long period there was opportunity to cut out the immense valleys occupied for ages then as now, by small streams. The unconformity of the drift on this ancient surface reveals the direction of drainage in pre-glacial times. This unconformity indicates that the more prominent ravines of the present lie in pre-glacial ravines, though frequently on one side of the ravine.

At present three rivers carry the surface water to the Des Moines. At times in the spring these rivers are filled till their flood plains are submerged, but ordinarily they are nearly dry. Making what seems due allowance for high water in spring, one cannot help but wonder how these streams could cut into Carboniferous strata or even wash away drift material till each little river had such broad flats as those to be seen north of Greenbush on North river, at Summerset on Middle river, and south of Indianola on South river.

Comparing the ravines that open into these rivers, we notice that where the surface rocks are least easily decomposed there the sides of the ravines are steepest and out-crops most easily found, while in sections where the surface rocks are soft, as north of Lathrop, there the sides of the ravines are rounded and out-crops less frequently found; yet over it all the loess is generally undisturbed. Some of these main ravines cut deep into loess, while the same deposits are apparently as deep on the knolls that separate parts of the ravine. Back from the main ravines reach the smaller ones, rarely cutting deep enough to remove anything but loess.

East of Buffalo bridge a valley nearly a quarter of a mile wide is cut through a hill fully a hundred and seventy feet high composed of masses of limestone, but the ravine mentioned now contains a stream nearly dry the larger part of the year. What little water there is in this gorge flows northward.

Comparing the valleys running to the north with those running southward there is nothing to indicate that one set has been favored more in its formation by either ice or water from melting ice masses. We should naturally expect ice moving from the northeast to gouge out the soft material lying on the north slopes near the tops of the hills; yet such material is still found exposed. At the unconformity mentioned where the ravine opens to the northward the strata referred to are very exposed to such erosion. The valleys sloping to the northward have no characteristics in common, distinguishing them from valleys sloping southward. Especially is it difficult to conceive how ice, or water from a melting ice mass, could erode such a valley as that mentioned as lying just east of Buffalo bridge, Madison county, or of those in White Oak township, Warren county.

A similar statement may be made in regard to the river valleys. The rivers wander here and there over a partly alluvial plain with drift along the margins, at times even on the very banks of the rivers themselves.

Comparing these different data it is clear the river valleys were marked out chiefly in pre-glacial times. During Mesozoic and Tertiary times when this region was subject to constant erosion, wide valleys were cut into the carboniferous strata as deep as the present valleys. While the drift is an important factor in the present configuration of the country, yet in the region referred to the ice had little to do in erosion, and the waters from melting ice sought in general the natural previously determined drainage courses thus keeping open the rivers and many of the chief ravines of pre-glacial times, while only the lesser ravines have been marked out since the drift was deposited.

STRUCTURE OF THE MYSTIC COAL BASIN.

BY H. FOSTER BAIN, IOWA GEOLOGICAL SURVEY.

The lower measures of the Iowa-Missouri coal field consist of a series of sandstones, shales, fire clays and coal beds, which have been found to interlock in a characteristically irregular manner. The different individual beds have, with rare exceptions, only a limited extent, and frequently grade into each other in a manner making their stratigraphy quite complex. This variability has been recognized by many workers* and has recently been elaborated† so fully that only a reference is necessary in this connection.

The explanation of the irregularity is found in the conditions of the depositions of the beds. It depends primarily upon the facts indicated so abundantly by the nature of the beds themselves—that these measures are marginal depositions, and it has been suggested‡ that in this field the lower coal measures represent the marginal deposits, of which the upper coal measures are the, in part, contemporaneous open sea beds.

In certain portions of the field the irregularities may be directly traced to the influence of the uneven nature of the floor upon which the beds were laid down.

*Swallow: Rep. Mo. Geol. Sur., p. 87, Jefferson City, 1855.

Worthen: Geol. of Iowa, vol. I, p. 250, 1858.

Broadhead: Rep. Mo. Geol. Sur., II., p. 166. Jefferson City, 1872.

Norwood: Rep. Mo. Geol. Sur., pp. 200-215, 1873-1874. Jefferson City, 1874.

†Keyes: Stratigraphy of the Carboniferous in Central Iowa; Bul. Geol. So. Am., II., pp. 277-292, 1891.

Winslow: Mo. Geol. Sur., Prelim. Rep. on Coal, pp. 21-22, 1891.

‡Winslow: Missouri Coal Measures and the Conditions their Deposition; Bul. Geol. Soc. Am., III., 109-121, 1892.

Keyes: Geol. Sur. Iowa, vol. I., First Ann. Rep., pp. 84 85, Des Moines, 1893.

The limitations of the various strata are perhaps more strikingly shown in the coal beds themselves than in any others. The few limestones known to occur in the Lower Coal Measures, such as that shown in the banks of Walnut Creek at Mystic, are of course persistent over wide areas. Certain of the sandstones, such for example as that exposed at Red Rock, in Marion county, attain a considerable geographic extent. The shales, however, and even more particularly the coal beds, usually cover areas quite limited. Indeed it is the exception to find a coal bed which can be traced more than a few miles at most.

In marked contrast to this general character is the coal seam at present worked in Appanoose and adjoining counties. As compared with the other coal seams of Iowa the extent of the one in question is quite exceptional. As nearly as can now be determined it extends over a distance of nearly fifty miles north and south and at least forty miles east and west. There is probably no other vein in the Lower Coal Measures of the State which extends unbroken over an equal stretch of territory. Not that it is now absolutely continuous over the whole extent, but that its identity may be accepted with considerable assurance.

A general section representative of the strata of this region taken from the record of several mines at Centerville is as follows:

		FEET.	INCHES.
17.	Soil, fine black	3	
16.	Clay, yellow	33	
15.	Clay, blue, containing boulders and fragments of wood, coal and limerock	30	
14.	Limestone	6	
13.	Shale, argillaceous, blue	3	
12.	Shale, argillaceous, red	11	
11.	Sandstone, soft with thin hard layers	8	
10.	Shale, argillaceous	10	
9.	Limestone, compact gray	3	
8.	Shale, bituminous pyritiferous	7	
7.	Limestone, usually bituminous "Caprock"	3	6
6.	Shale, firm bituminous	1	2
5.	Coal	1	8
4.	Clay-parting		2
3.	Coal	1	2
2.	Fireclay	3	
1.	Limestone (seen in the bluffs at Mystic)	2	10

The thickness and character of these different layers vary within certain limits, but the general features of the section may be considered as fairly constant. Other bands of limestone occasionally make their appearance, and the character of the shale is of course inconstant. The presence of numbers 9 and 14 is tolerably constant throughout the field. They are known respectively as the "Seventeen" and "Fifty foot" limestones from their general occurrence at about those heights above the coal. They may be relied upon as fairly accurate guiding marks, though they have in certain places been removed by later erosion.

An examination of the coal in the above section shows that it has several points which are peculiarly characteristic, and make its recognition easy and secure.

The following five sections are taken from different parts of the field, and are a few of a large number showing the characteristics of the vein. They will show the main evidence relied upon to establish the identity of the seam, though much confirmatory material could be added from the nature of the coal and the general geological and topographical relations of the region:

(1.) Section measured as exposed along Walnut Creek at Mystic, in the north central part of Appanoose county:

	FEET.	INCHES.
7. Limestone, massive, grey (seen in Lone Star drift)	2	6
6. Shale, bituminous	1	
5. Coal	1	6
4. Fireclay		2
3. Coal	1	
2. Fireclay	1	3
1. Limestone	2	10

(2.) Section as seen in a mine at Seymour, Wayne county, at a depth of 242 feet:

	FEET.	INCHES.
7. Limestone "Caprock"	2	
6. Shale, bituminous	1	6
5. Coal	1	6
4. Clay		2
3. Coal	1	
2. Fireclay	1	2
1. Limestone bed-rock		

(3.) Section examined in a mine at Centerville, Appanoose county, at a depth of 150 feet:

	FEET.	INCHES.
7. Limestone		
6. Shale, black	1	
5. Coal	1	5
4. Fireclay		3
3. Coal	1	2
2. Fireclay	1	8
1. Limestone		

(4.) Section at Blackbird Coal Company's shaft, two miles north of Unionville, Putman county, Missouri:

	FEET.	INCHES.
7. Limestone, hard gray	3	
6. Clayey gray shales (Clod)		6-8
Black fissile shale	1	
5. Coal	1	8-10
4. Clay parting		1-3
3. Coal		10-12
2. Clay	3	
1. Limestone		

(5.) Section of coal bed at Stahl, Adair county, Missouri:*

	FEET.	INCHES.
7. Limestone	1	10-12
6. Clay (Clod)		2-3
Black fissile shale	1	6-12
5. Coal	2	
4. Clay partings		1-3
3. Coal	1	
Clay		1-2
Coal		1-2
2. Clay	1	4-6
1. "Bottom Rock"	1	6

*Sections IV and V taken from Missouri Geol. Sur., Prelim. Rep. on Coal, pp. 56 and 61 Jefferson City, 1891.

An examination of these different sections shows a remarkable persistence of character. The thin clay parting remains constant between two and three inches over the whole distance. The greatest variation is shown in the underlying fire clay and overlying shales.

In Iowa this coal has been found along both branches of the Chariton river in the northeastern part of Wayne county, and mined near Grffiinsville and Milledgeville, in the northwestern part of Appanoose county. Its presence on Little Walnut creek, near Walnut City, is known. It is well exposed along Big Walnut, and is extensively mined at Brazil, Mystic and Rathburn. It has been mined at Plano, Garfield, Dennis, and a few miles southwest of Moravia. There is a coal exposure on Soap creek, at Foster, in Monroe county, which may be the same. At Centerville, Numa, and Jerome, the coal is mined at depths of about one hundred and twenty-five to one hundred and sixty feet, while at Seymour in Wayne county, it is reached at two hundred and forty-three feet; and at Howard, in the same county, is reached at a slightly less depth. At Livingston and Cincinnati in the southern part of Appanoose county, it lies nearer the surface; near Hillstown, in the southeastern part of the county, it outcrops along the Chariton. Coal is mined at Coatsville, in Schuyler, Stahl, in Adair, and Mendota, Unionville, and other points in Putman counties in Missouri, which has been considered* to belong to the same seam, and part of it at least, has been directly correlated† with the Mystic coal. Without doubt this is a continuation of the vein mined in Iowa; since the mines at Cincinnati, Iowa, and Mendota, Missouri, are only a short distance apart, and the same is true at Hillstown and Coatsville. The character of the coal, and the attendant strata, as well as the general geological relations in the region in question, all bear on this assumption.

The presence of a seam of coal with such exceptionally uniform character and wide geographical limits within the boundaries of the lower coal measures as now recognized, is an item of considerable economic, as well as scientific interest. It has had a very important bearing upon the development of the coal industry of that portion of Iowa, and has been one of the leading factors in the remarkable growth which that industry has there experienced.

SIGOURNEY DEEP WELL.

BY H. FOSTER BAIN.

During the summer of 1888 a deep well was drilled at Sigourney, in Keokuk county. Captain Parker, who was at that time mayor, carefully preserved samples of the different strata passed through. These samples have recently been re-examined, and form the basis of the following notes.

*Winslow: Geol. Sur. Mo., Prelim. Rep. on Coal, pp. 54-62, Jefferson City, 1891.

†Norwood: Rep. Mo. Geol. Sur., 1873-1874, p. 295, Jefferson City, 1874.

While the unreliability of records derived from the ordinary or churn drill is fully recognized, it is believed that the care with which these samples were selected and preserved, at least considerably reduces that element of doubt. Previous accounts of this record have been published in the local newspapers, and re-published by C. H. Gordon in the *American Geologist.** Recent studies in the region, as well as a revision of the material, give, however, considerable information not available at that time.

The following table represents the record as recently determined, as well as the interpretation:

1- 98	Earthy matter	98	Drift 98
98- 120	Limestone, impure, earthy	22	
120- 135	Limestone, cherty	15	
135- 155	Shale, calcareous	20	
155- 165	Limestone and shale	10	
165- 170	Limestone, hard, bluish gray	5	
170- 187	Limestone, cherty, light	17	Saint Louis... 89
187- 189	Shale	2	
189- 314	Limestone, hard, white with brown particles	125	
314- 315	Shale, dark green	1	
315- 356	Limestone, grayish white to drab, *Rynchonella* at 342 ft.	41	Augusta 168
356- 554	Shale, soft, green	198	
554- 556	Limestone	2	
556- 585	Shale, soft, green	29	Kinderhook 229
585- 835	Limestone	250	Devonian 250
835- 865	Sandstone	30	
865- 871	Limestone	6	Niagara 36
871-1030	Shale, blue argillaceous	151	Maquoketa 151
1030-1275	Limestone	245	
1275-1281	Shale	6	Trenton and
1281-1315	Limestone	34	Galena 285
1315-1430	Sandstone	115	Saint Peter 115
1430-1717		287	
1717-1888	Limestone	171	Oneota.

A comparison between this and the previously published record shows several discrepancies. The drift is in both cases given as 98 feet deep. The next 89 feet is now referred to as the Saint Louis, whereas it was formerly considered to be Keokuk. There are a number of reasons for this change. In the first place, an examination of the samples shows that the beds are not a single homogeneous limestone as represents the Augusta of this region, but are made up of alternating bands of limestone and shales such as compose the Saint Louis. It is also worthy of note that the particles of limestone preserved are of the fine grained, compact character and ash to brown color so constantly seen in the Saint Louis of this immediate region, and not of the coarser crystalline variety shown in the nearest exposures of Keokuk.

The topographic features also bear out this assumption. A line of levels shows that the mouth of the well is 118 feet above the bed of the river two miles south of town. Saint Louis limestone is exposed along the river, reaching here a height of nearly twenty feet, or about what it would be if on a level with the strata found in the well, which are referred to the same age.

*Gordon, Notes on the Geology of Southeastern Iowa (Am. Geol., IV, 237-239, 1889.)

Keyes* has recently shown that the two limestones found in southeastern Iowa, and long known as the Keokuk and Burlington, are really conformable members of the same formation to which the name Augusta has been given.

Worthen,† in his notes on Washington county, calls attention to remarkable thinning out of the Keokuk; it being greatly reduced or entirely absent over the regions studied. This observation has, during the present field season, been completely substantiated, not only for Washington, but Keokuk county. These facts taken together, all point to the same conclusions: that the first 89 feet of limestone pierced belongs to the Saint Louis, while the Keokuk is represented merely in a few feet of the succeeding 168 feet of strata. The two bands of heavy limestone comprised in the strata thus referred to, the Augusta, are closely similar in lithological character, and resemble the Augusta limestone of the region as nearly as can be determined. At a depth of 342 feet a fossil, Rhynchonella sp. und., was brought up, it being the only fossil preserved. Below this point the element of uncertainty becomes greater. The succeeding 229 feet of shale is probably all referable to the Kinderhook, though the thickness is somewhat greater than an examination of the Washington county outcrops seem to indicate. The 250 feet of limestone which succeeds is most probably Devonian. The succeeding 30 feet of sandstone and 6 feet of limestone are more probably Niagara, since Calvin has shown that the Niagara at Washington is arenaceous. It is prossible, however, in this case, that the sandstone encountered may be of Devonian age and represent the Montpelier sandstone. The overlying limestone being the Cedar Valley.

The Maquoketa shale seems, by comparison with neighboring records, to be well recognized.

The heavy limestone band, 285 feet, succeeding the shale is probably representative of the Trenton and Galena, though it seems impossible to draw a good line between them.

The 115 feet of sandstone which succeeds seems to be the Saint Peter. Beneath this for some distance no samples were obtained as the current of water struck was so strong as to wash away all the drillings. The lower position of the well yielded samples which an examination proved to be limestone as Gordon surmised, and not sandstone as published. This seems to clearly prove that the well ended in the Oneota, though the top of the formation was not definitely located nor was it penetrated, so that its thickness under this portion of Iowa is as much a problem as ever.

The well was sunk in hopes of obtaining strong flow of artesian water. A moderate flow was obtained but has never been used to any great extent. At 1,320 feet in the Saint Peter sandstone a vein of water was struck which contained mineral matter and possessed a strong odor. At 1,360 feet in the same formation an opening was struck and the drill suddenly dropped two feet. A strong current of fresh water carried off all the samples and the water increased to the depth of 1,388 feet, when it flowed over the top of the well while drilling and stood within thirty feet of the top when the drill was at rest. No more water was struck from here to the bottom of the well.

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*Keyes, Geological Formations in Iowa (Iowa Geol. Sur. I, First Ann. Rep., 1892, 59-60, Des Moines, 1893).

†Worthen, Geol. of Iowa, vol. I, p. 244, Albany, 1858.

SOUTHERN EXTENSION OF THE CRETACEOUS IN IOWA.

BY E. H. LONSDALE.

The Cretaceous deposits of Iowa, from time to time, have received the attention of a number of geologists. The most important researches were made by Marcou, Meek, Heer, White and Calvin. Their investigations were carried on chiefly in the vicinity of Sioux City. The formation elsewhere in the State has, with a few exceptions, received no consideration. Its exact extent is yet to be determined; its vertical thickness is yet unknown; the relative ages of some of its beds remain to be established.

Over western Iowa, in fact, over practically the whole State, resting upon the pre-tertiary beds, whatever these beds may be, is a mantle of debris collected and carried by the great glaciers as they advanced and receded, then and in the end depositing that material which is now recognized as drift clays, sands, gravels and boulders.

This drift material, as a whole, commonly so extensive in vertical thickness, so persistent in its occurrence, and so readily yielding to the weathering agencies, has almost completely concealed the older rocks upon which it traveled and deposited itself. There are, however, occasional exposures of these rocks standing out more or less precipitously along preglacial streams which were of such magnitude or position, as the case may be, to withstand the attack made by the glaciers, and thereby continue their existence; along postglacial water courses which have cut through the drift and upper strata of the underlying formations thus developing a narrow or broad channel and growing new exposures along its way. These few outcroppings afford about the only source from which reliable geological results can be gathered.

The Cretaceous, made up as it is of soft layers, such as sandstones, whose particles are commonly loosely or not cemented together, and beds of clay shales, would naturally suffer to a greater extent from the effects of the glaciers and weathering than would the limestones and other hard rocks of older formations. It would consequently be expected that the limits of the former would not now be even approximately the same as the original restriction of the Cretaceous in Iowa, nor, as nearly the same as are the boundaries of the earlier formations. Again, on account of the texture of the Cretaceous the exposures soon became covered with debris, even though at the close of the glacial period they were yet bare. Therefore, only rarely will faces of rocks be left to view. This is the case not only inland but along the bluffs of large and small streams.

White has probably given more attention to the inland exposures of Cretaceous than any one else. In addition to the Sioux City region he described beds *in situ*, in Guthrie and some of the southwestern counties and set them down as Cretaceous. To those in Montgomery county, consisting of almost wholly of ferruginous grits, he gave the name Nishnabotna sandstone. The exposures farthest to the southeast were located in Guthrie county; the southernmost at Red Oak, Montgomery county. These are all described as outliers, the distance from the assumed eastern and southern limits of the main Iowa Cretaceous deposits, of which the Sioux City beds form by far the most important adjunct, varying from twenty to nearly one hundred miles. In individual size these outliers have been considered as only a few miles, perhaps one to less than twenty, in their greatest diameter.

During the field season which has recently closed a considerable amount of work was done in southwestern Iowa; additional information pertaining to the Cretaceous outliers in general, was secured; the southern limit was extended and conclusions pertaining to areal mileage of the different outliers have been drawn with greater or less satisfaction.

In the first place let the topography of southwestern Iowa be considered briefly. Eastward from the bluffs which are prevalent along the great flood plain of the Missouri or adjacent to the river itself the counties consist of gently rolling uplands, which rise gradually to a height of one hundred to two hundred feet above the near by waterways. The tops of the ridges between the usually parallel streams continue in their axial lines in an almost unbroken plane for many miles. The bottom, level land next to the larger streams varies in width from a few yards to one or two miles, this width depending largely upon the size of the stream which penetrates the low land. From the outer margins of these bottoms there rise gradual slopes curving smoothly to the upland drainage lines. Occasionally are found outcroppings of bedded rock in these slopes but they are in no wise extensive in any locality. There are, however, in western Iowa beds of the Coal Measures which are exposed, but rarely are any such beds exposed at a great distance above the streams near which they are situated. The top of many are but a foot or so above the water, others fifty or possibly more; but those approximating the former in extent predominate. In the vicinity of the Cretaceous outliers this is even so and such occurrences would undoubtedly indicate if not certainly prove that these inland streams have cut through friable beds of the Cretaceous and but only a few of the upper beds of the hard Coal Measures, that possibly not unfrequently has the former formation not been passed through by the streams now existing and some of the so-called outliers are connected and not separated as heretofore supposed. The fact that the drift, though omnipresent, in this section of the State is not excessively heavy, not heavy enough to hide precipitous limestone bluffs, if they be of considerable thickness, makes this state of affairs more plausible. This condition seems even more probable in parts of Guthrie county where the bottom lands are much narrower than those to the southwest. Again, it is quite possible that these outliers in Montgomery and adjoining counties extend farther northward and those in Guthrie county farther northwestward, towards the sources of and between the streams along which they lie; at the same time shortening the space intervening between the outliers and the present limits of the main Cretaceous body in Iowa. Although no positive information can be given in support of this theory, the exposures being few in number and only adjacent to the streams, one must readily infer that this condition exists at least to a greater degree than heretofore accorded. It is a notable fact that between the Guthrie and Cass county outliers there are no exposures of bedded rock either of the Coal Measures or of the Cretaceous and it may even be that one or more of these outliers in the one county are connected with those in the other.

Further, as results of recent investigations, new or previously unrecorded, Cretaceous outcrops have been found; the southernmost deposits of this age are no longer confined to central Montgomery and northeastern Mills counties.

In Montgomery county along the western slope of the ridge lying adjacent to and east of the East Nishnabotna, Cretaceous beds were recognized by an almost continuous exposure from Red Oak, the locality where White claimed the southernmost Cretaceous existed, to the south boundary of the county. The character of the bed varies here from a fine white to brown non-firm sandrock to a compact pudding stone. This latter is composed largely of pebbles from one-fourth to one-half an inch in diameter, imbedded in a somewhat to quite siliceous limonite matrix. In some of these exposures are absorbed excellent samples of cross bedding. At Coburg, only one mile north of the south line of Montgomery county a bluff rises abruptly from the outer margin of the here rather broad alluvial plain. Near the base of this bluff is a bed of fine friable sandrock eighteen feet thick lying beneath a few feet of coarser sand, small pebbles occurring in bands, over which bed rests about ten feet from the pudding stone. This entire section presents an elegant cross bedded character. About half way between this point and Red Oak these same beds occur and are more fully exposed. The total exposed thickness of the lower sandstone is thirty feet while that of the overlying pudding stone is perhaps as great. This latter rock is very hard and firmer than any Cretaceous rock yet noticed in Iowa, and is quite persistent in this vicinity, withstanding to a great degree the eroding agencies, so preserving the under deposits.

Two and a half miles eastward from Cobarg, on the county line a soft, Cretaceous sandrock rises above Ramp creek forming on the south side of the creek a perpendicular bluff twenty feet in height. South of this bluff, in Page county, small outcrops of such stone are noticed; some in the slope of the hill higher than the top of the bluff just mentioned. On the hill to the northward a well entered the sandstone at an elevation some higher than that of the top of the creek bluff. These facts go to prove that the thickness of the bed here is not much less than it is found to be in northern Montgomery county. The bottom of the bluff extends into the bed of the creek and only a short distance up the stream Coal Measure limestone crops out, with no perceptible dip in any direction, several feet above the water, indicating again the unconformability of the Cretaceous upon the lower rocks.

In Page county about one mile east of Essex (Tp. 70 N., R. XXXIX W.) the pudding stone such as described elsewhere, is found exposed along the roadside. Here it has about the same relative position above the East Nishnabotna as at points farther northward. This outcrop is only twenty miles north of the Missouri line and is decidedly the southernmost exposure of the formation recorded as existing in Iowa. South of this exposure about five miles a well more than 300 feet deep was bored and no bed, definitely recognized as Cretaceous, was shown in the record; though it is possible that some of the upper clays there met were of this age. No samples of the borings were seen.

It must be remembered that the surface of the Upper Carboniferous at the incursion of the Cretaceous sea in Iowa was not regular; perhaps even more irregular and broken than the surface of the strata is to-day. Deep channels, gorges, depressions, and rises marked the entire surface. The Cretaceous as a shore deposit may have wholly filled these Carboniferous channels and hollows, spreading itself in great depth near the floor, or partly leaving protuberances and ridges of higher elevations uncovered. However this may have been, the friable Cretaceous was, after the time of its laying down, greatly modified both by the preglacial weathering agencies and the glacial grinding and corroding. During those stages new channels were cut, others more deeply corroded, many extending through the entire thickness of the formation; large areas were disturbed, only to be obliterated by the repeated advancement and retreat of the glacier, and the high and low points were alike mantled with drift debris. The southern and southeastern limits, would, since the glaciers traveled in a southeasterly direction, naturally be more altered than would other portions of this shore deposit, the original shore line would be wholly displaced and a new line, probably a number of miles northward, left to mark the present irregular boundary. Thus it may be seen that the Cretaceous is not one persistent bed everywhere of the same thickness with its boundary an unbroken line, and its character unvarying.

Now extending from some of the outliers noticed the topography presents itself, just as it appears at the outlier, sometimes for several miles in length. To cite a case, consider the outlier which is exposed at Coburg and in that vicinity. Here for several miles to the southwest, between the West Tarkio and the East Nishnabotna rivers the upland topography such as at Coburg, continues without any abrupt change. Again, while no Cretaceous has been noted as occurring between the East Tarkio and the West Nodaway rivers, the topography in Page county between these streams resembles, in many respects, that between those streams to the west, along which Cretaceous beds have been found in Montgomery county.

It would appear, therefore, from surface features of this county, that the upland between these four streams are made up largely of Cretaceous deposits covered only by a mantle of drift. If this is so, it is probable that in the two counties lying in the most northwestern portion of Missouri, along the northern border, and through the entire length of Page county, Iowa, will be found just such beds of Cretaceous age as occur farther northward in the latter State. Additional examination of the region at hand may bring out definite results and prove that Cretaceous beds do now in reality exist in the doubtful localities just mentioned.

In doing this work it must be borne in mind from what has been said, that because the topography appears so in any place it does not necessarily follow that under such topography rests the Cretaceous; the marginal shore deposits may have been so modified and the debris from the Ice age so unevenly laid down that the existence or non-existence of the Cretaceous can no longer be recognized by mere topographic features of the land surface.

Near Coburg the Cretaceous appears to be quite heavy, but if this formation is found to extend southward and into Missouri where no areas, however limited in extent, have yet been found, it would no doubt be quite thin unless in exceptionally rare cases, for towards the southern boundary of Page county the Carboniferous rocks are not infrequently found, where exposed, a considerable distance above the drainage line, the ridges are not more elevated above them nor the drift less thick upon the upland.

Just how far the shore line of the Cretaceous sea extended southward cannot definitely be figured now, but, considering the position and abundance of outliers to the south and southeast along the present border, the direction the glaciers advanced and the readiness with which the friable beds could be broken off and carried away, one can immediately conceive how this shore line and the main deposit have been extensively altered, and how the present southern boundary may be far northward of the southern shore-line of the then probably continuous deposit.

For the present, however, it seems desirable to call the exposure near Essex at least very near the farthest south any Cretaceous *in situ* exists in Iowa; realizing at the same time the possibility, if not probability, that such may yet be found southward and in Missouri.

The finding of Cretaceous boulders amongst the drift is by no means uncommon. At the foot of the Missouri bluffs near Henton, in Mills county, a number of irregularly shaped masses of pudding stone were secured. Those were quite similar to the bedded stone in some of the counties further eastward. Just across into Missouri from Blanchard, Iowa, on the bank of the West Tarkio is, in a cut recently made, a fifteen-foot bed of more or less clayey sandstone doubtless Cretaceous in origin but modified on being removed and deposited here by the glacier. It would not seem that this sandbed nor the pudding stone had been carried away any great distance from their place of original deposition but their sources are yet to be traced.

TOPOGRAPHY OF THE GRANITE AND PORPHYRY REGION OF MISSOURI.

BY E. H. LONSDALE.

When speaking of the Archæan hills of Missouri Pumpelly has likened them unto "an archipelago of islands in the Lower Silurian strata which surrounded them as a whole and separate them from one another." To one who knows this interesting territory with its isolated and grouped knobs hills and mountains of crystalline rocks standing out more or less prominently and dotting the broad expanse of more recent sedimentaries, this figure is an exceedingly happy one; one most admirably taken.

In order to appreciate the picturesqueness of the scenery there presented it becomes requisite that not merely a birds-eye view be taken but also to look deeply and well into the mountains and vales, trace out the tortuous water courses as they have etched their tangled way through oftimes seemingly impenetrable measures and softer strata; to survey the streams and behold there the narrow chasms or gorges with mural escarpments which occur in irregular succession. Thus will the hidden scenery, the beauty of the landscape, sculptured by nature, be revealed.

The crystalline rocks of Missouri are for the most part porphyries and granites and are confined exclusively to the southeastern portion of the state. They occur southeastward, almost to the northern limit of the earthquake or sunken area of Missouri; they occur westward more than one hundred miles from the Mississippi, the nearest known outcrop to this stream lying less than twenty miles distant. If a quadrilateral with township lines be here drawn to include all exposures of Archæan rocks, it would contain about four hundred square miles; a circle drawn to surround these exposures would have a diameter of more than eighty miles. Yet the surface of either of these figures which is occupied by the crystallines is less than one-tenth of the total enclosure. Occurring in ten counties, they are more abundantly exposed in Iron, Saint Francois, Madison, Wayne and Reynolds counties. In the others the exposures are scattering and not unfrequently quite isolated. In fact, some of these isolated outcrops being quite low, not much, if any, above the general level, are found, perhaps, only by chance. These crystalline rocks are the oldest in the state. They stood long prior to the forming of the latter sedimentary rocks. After standing for ages as parts of the continental body, they now appear with sandstones and limestones originating from the degradation of this continent surrounding them.

The Archæan hills often occur in groups each separated by divides or valleys of the same formation or they occur as individual and grouped points separated by Lower Silurian or Cambrian beds. The distance from Archæan, across Cambrian, to Archæan, may be a few feet or twenty or twenty-five miles and the length or broadest diameter of the continuous crystalline areas varies to about this extent, though the great majority of these are much smaller than the upper extreme.

Made up almost wholly of the crystallines and other hard rock and void of any glacial drift, southeast Missouri abounds in excellent exposures of the beds there existing. Presenting such varieties of rock, frequently in occurrences somewhat singular, the attention of the geologist is ever attracted. Problem after problem has arisen and been solved, yet to-day the field is new; many problems of great importance stand out for solution.

In addition to the porphyries and granites here present there are large areas of sandstone, limestone, or limestone capped with chert masses and fragments. Each of these is represented by a type of topography entirely distinct from that of any the other formations. The valleys of the sedimentary rocks do not resemble the valleys of the crystallines more than the hills of the former the mountains of the other. Of course in some places the type may be less characteristic than in others.

To the east of the southern limit of the crystalline region the elevation of the Mississippi river is approximately 300 feet above sea level. The highest ascertained altitude of the Archæan hills is 1,800 feet whilst the greatest elevation of the Cambrian hills is about 1,700 feet. Of the former the porphyry hills are the highest; of the latter the chert-capped limestone ridges are more elevated, consequently more conspicuous.

The well known higher porphyry mountains may frequently be recognized many miles away; their position, and consequently name, being readily detected, owing to the peculiar or distinct topographic features characteristic of the individual mountains. Famous Pilot Knob and its neighbor just across the valley of Knob creek, Shepherd mountain, are excellent examples of such forms. In the case of the former it is especially so, for, besides standing out a rather sharp, conical mountain, singular in form it is also marked by the deep cut from which iron has been mined for years which extends almost to its summit. Although this mountain is not so high by nearly 300 feet as some others, the distinctive form which it possesses together with the artificial cut makes its recognition doubly easy.

In the extreme southeastern portion of the State extending northward from the Arkansas-Missouri line and westward from the Mississippi river lies what is known as the earthquake region. This is now a rather extensive territory composed for the most part of lowlands, swamps and marshes. The lowlands commonly rising not many feet above the "Father of Waters" on the east are of Tertiary and Quaternary age. Grading seemingly somewhat gradually on the west on account of the contact with the low or bottom land naturally approaching the waters of the Black river, and quite abruptly on the north, the topography of the swamp region stands in marked contrast with the rough topography of the Archæan and Cambrian hills; the first with far separate contours and sluggish streams, the last with a magnificent drainage, high hills and narrow valleys.

As has been said, each formation in distinct area, whether it be porphyry, granite, limestone, sandstone or a combination of two or more of these will have its own special type of topography, each peculiar in itself as well as when compared with others. So by means of the topographic maps one can ordinarly discern the formations represented thereon.

Whilst in territories of limestones and sandstones the number of streams possessed by each is nearly the same, such may be said of granite and porphyry fields; but the number of larger streams and stream-ways in the Cambrian greatly exceeds the number in the Archæan. The streams in the former are more tortuous, the channels considerably wider and the flow less rapid. This is all largely due to the great difference in the texture of the rocks of the two geological formations, the comparative softness of the sedimentaries augmenting erosion. What is but a dull drainage line in the crystallines becomes, in a corresponding period, a well marked ravine in the sedimentaries.

The regularity with which the Archæan streams have been and are being formed depends primarily upon the form of the upland. If it consists of hilltop after hilltop the streams or gullies will be more common and more strongly marked than if the summit is not pointed, but is a narrow or wide plane of some length.

The limestone areas in southeastern Missouri are of two kinds; the common is the irregularly broken ridge with a crest having about the same level, from which extends more or less successively, often for a considerable distance, points or spurs of various lengths. Nearly the whole surface is covered with detritus which consists mainly of chert fragments often coated with drusy quartz. These ridges made up for the most part of the Magnesian limestones in heavy ledges, are only recognized as bearing such by occasional out-croppings of the same at the base and on the slope at variable altitudes. The topography of this country is rather simple and in a way monotonous, yet somewhat difficult to map on account of the numerous protruding spurs or points. The contours appear near the base rather far apart; toward the summit they run closer together and at nearly regular intervals until the topmost contour is reached, when a break in the regularity is occasioned. Here when the interval is as great as twenty feet the line frequently extends perhaps a mile or more with little curvature, both sides parallel with the axis of the ridge. When these chert-covered areas are more limited in extent hills rise as individual points separated by synclines whose troughs are of nearly the same level. In this case the regular contouring is unbroken from base to summit.

The other limestone regions are recognized by gently sloping fields capping the heavily bedded stone which, upon decomposition gives rise to the dark red coloring prevalent in the soil above and the associated clay. The larger streams traversing a region of this character leave banks of roughly weathered rock and but little detrital material; along the smaller ones bedded rock is seldom exposed.

There is presented in a region distinctly of sandstone a barren, for the greater part level, area cut by ravines, one or both banks being of solid sandrock ofttimes left in overhanging ledges by the eating out of the under portions of the bed. Along the nearly level tops, outcrops of sandstone are frequent, as the overhanging soily material, which in time accumulates does not form a mantle of equal thickness over the surface of the stone, but being of a coarse, sandy nature, is transferred from place to place and collected in heaps leaving other portions bare.

Over southern Missouri the limestones and sandstones are so closely, albeit irregularly, associated that their mode of occurrence, extent and relative position in the geological scale has long been a subject of discussion. Here there are extensive regions where both kinds of rocks prevail. Outcrops are common; first one then the other appear, over-lapping and interlocking. The problem of classification becomes intricate. The general surface features of a combination of the two sedimentaries are not like those of either alone. However, the type exhibited is but little more than a combination of the types represented by the rocks separately.

The topography of the Saint Francois mountains, this name having been applied by Winslow to the porphyry and granite hills and mountains of the region in question, is indeed striking, much more so than is that of the Ozarks to the west.

These Archæan mountains stand out in bold relief among the knobs of the Cambrian. Where both occur the beauty of the relief maps is greatly enhanced by the presence of narrow gorges and steep acclivities which not uncommonly form solitary high peaks of conical form, which are surrounded on all sides by lower lands of the Cambrian.

Porphyry makes up by far the greater portion of the 400 square miles of crystallines. The style of topography although varying is impressive, and in not a few instances at all similar to that of the granite. But as a whole, the type which represents either rock will almost invariably prove itself strictly characteristic of the ancient rocks. The nearest approach to the porphyry type is that of the chert-capped limestone hills previously mentioned. These occasionally do resemble in outline the lower pointed porphyry knolls, though the angle of slope is commonly greater in the latter and the contours less sinuous.

From the sandstone and limestone uplands great hills of granite or porphyry not unfrequently ascend abruptly to diversified heights. Often do the sedimentary rocks almost completely conceal the crystalline. In other cases the stratified rock now extend only a short distance up the hill and across the valleys and shallow divides.

As a rule the porphyry mountains are either pointed at the top or have a long, narrow crest, but occasionally large mountains have summits quite broad, grading into the steeper hillsides; Taum Sauk mountain, perhaps the highest in the region, is a good example of this form.

The contouring of these mountains is quite plain, yet distinguished in being as a whole different from that of other hills in this region. The angle of slope from base to summit is, of the larger mountains, almost constant, no matter whether this angle be small or great, whether the mountain top be pointed or narrow crested. Pilot Knob may again be taken as an example to illustrate the former and Buzzard mountain, adjoining the Knob on the north, to illustrate the latter.

Over the inclines of the steeper porphyry hills great blocks and fragments of the rock have accumulated as they weathered from the body mass. This detritus is often of great thickness and hides the solid rock except in case of almost perpendicular faces. Thus it modifies somewhat the otherwise rugged surface. Soily material is here commonly very thin, and vegetation is not abundant and the rocks are of slow decomposition.

Cañons are not unfrequent in their appearance over the Archæan region. They are found of variable lengths in the granite as well as in the porphyries. The many water-courses, in seeking an outlet, have cut through great bodies or hills of these excessively hard beds, which as yet confine the water to very narrow channels with more or less expansive precipitous walls, bare and rugged in outline. The beds of the streams are broken and waterfalls abound.

It has been mentioned incidentally that the topography of a granite field is essentially different from that of the porphyry. The porphyries, almost without exception, have an aphanitic structure, whilst the granites are often extremely coarsely crystalline and are, therefore, subject to much more rapid erosion, erosion on all exposed faces to about the same extent leaving a rounded surface in every case. Of the porphyry, weathering takes place not in decomposition of the surface, but by merely a separation of the stone into blocks and fragments along joint planes, in this rock always numerous whilst comparatively rare in the granite. Occasionally large blocks of granite break away along joint planes and, weathering, are transformed into huge boulders, which either remain on the solid rock bed or tumble into the streams at the foot of the mountain.

Granite mountains are commonly rounded at the tops and often the upper gently rolling surface extends over quite a large territory. They are of less height and may make up the greater part of a mountain whose highest point is of porphyry. The slopes are irregular and broken. To map (using compass, aneroid and level) with accuracy and detail, a field of granite must necessarily be traversed at frequent intervals, perhaps more so than is required in the mapping of any other formation in the Archæan regions. Where cañons occur in the granite their walls are more rugged, less precipitous and higher than in the porphyry, and the waterways are broader.

Closely associated as they are, the crystallines and the Cambrian ledges exhibit the contact of the two formations in many places. In some portions of the region it is not uncommon to find sandstone more closely accompanying the granites; limestone, the porphyries. Dikes are found more commonly in the granite. Iron ores are found mainly in the porphyry, while the lead ore in the crystallines is confined largely to the granite.

Specimens from many localities show an almost continual change in the hue, if not in the texture, both of the granites and porphyries. Between fifty and one hundred hues are represented in the former, while in the latter about two hundred distinctly different hues are shown, each in the corresponding number of specimens collected.

Associated as a dike rock in the granite, olivine diabase is also found, making up a few areas of considerable size. These have a topography much like that of the smaller granite fields. Limited areas of so-called syenite occur; also other forms of crystallines, rocks which will not here be mentioned.

OCCURRENCE OF ZINC IN NORTHEASTERN IOWA.

BY A. G. LEONARD.

In the Upper Mississippi valley for a considerable period after the mines began to be operated much more lead than zinc was produced. It was not until 1860 that the latter metal came into market. Since then the zinc production has rapidly increased. During the ten years previous to 1882 the output of zinc more than doubled that of lead, while in 1889, according to the last federal census report the proportion between the two was as 13 to 1 for the entire region.

On account of their increasing importance the zinc deposits will be especially described in this paper, but as the two metals are so closely related in occurrence what is said of one will, in many cases, apply equally well to the other.

Not until the year 1880 were the Iowa mines worked for zinc carbonate or "dry bone," as it is called by the miners. Up to that time the carbonate, though found in many of the mines, was thought to have no special value and had been thrown away as worthless, or when found in the diggings the latter were abandoned.

In the fall of 1880 two wagon loads of zinc were taken to Benton, Wisconsin, by Mr. William Hird and sold for $16.00 per ton. So far as known this was the first zinc ore sold from the mines of the State, and from this time on the carbonate has been mined in rapidly increasing amounts. The first mine to be worked for zinc was the McNulty, often called the "Avenue Top" mine, at the head of Julien avenue, Dubuque. This had previously been operated for lead and $25,000 worth is said to have been taken from it. The galena gave out in the crevice and a short distance beyond the zinc carbonate began to appear. It is estimated that this mine has yielded not less than $50,000 worth of the latter. After the sale of the first dry bone many began at once to search for it and numerous mines were soon being operated. Old lead mines that had been abandoned were again opened and worked for zinc when the associated ore began to appear.

A slight examination of the great mining regions of the globe will show that they are situated in regions of disturbance in the earth's crust. The strata have been more or less tilted from their original horizontal position, or are fractured and igneous masses intruded into them. In other words, the ore deposits of the globe conform to the general law stated by Humboldt that "the deposits of the precious metals and of lead, zinc, and mercury are usually associated with intrusions of igneous rocks."

The zinc deposits of the Upper Mississippi form a notable exception to the above law. They occur in practically undisturbed strata which show no evidence of having been subjected to metamorphic agencies or of having any connection with igneous masses.

The manner in which these deposits occur is also unusual. They are not in true veins, filling fissures produced by some deep seated cause and extending to a considerable depth, but the zinc is found in crevices which have a comparatively limited extent downward, and show no evidence of having been connected with igneous masses below.

Whitney says, in connection with the Upper Mississippi region,* "These deposits approach most nearly in character to what have been designated as gash veins; but they are in some respects peculiar in character, no mining region exactly resembling this in mode of occurrence of its ores, having been observed by me in any part of the world, unless it be in the Missouri mines in which the conditions of the Upper Mississippi region are closely imitated although upon a somewhat limited scale." In Missouri the zinc ores occur in the sub-Carboniferous formation. There is in that region an apparent connection between the surface drainage of the country and the deposits.

Other occurrences for zinc are those of Kansas, New Jersey, Pennsylvania, Tennessee and Virginia. The principal foreign countries for the production of this ore are the Rhine District and Belgium, Silesia, Great Britain, France and Spain, The first named region has for years yielded more than the other four combined.

The zinc ore of Iowa is found in crevices in the Galena limestone. The strata of that region are cut by fissures, and it is in the expansions or openings of these that the deposits occur. There is a very noticeable uniformity in the direction of these crevices. With few exceptions they have either an east and west or north and south direction, the former being much the more common. Besides these two sets there are others, known as "quarterings," that cross the main ones at varying angles. The larger crevices and those carrying most of the deposits are the east and wests, while the north and souths are narrow, and, when occurring in them, the ore is in sheets. The

* Wisconsin Report, vol. 1, 1862.

latter set in many cases serve as feeders to the major clefts, and at their intersection large bodies of ore are apt to occur.

The zinc as a rule is found in what are called "openings." These are formed by the widening of the crevices due to decomposition or solution of the rock in these particular layers. These cave-like expansions usually include a number of strata which form more or less irregular walls of either side. At the surface the fissures commonly appear simply as a seam in the rock, which followed down probably contains little or no mineral until it suddenly widens out into the opening where the ore, if any, will be found to occur. The dimensions of these openings are very variable, their height being all the way from three or four to forty feet, and their width from one or two up to twenty and in a few instances even forty feet. They are commonly limited above by a hard persistent layer of limestone appropriately called by the miners the "cap-rock." The latter is almost invariably cut through by a seam which may be so small as scarcely to be distinguished, or by an open fissure of varying width that often carries ore. The opening frequently extends up above the main level of its roof, forming large cone-shaped or irregular cavities or "chimneys" as they are called. On the other hand it may widen out and form large rooms or "caves" filled with the zinc ore.

It is not uncommon for the ore-bearing cavity to be divided or almost blocked up by a large mass of limestone known as the "key-rock." This obstruction has probably been left because of its greater compactness, that has enabled it to resist the destructive forces that have removed the surrounding rock.

The expanded crevices often contain rounded blocks called "tumblers," that, like the key-rock, have escaped decomposition, their edges and corners worn away by air and water.

The term "opening" is liable to be misleading as conveying the idea of an open space. They are, as a matter of fact, usually filled with ore mixed with more or less clay and rock fragments. Even where large caves are formed these may be filled to the top with crevice material mixed with zinc carbonate. On the other hand openings are found empty or only partially filled with clay, and can be traversed for hundreds and even thousands of feet through passages where no work has been done to clear the way.

The ore-bearing crevices, when followed down, are found to widen out into several openings, one below the other. The upper one is called the "first" opening, the next below is the "blue rock" opening of the miners, and still lower is a third and fourth. In the mines of the Dubuque region, the first is the only one that has been largely operated, the water hindering progress at the lower levels. The second has, however, been worked when possible. In the Center Grove mines, two miles west of Dubuque, ore has been removed from the third and, in one case, from the fourth opening.

The ores of zinc found in the Iowa mines are the carbonate (Smithsonite), sulphide (Sphalerite), and, in comparatively small amounts, the silicate (Calamine).

The carbonate or dry bone is by far the most common. It occurs in a great variety of forms; in cellular masses; as botryoidal coatings; in earthy masses and impregnating the rock. It is found coating galena crystals and also entirely replacing the lead and forming pseudomorphs. Several interesting specimens were seen in which fossils had been replaced by the carbonate. One of these was a slab of dry-bone on which were several large gasteropods, their substance changed over into the zinc ore, which had preserved their outline perfectly. The carbonate will contain on an average 35 to 40 per cent of zinc.

The sulphide or "black-jack" of the miners is not found so abundantly in Iowa mines as is the Smithsonite. This is doubtless due to the fact that the former has been largely altered into the latter as will be explained later. The ore contains considerable iron and is so dark colored as to resemble the galena on a cleavage face.

The silicate is rarely found. When occurring it forms coatings on the the Smithsonite. Some specimens collected had a banded structure and were not unlike quartz in appearance,

All the carbonate has without doubt been derived from the blende. Several facts indicate this to be the case: (1) It is not uncommon to find pieces, the outside of which are dry bone while the unaltered interior is composed of the sulphide. (2) In the lower levels and where it is below the water the ore occurs as the blende. This is the universal rule and would seem to be owing to the fact that the deposits beneath are not subjected to the alteration agencies at work nearer the surface.

The zinc ore may occur pure or mixed with more or less clay and rock. The carbonate is found coating the sides and top of the opening and covering the rock fragments in these. As before stated large masses of nearly pure dry bone occur filling large caves. In one of these great cavities the ore was so loosely deposited that a blow of the pick would cause tons of it to come tumbling down.

In their vertical distribution the lead and zinc ores of Iowa are unlike the occurrences in other parts of the region. Chamberlain makes the following statement concerning this:

"It is a law to which no noteworthy exceptions have yet been authentically reported, that lead predominates in the upper beds, but relatively decreases in the lower, while the zinc ores are very scant in the upper horizons, but relatively increase and often predominate below." This law does not hold good for the Dubuque region. There the zinc ore commonly occurs on the same level as the lead, and in some cases even above it. The zinc ore occupies the upper beds of the Galena limestone, few shafts reaching a greater depth than 120 feet, and then the upper portion of many is in the Maquoketa shales. It is doubtless true that the majority of the mines are in the upper one hundred feet of the Galena limestone, while in Wisconsin the zinc is confined mostly to the underlying Trenton. It often happens that the lead gives out in the crevices and, a short distance beyond, in the same opening, zinc ore will appear. Why the Galena should suddenly cease and the carbonate come in within a few yards, is a fact hard to explain. The two ores rarely occur mixed together, and where they are mingled the lead is in small quantities.

It will not be in place here to discuss at any length the theoretical questions connected with the zinc deposits. The subject is a difficult one, and sufficient data are wanting to prove, in a satisfactory manner, some of the theories advanced. But the questions connected with the origin of the zinc deposits are of much interest, both practically and scientifically and will be stated briefly. They are best set forth by Whitney* and more recently, and in greater detail, by Chamberlain†.

First, then, as to the formation of the crevices. Extending east and west through the zinc region are numerous and abrupt undulations of the strata. These were caused by a horizontal pressure acting from the south resisted by a corresponding force from the north. To state it differently, the oscillations are due to lateral force from the Interior Sea to the south and resisted by the Archæan land area to the north. These flexures produced the crevices. As the strata were elevated the heavily bedded limestones were fissured parallel to the axis of elevation and more or less open crevices formed. In a direction at right angles little force was exerted and the beds were only fractured, producing north and south fissures.

As suggested by Whitney, the shrinkage of the rocks may account for some of the crevices, at least to their open character, though it is difficult to see how shrinkage could have the great influence attributed to it by that writer.

The ore receptacles having been formed, whence came the zinc to fill them? It will be necessary simply to mention here the rejected hypotheses, namely, those of sublimation, and of thermal waters. Facts are well nigh overwhelmingly against the idea that the fissures extend to any great depth, being confined chiefly to the Galena and Trenton limestones, and without such extension downwards either of the above theories are very improbable if not impossible. All the facts indicate that the zinc comes not from below, but from the limestones in which occur the crevices. It was deposited along with the sediments by the waters of the Silurian sea. The latter derived its metallic salts from the waste of the pre-existing land surfaces. Chamberlain describes in detail the cause of localization of the deposits to a few areas, ascribing it to the currents of the ancient sea, taken in connection with the precipitating agencies of organic matter.

After their deposition in the limestone beds the zinc was concentrated in the crevices by the action of drainage waters percolating through the metal-bearing beds. In this way the zinc was concentrated in the fissures where it is now found.

SATIN SPAR FROM DUBUQUE.

BY A. G. LEONARD.

Located less than six miles south of Dubuque and one and three-fourth miles due west of Massey station on the Chicago, Milwaukee & St. Paul Railroad are some curious "spar caves" as they are appropriately called. In these caverns are some occurrences of satin spar that are very unusual and of much interest. It is

*Geology Wisconsin, vol. I, 1862.

†Geology Wisconsin, vol. IV, 1873-1879.

doubtful whether there is another locality where such peculiar forms of calcite are found, two varieties being associated together in the stalactites. The latter have also undergone a change in structure since first formed. The caves were discovered by Mr. Baule, of Dubuque, while prospecting for lead. They are openings in the crevices of the Galena limestone like those in which the lead and zinc ores occur. Large and productive crevices have been worked less than a half mile to the north, and the spar-bearing fissures also carry lead at a lower horizon. Followed west out on to the high prairie land back from the river these crevices are marked by sink holes, and on a winter day the moisture is seen rising from them. The magnesian limestone of the region is cut by innumerable large and small fissures that at certain horizons form extensive openings that can be followed for thousands of feet, and form a labyrinth of underground passages. All the latter are formed by approximately east and west, north and south, and "quartering" crevices. The openings vary in size from those so small that one can scarcely force his way through, to others having a width of ten or twelve feet and height of five feet. Some are over forty feet in height.

These caverns are either empty or filled entirely or in part by clay. The deposits of lime carbonate occur only in certain portions of these openings where the moisture is most abundant. At these points the top and bottom are decorated with stalactites, stalagmites, and a wonderful variety of beautiful and fantastic forms. The passages are in places closed up by thick deposits requiring blasting to remove them. Strong currents of air pass through these caves and are doubtless instrumental in producing the curious formations.

In these underground passages two varieties of calcite occur.

1. Satin spar, formed of radiating fibers with silky luster. Colorless and white varieties both occur.

2. Argentine (Schieferspath). This variety has a pearly luster and is composed of more or less undulating lamellæ. Color, white. It agrees with the descriptions given by Dana and Tschermake for Argentine, and is to all appearances that variety of calcite. The latter author mentions it as occurring in Bohemia, Saxony and Cornwall.

Satin spar occurs in several different forms: (1) Includes those which are pearly white, on the surface of fracture and have a silky luster due to the radiating fibers that form a velvety surface of great beauty. This variety occurs in bunches or clusters of twisted and gnarled stem-like forms. (2) Includes those stalactites proper which are formed of radiating fibers. These have in cross section a subvitreous luster, but on the surface they are (a) either covered with a fine white powder (which under the microscope is seen to be composed of irregular grains or minute crystalline bodies), and have no luster, or (b) the outer surface is formed of little rhombohedrons and has a silky luster. These stalactites are white or colorless, opaque or translucent.

There are still other stalactites differing from any of the above that have a concentric, banded structure. These are of unusual interest. Beginning at the center they have (1) a crystalline or granular core, often showing bright rhombohedral cleavage faces; (2) a thin band of clay apparently wanting in some cases; (3) peary white lamellar calcite (Argentine); (4) band of clay; (5) fibrous calcite and (6) outer surface composed of little rhombohedrons. There are several points in the structure of these stalactites deserving special notice. They have not, as yet, been studied microscopically, as is hoped may be done later, but the following facts regarding them are reasonably well established. There is every indication that the crystalline core was once fibrous, but this structure has mostly disappeared, especially in the larger stalactites and the rhombohedral cleavage has replaced it. In the smaller forms the transition from the radiating fibrous condition to the crystalline aggregate of rhombohedrons can be traced; the long acicular crystals become less distinct, but traces of them can still be seen after the rhombohedral form makes its appearance. Recrystallization has taken place and the particles have rearranged themselves to conform with the interior structure of the rhombohedrons; in other words, they are identical with the crystal form of the latter in all but external outline, and this has been prevented from developing, showing itself only on cleavage faces. A strong indication that this granular core was once fibrous is the fact that this is the common structure found in all these caves. The small forms all show the fibers, but as they increase in size alteration has taken place.

Another point of interest about these stalactites is the band of pearly, lamellar calcites occurring between the granular, crystalline core and the fibrous external layer. These white, undulating lamellæ form concentric rings in marked contrast to the radiating fibers associated with them. Occurring on both sides of the Argentine there is in most cases, if not in all, a thin band of clay. It is this that has doubtless stopped deposition for a time and the different variety was formed on account of the changed conditions.

The rhombohedrons forming the outer surface, while the interior is still formed of the radiating fibers, also deserve more than passing notice. They occur on the larger stalactites, not on the delicate branch-like forms. The outer surface of the latter owes its silky lustre to the innumerable fibers composing the surface. These frequently form delicate, cotton-like masses covering the outside of the satin spar. But on the majority of the stalactites occur the crystal aggregate of rhombohedrons. These may have have been deposited after the radiated interior was formed, but they seem to be due, rather, to the alteration or recrystallization of the fibrous mass, as in the case of the granular core. The conditions under which the fibers were formed have changed and there has been a corresponding alteration in the crystalline condition of the calcite.

If not the most interesting to the mineralogist, the white satin spar occurring in the large branch-like clusters is at least notable on account of its great beauty and rarity. It is difficult to give any idea of the rare and delicate appearance of these masses as they hang suspended from the roof of the caverns. At a distance they resemble white branching coral as much as anything. But near at hand the twisted and gnarled stems with their beautiful silky luster bear no resemblance to coral. The peculiar shapes assumed by these forms, differing so much from the ordinary stalactites, are no doubt due to the air currents moving through these passages. The wind coming now from one direction, now from another, causes the drops holding the lime in solution to be blown to one side and another of the slowly growing stem, the drop being held by the surface tension. The water does not trickle down undisturbed, as when forming the long straight stalactites depositing an even layer on the end and sides, but the carbonate is deposited for a time on one side of the branch and then, later, on another side. These clusters are extremely delicate and are removed with difficulty from the rock to which they are attached.

In these caves are found many large and fine stalactites and stalagmites. Some are short and stumpy, others long and slender. In one small opening three by three feet the deposition of calc spar had gone on to such an extent that there was a deposit several feet thick on the floor, while hanging from above were numerous stalactites. These were arranged mostly in two rows along the sides of the cavern and touching the bottom or joining the stalagmites below they formed columns. The passage-way thus made resembles a miniature colonade.

OCCURRENCE IN IOWA OF FOSSILIFEROUS CONCRETIONS SIMILAR TO THOSE OF MAZON CREEK.

BY ARTHUR C. SPENCER.]

The wide celebrity of the fern-bearing concretions from the Carboniferous beds of Mazon creek, Illinois, attaches more than passing interest to the occurrence of similiar structures in the Coal Measures of Iowa.

These concretions are found in a small ravine near the Des Moines river, north of Dunreath, in Marion county. Careful search for similar concretions in the gullies of the neighboring streams has not been successful, from which it seems that the strata, which are cut by the streams in question, lie above their general level on a slight anticline. The other alternative is that the concretions are limited to a very small area, but from the relations of the overlying beds the first explanation seems to be correct.

The plant remains are found in nodules or concretions, scattered through beds of drab shale. These, when broken open, often display very perfect forms. Plant remains are not, however, present in all the concretions. Others are like small septarial masses and are filled with zinc blende.

The nodule-bearing shale is from three to perhaps ten feet in thickness, and of a light drab color. It rests upon an irregular layer of large septarial masses which, exposed in the dry bed of the stream, resemble roche-moutenees on a small scale. Above are shales in part bituminous and in part areaceous. Four inches of compact gray limestone, bearing fern impressions follows, above which is more sandy shale and a thin seam of coal which has been mined near by. The coal is about fifteen feet above the concretionary bed.

Many of the concretions have been washed out and are found already opened, but the best specimens are those recently exposed, which afford very perfect leaflets of several ferns. Among the forms identified were: *Neuropteris hirsuta*, *Neuropteris augustifolia* and *Annularia longifolia*. Others will undoubtedly be found when more material is examined.

EVIDENCES OF DISTURBANCE DURING THE DEPOSITION OF THE BURLINGTON LIMESTONES.

BY F. M. FULTZ.

In a general way the lithological characters of the Burlington limestones, including both the lower and upper divisions, are the same. It is true that some layers are more compact than others, some more massive and a few are even crystalline enough in texture to imperfectly resemble marble, yet they all owe their origin to the same source. The material comprising them is almost wholly crinoidal. To such an extent is this true, that, with the exception of a very few layers, it is scarcely possible to find a cubic inch of rock that does not show its crinoidal origin. There are a few layers of shales, clays, etc., but for the most part they are quite thin and form but a very small part of the whole. However, they are deserving of some attention and I shall take occasion to refer to at least one or two of them specifically.

What I will endeavor to point out in this paper is, that during the deposition of these limestones, there were some periods of disturbance. The evidences of such disturbance are: (1.) The more or less abrupt changes in fossil forms. (2.) Change in lithological characters. (3.) Erosion and unconformability. I wish to speak more particularly about erosion, but will first say a few things about the change in fossil forms.

I have already mentioned that the prevailing life was crinoidal. Not counting synonyms there are probably between 350 and 400 species of crinoids found in the Burlington limestones. The greatest number occurring in any one layer is not more than one-fourth of the whole; usually much less than that. Besides, many of these species do not lap over each other and there are several breaks where not a single species bridges over the change from one stratum to the next higher, without some difference in form. So universal a change in fossil forms would indicate a sudden change in climatic conditions, and since in each succeeding stratum there seems to be no diminution, either in number of species or individuals — the genera remaining nearly the same and the species closely allied to former existing ones — there must have been a comparatively early return to the former conditions. Of course, while all life may have been extinguished at one point, no doubt it flourished in full vigor at no very great distance away, and as soon as the conditions again became favorable it once more occupied its old ground. If the period of interruption was short, or the area of disaster not too widely spread, the new forms of life would not differ much from the old. But if the area of disaster was extensive or the period of interruption prolonged, then the result would show the extinction of species and the beginning of new ones. As a rule species do not gradually die out, *they are killed off*. At least this is the apparent fact if the study of life is confined to a single locality. Of course to try to make the rule general would be to deny the theory of evolution. Since life is largely dependent upon climatic conditions, it follows that a sudden change in these conditions means a sudden change of life. So that, if in passing from one stratum to another, we find a considerable change in fossil forms, we must accept it as evidence of change of conditions under which the depositions took place.

Now, as I have already stated, we find such comparatively marked changes of fossil forms at several places in the Burlington limestones. Knowing such to be the case I have been on the lookout for further evidences of changes in the way of erosion, unconformability, etc.

It has generally been accepted that the deposition of the whole lower Carboniferous group in southeastern Iowa was uninterrupted. I quote from White, Geol. of Iowa, 1870. Vol. 1, page 202, "The accumulation of the strata which compose all the formations of the sub-Carboniferous group in southeastern Iowa, from the lower Burlington limestone to the Saint Louis limestone, inclusive, was evidently uninterrupted." And this seems to have been the generally accepted idea. White admits the change of fossil forms, but limits the changes to siliceous beds only, and advances the theory that life died out owing to the waters becoming charged with siliceous material. He makes no statement of the fact that some of the most distinct lines of change are at intervals between the lower and upper flint beds, and also below the lower one. It is most likely, too, that the flint beds mark *gradual* rather than *sudden* eras of change. However, of this I will say more later.

White gives 50 feet as the thickness of each division of the Burlington limestone, making 100 feet for the two. Now, at Burlington, the typical locality, the two together measure scarcely more than 50 feet. Of course there are deposits at other places in southeastern Iowa belonging to the Burlington series which are not represented at Burlington itself. And no doubt the complete section of the two divisions together would reach 100 feet. Now, while there was a cessation of deposit and corresponding absence of life in one locality, the rock building was steadily going on at other points not far distant. So that while 50 feet may be the maximum thickness at any one locality, the total thickness of the complete series might easily be 100 feet.

The lower division of the Burlington limestones gives a more continuous section than the upper. As to fossil forms there are some pretty distinct lines of change, but so far I have been unable to find any evidence of a corresponding era of disturbance. There is no positive evidence that there was a cessation of deposition The surfaces of some of the strata have a water-worn appearance, but no erosion has so far been discovered. It would not surprise me, however, to hear of such evidence having been found. The lower half of the lower division is well-bedded and seems to have been laid down in comparative quiet waters. The upper half is poorly bedded and contains many flint bands and irregular pockets of coarse sandy clay. It shows much disintegration.

As to the origin of these flint bands there has been a great deal of speculation, but so far no very satisfactory theory has been advanced. An examination of the beds will show that life did not suddenly cease with the advent of siliceous material. Frequently layers are found which are literally covered with fossils. My attention was first called to this fact by Mr. Chas. R. Keyes about two years ago while examining the Burlington limestone at Louisiana, Mo. I have since found it to be true at Burlington and other places. The fossils are always fully solicified, although perfect in form and detail. Also they are usually very small, not exceeding one-fourth the size of individuals of the same species found in the associated limestone layers. So White's statement that the conditions seemed to have been unfavorable for the support of life, is true, at least in part. But I think the flint beds contain much more evidence of life than he has given them credit for. There is no doubt, however, that the flint beds of both the upper and lower divisions mark eras of change in fossil forms. It would be strange if they did not, considering that the minimum thickness of either is fully ten feet. But they do not furnish the most distinct lines of change inasmuch as some of those in the limestone takes place in passing from one stratum to the one directly superimposed.

In the upper division I have found direct evidence of disturbance and erosion at one of these lines of change in fossil forms. Everywhere in the vicinity of Burlington, where the upper division is found, there occurs, well down toward the base, a stratum of heavy bedded white limestone. It is about six feet in thickness and generally underlying it there is either a thin layer of blue clay or friable, yellow, sandy limerock. Immediately overlying it there is uniformly found a bed of tough blue shale. I had frequently noticed the upper surface of the limestone layer as exhibiting a water-worn appearance and so was not surprised when I found direct evidence of erosion. This discovery was made in the Cascade quarry in the south part of the city limits of Burlington. In this quarry nearly the whole depth of the Upper Burlington limestone is worked. The massive white layer spoken of is here between 5 and 6 feet in thickness and furnishes a goodly part of the rock taken out.

The Cascade ravine is about half a mile in length and enters the Mississippi river at right angles. These quarries are situated about a quarter of a mile back from the river and on both sides of the ravine. It was in the one on the south side that the discovery was made. This quarry is on both sides of a short, but deep, lateral ravine, the bottom of which is several feet lower than the stratum of white limestone. In working off the corner between the main and lateral ravines, the white limestone layer was found to be much eroded. The erosion is lateral rather than surface and occurs on the side toward the lateral ravine. The layer of blue shale is deposited directly upon the eroded surface and conforms to all the inequalities, some of which are quite abrupt. One bench of the eroded surface amounts to fully two feet and yet the blue shale covers this without a break. The blue shale itself is capped by well-bedded limestone.

This is direct evidence of erosion in the early part of the deposition of the upper Burlington limestone. An interesting fact is developed that the present drainage system was probably fixed at that early date. The position of the eroded surface of the white limestone layer, and the inclination of the directly superimposed beds all indicate that the lateral ravine had its beginning at a time at least as early as that. Of course the principal ravine must have existed to furnish an outlet. Along the banks of the principal ravine I have never seen the white limestone layer exposed, but have no doubt it would exhibit the same erosion as found along the lateral ravine. All the superimposed strata exhibit a decided inclination towards the ravine, which would tend to confirm the theory.

In conclusion, I would state that there seems to be no doubt whatever that the deposition of the Burlington limestones was not continuous. I expect to see other evidence of this fact discovered in the near future.

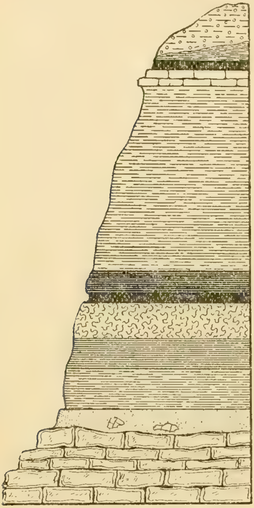
COAL MEASURES OF POWESHIEK COUNTY.

BY ARTHUR J. JONES.

Nearly all of Poweshiek county is covered by loess and drift to such a depth that little is known concerning the underlying stratified formations. Almost the only natural exposures of rock in the county are in the southwestern part where there are frequent outcroppings of Saint Louis limestone and Coal Measure strata; for the remainder of the county the only data obtainable are from wells sunk in various places. From these it appears that the northern, middle and eastern portions of the county are underlaid immediately below the drift with Lower Carboniferous strata. The Saint Louis limestone was found at Grinnell a little over 200 feet from the surface, while a little farther east the drift is still thicker with no indication of shale or coal. Coal has been found in paying quantities a few miles west of the county line in Jasper county at the Black Oak mine, and also a short distance from the south county line at the Evans mine. A direct line drawn from one of these mines to the other would cut across a considerable part of the southwestern corner of Poweshiek county. At Thornburg also, not far from the southeast boundary, coal mines are being operated. But although coal has been found on both sides so near, few workable veins have yet been found within the county limits.

At Searsboro two drill holes were sunk during the past summer and small quantities of coal were found not over ninety feet from the surface. Almost directly south of this place near Moore there are numerous traces of coal. Here the Saint Louis limestone appears for several miles along the north Skunk river. In the hills south of the river where they have been undisturbed, the Coal Measures are seen to lie unconformably upon the limestone. In a number of places in these hills prospect holes have been sunk but only a small amount of coal has ever been taken out. A short distance southeast of Moore, on the south side of the river, there is a fine exposure of limestone and shale. Here there is a bluff which shows over forty feet of Coal Measure strata with the Saint Louis limestone appearing at the base. At this place there are seen two seams of coal, the lower eighteen inches thick and the upper twelve. They are separated by twenty feet of shale and a thin layer of impure limestone which is only a few inches below the upper vein. Here a drift was at one time operated, and in a ravine near by considerable quantities of coal were taken out and sold to local trade.

The section at the old Petit mine is as follows:



Section near Old Petit Mine.

		Feet.	Inches.
12.	Drift	5	
11.	Shale, argillaceous		6
10.	Coal		10
9.	Limestone, impure	1	6
8.	Shale, light colored above, getting darker below	18	
7.	Shale, dark, bituminous, somewhat fissile	2	
6.	Coal	1	
5.	Fire clay	3	4
4.	Shale, variegated	3	
3.	Shale, light colored, calcareous	4	
2.	Sandstone, brown and yellow, with limestone nodules	2	
1.	Limestone, compact, brittle (Saint Louis exposed)	7	

But both mines have been abandoned for fifteen years, the larger coal seams near New Sharon receiving all the attention.

Farther eastward on Buck creek shale outcrops in numerous places, and a small vein of coal is also found. Drill holes put down in the neighborhood disclose several small coal seams, but none sufficiently thick for profitable working.

There have been various reports of coal both west and south of Montezuma, and it is probable that the Coal Measures occur here also, although probably quite thin.

In the southeast part of the county, near Deep River, three feet of coal have been found at a depth of 157 feet, overlain by seven feet of shale.

It is, then, highly probable that the Coal Measures extend over the entire southern tier of townships, including the towns of Searsboro, Montezuma and Deep River.

Systematic borings may yet reveal coal in paying quantities within the limits of this county.

CARDIOCARPUS IN IOWA.

BY ARTHUR J. JONES.

While engaged in geological work in Guthrie county a number of peculiar seed-like structures were collected from a seam of bituminous coal. They occurred in the newly opened mine of Mr. Scott, three miles northwest of Fanslers.

These seeds are not more than half an inch long and are quite thin. They are acuminate and vary from oval to broadly heart-shaped. At the base is a scar evidently indicating the juncture of the stem. No connection, however, was seen between the seed and the stalk of any plant in the coal. They are covered with a thin coating of pyrite and they all occurred in an eighteen-inch vein of coal.

Similar seeds are described by Lesquereux and Newberry as belonging to the genus Cardiocarpus and found in the coal measures of Pennsylvania, Ohio and neighboring states. The structures observed are evidently merely nuclei, although scarcely a trace of an encircling rim can be seen on any of them. The specimens collected are similar to the nuclei of Cardiocarpus bicuspidatus and C. zonulatus.

It is now generally conceded that the seeds called by the generic name Cardiocarpus are merely the mature fruit of certain species of Cordaites. The Cordaiteæ form a distinct order of gymnospermous plants very closely allied to the Cycads on the one hand and to the conifers on the other. They, however, bear a strong resemblance to the Lycopods and for some time were classed under this head. The living plant which most nearly resembles Cordaites is Cycas revoluta. Newberry says that the fruit Cardiocarpus was probably somewhat drupaceous when living, the nucleus being entirely concealed, but compressed by the great weight of the overlying strata it has become flattened; the fleshy pericarp is now the thin membraneous rim, and the nucleus appears at the center, not so much crushed on account of its more solid structure, but somewhat flattened.

This fruit and other remains of Cordaites have been found in Ohio, Pennsylvania, Tennessee, Indiana, and various other states, but they have not been reported from Iowa.

NORTH AMERICAN CYCADS.

BY THOMAS H. M'BRIDE.

As is well known the Cycadaceæ constitutes a small section of the gymnospermous plants. They are therefore, related on the one hand to the *Gnetaceæ* or joint-firs, and on the other to the *Coniferæ*, the conifers, our familar pines, cedars, firs and yews. The Cycads are, however, both in habit and structure quite unlike in many ways, all other existent plants. Nevertheless the fruit is borne in cones as in the *Coniferæ*, and their stems, such stems as they have, are full of a gummy, resinous (?) sap, and the general structure of the wood, the disposition of the medullary rays also resembles these features in some of the coarser grained larches. On the other hand some of the Cycads, notably the species of the genus *Cycas*, resemble in some respects the ferns, their leaves unrolling from the stem's top are circinate in vernation. To Saporta Cycads have the appearance of small, low palms, the trunk is so short and massive, supporting its crown of far-spreading leaves. Again the roots of most Cycads are poorly developed and resemble those of the *Monocotyledones*. Accordingly it may be said in a general way that Cycads are plants having leaves like the ferns, cones like the conifers, stems like the palms, and roots like lilies or grasses.

In days gone by these curious plants have been variously classified, accordingly as an author in his description laid stress upon this or that feature of the confused make-up. It must be said also in this general description that while most Cycads are as has been said simple low stumps a foot or two high, there are species, notably the Moluccan, that have tall and branching trunks forty to fifty feet in height.

The nature and habits of Cycads are fairly illustrated by *Cycas revoluta*, a not uncommon species in our greenhouses, and by our native American species *Zamia integrifolia*, of which more is to be said presently.

Miquel, a Dutch botanist as it appears studied the cycadaceous plants and published his work as long ago as 1842. Sir Joseph Hooker's descriptions in Genera Plantarum are drawn largely from Miquel's work. An abstract from Hooker (Gen. Pl.) is here presented for the better understanding of our subject.

"Flowers diœcious strobilaceous, Perianth always wanting. In staminate flowers the strobiles subterminal toward the apex of the trunk or caudex, generally solitary, oblong, ovoid or cylindric, very rarely subglobose; scales thick, coriaceous, alternately multiseriate, imbricate or vertically superposed and valvately united bearing on the dorsal side the polliniferous locules; these are arranged without order, three or four in a place, sometimes stalked but generally sessile opening by a slit and showing ellipsoidal pollen. The pistillate strobiles in *Cycas* have flat pectinate elongate scales bearing two or more ovules on the margin; in other genera the scales are shorter, more or less peltate, and bear one ovule on each side of the narrowed base. The ovule is orthotropous and sessile; the seeds large, ovoid or oblong and usually fleshy and red outside but with a tough inner coat; the endosperm is thick, rather abundant; the cotyledons grown together, unless at the base; the plumule squamose emerging through a cleft in the cotyledons.''

"Cycads are perennial plants abounding in gum, growing at the apex only, and as if corticated by the persistent bases of leaves and prophylla; the vascular system made up of rings of bast and wood, surrounding a well developed medulla or pith, which is rich in starch. Demarcation of annual rings does not appear and sometimes there are woody strands in the pith; the roots are fibrous and make up coralliform masses which are often partly above ground and sometimes by buds reproduce the plant."

Of existing Cycads there have been recognized some seventy species, of which the greater number occur in the tropics around the world. Some, however, are found in the temperate regions of South Africa and many in Australia and the adjacent islands. In Florida there is one species, as has been said, and one has been reported from Japan.

Our species *Zamia integrifolia* "Coontie" is a remarkable plant, having for stem a sort of subterranean bulb which has, however, a scarred cortex, a woody, cylinder and an abundant pith; large coriacious pinnately divided leaves which appear one after the other in a sort of a whorl, thus including leaves of different size, and for fruit shows cones of two kinds, staminate and pistillate, much alike although the latter is larger. Each cone is made of scales which are thickened, finally peltate, outwardly and bear at base the pollen-sacs or ovules as the case may be. The cones are not quite apical and they appear to spring from the axils of the leaves although this is not yet clearly made out and leaves and foliar organs are strangely mixed. In Cycas the cone is apical and subsequent growth starts up at one side of the cone's pedicel.

All this has been said of living or existing Cycads in order to make clear what may be said in reference to our North American fossil species. Saporta has pointed out very clearly that the ancient European Cycads (for there were once such plants in Europe although none there now) of which we have the trunks, do not differ from our modern forms much more than these now widely separated species differ from each other. "Fossil species are as a rule," he says, "far smaller than existing forms." A curious fact which leads to many surmises. For it must be said that the group under discussion as at present defined is but a remnant of a flora that from the Trias, probably, on down and through the Cretaceous shared with loftier plants all the forest regions of the earth, as these forests shifted through the ages from shore to shore, from zone to zone. Here in North America where now but a single species exists, persists, these remarkable organisms spread at one time from the Dakotas to Greenland, probably covering all that was then United States from Colorado to Maryland. As long ago as 1874 Lesquereux described from a single leaf fragment a species of Cycad which he named *Podozamites haydenii* from the Dakota sandstones of Nebraska. A few years earlier Heer in his *Flora Artica* described fossils representing at least four genera of Cycadaceous plants from the Atane Schists of Greenland. It speaks volumes for the wonderful botanical instinct of these men, that their conclusions, founded upon the study of mere leaf impressions and these often fragmentary were nevertheless accurate. These conclusions have since been wonderfully confirmed by the discovery of undeniable Cycad fossils in the regions and from the very formations and strata from which some of the leaf fragments came. While the ordinary botanist finds sometimes on a single tree leaf differences enough for his confusion, these pioneers in Paleophytology have from the dim venation preserved in sand laid a sure foundation for our knowledge of the flora of the ancient world.

In 1878 Lesquereux described, from what he supposed tertiary beds, (since regarded as belonging to the Laramie group) a single species[1], and in 1883 he added six more from the Dakota sandstones; all as heretofore represented by foliar remains except the Laramie specimen, which is described from supposed fossil fruit. In the meantime, however, rather, far before, in 1859, so long ago, the state geologist and chemist of Maryland, Dr. Tyson, had found two Cycad trunks near Coontie station, on the line of the Baltimore & Ohio railway. Dr. Tyson seems not to have appreciated his find. He seems to have referred to the matter in his correspondence, and Rogers, of Pennsylvania, Uhler and others, have published references to the Maryland Cycads, but for some reason the fossils, strangely enough were never described, never found place in our American geological literature. They lay in the museum of the Baltimore Academy of Science where still they lie, and so neglected were forgotten. We may be sure Lesquereux knew nothing of them, nor Hall, and not until Fontaine in 1889 — thirty years after Tyson first saw the specimens — began the study of the Potomac beds for the United States Geological Survey, did these notable old fossils receive merited recognition and description. In volume XV, Monographs of the United States Geological Survey, Fontaine figures the Maryland Cycads for the first time, and so for science gives them at last "a local habitation and a name."

Fontaine unable, as he thought, to refer the specimens to any established genus, erected for the Maryland fossil a new genus which, in honor of Dr. Tyson, he called *Tysonia*, and has thus described it:

"Trunks varying considerably in shape and size, petrified with silica, more or less flattened; seen with the broader sides in front they are oblongate and truncate; in cross-section they are broadly sub-elliptical; medulla proportionately small; woody cylinder comparatively thick; cortical exterior layer with the permanent basis of the petioles very thick; basis of the petioles in cross-section normal sub-rhombic, or sub-triangular with the lower angle very obtuse; the outer angles acute and prolonged, the superior side forming a curved line bent upwards or forming an obtuse angle, but often from pressure distorted into irregular rhombic or triangular forms; trunks each with a large eccentric terminal leaf-bud, or growing bud; some of the trunks, probably of female plants, have numerous lateral buds; others, probably male plants, are without lateral buds, basis of petioles represented by open casts," etc.

Mr. Fontaine regards the Maryland forms as constituting a single species—*T. marylandica.* His new genus, he says, is intermediate between two genera established by Carruthers, viz.: *Mantellia* and *Bennettites.* Carruthers, on being shown a photograph of one of Dr. Tyson's specimens, said: It is obviously a *Bennettites*, and near *B. saxbyanus.* It is further to be remarked that Mr. Tyson's specimens are all badly weathered and worn, if we may judge from Tyson's figures. Still the macroscopic characters seem in the main plain enough, but the microscopic characters have never been looked into, at least never published.

In 1891, in the posthumous volume of Mr. Lesquereux's work,* seven additional species are added to the North American list, as before, all represented by leaf impressions.

Such was the state of affairs in reference to our North American Cycads down

[1] United States Geol. Survey of the Territories. Vol. VII.

*Monograph U. S. Geol. Survey, Vol. XVII.

to July of the present year (1893). That is to say, our North American Cycads were represented up to that time by one living species, about a score of fossil species from the Dakota group of the west, known to Lesquereux by more or less fragmentary leaf-casts, such species as Herr, of Lausanne, had described by leaf-fragments from Greenland, and Tyson's two trunks, silicified, but withal poorly preserved, kept in the museum at Baltimore.

In July of the present year the writer, being in Hot Springs, South Dakota, came across a handsome fossil offered for sale. The fossil proved to be a magnificently preserved, silicified Cycad. Some days later, on a bare hill, about thirty additional specimens were found in a more or less perfect state of preservation. Time has not as yet permitted a microscopic examination of the Dakota specimens, but all macroscopic characters are decidedly those given in Dr. Carruthers' definition of his genus. Our form is referred to a new species; for, while very much like *B. gibsonianus*, of Carruthers, it yet differs in the distribution of the leaves, as well as in the distribution of fibro-vascular elements of the leaf-petioles themselves.

That the Maryland specimens are also members of the genus seems, as already stated, most probable. It will be remembered that Mr. Fontaine, in his description calls attention to the flower buds bursting through the cortex, and to the elliptical section of the fossil. Mr. Fontaine claims two sorts of buds on the Maryland specimen but offers no microscopic sections in proof of the claim, besides his specimens it would seem are too far weathered to allow the exact determination of such points. These specimens cannot represent the genus *Mantellia* for in this genus the stems are globular. In fact, the Maryland and Dakota forms are very closely related—are probably species of the same genus and that genus is, in the writer's opinion, neither *Tysonia* nor *Mantellia*. Microscopic characters indicate two distinct species, but microscopic details as yet are lacking for definite and conclusive comparison. It is hoped later to offer the Academy the microscopic characters of the Dakota species.

For further details, descriptions and figures the reader is referred to the *American Geologist* for October, 1893, and to the *Bulletin of the Laboratories of Natural History*, volume II, No. 4, State University of Iowa.

RHUS TYPHINA Linn.

BY T. H. M'BRIDE.

(*Abstract*)

Rhus typhina is a northern plant, ranging from New Brunswick to Minnesota. It comes into Iowa in the northern counties only, being found in Allamakee and Clayton counties, but, so far as reported, nowhere else. The plant along the bluffs of the Mississippi river rises to a height of some thirty feet and has a stem at base six inches in diameter. It is a beautiful shrub or tree, differing, at sight, by its velvety branches and long-pointed leaflets, from the ordinary sumac (*Rhus glabra* L.) and well worthy a place in our dooryards to say nothing of a wider and better acquaintance. Where it prevails it seems to exclude the other species. I have never found *R. typhina* and *R. glabra* on the same hillside. That the plant should extend down the Mississippi river on the bluffs to McGregor and Lansing or thereabouts and not go farther south along the same stream is an interesting fact in connection with the problems of plant distribution.

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BACTERIA, THEIR RELATION TO MODERN MEDICINE, THE ARTS AND INDUSTRIES.

BY L. H. PAMMEL.

It has been customary for the president, in making his retiring address, to choose some popular subject and discuss it on broad lines. In some cases my predecessors have given a resume of the scientific literature in our own State, and I need not say that we all feel proud of the work accomplished by this small band of workers. I shall venture, in this address, to discuss the subject of Bacteria along general lines and hope I may be able to correct some popular misapprehensions concerning the subject.

The word Bacteria has almost become synonymous in the minds of some with certain diseases in lower animals and man, but this popular construction is so erroneous, that I propose in this address to show the extent and importance of the question of bacteriology to many important problems.

We shall treat this question in the following way: History, methods of study, structure, question of species, hygienic problems, Bacteria and their relation to economic problems in agriculture and other industries.

We are told in an admirable treatise by Loeffler[2] on the historical development of bacteria that the presbyter, Kircher more than 235 years ago observed that air, water, soil, cheese and putrefactive substances contained countless numbers of "worms" as he designated them. Having observed these living organisms he at once concluded that the Italian plague of 1656 could be traced to these "worms;" but, the most remarkable of the early workers was Antony von Leeuwenhoek a mechanic of Delft, Holland, who had learned the art of making lenses while an apprentice in a linen factory. With his simple lenses and excellent powers of observation he was enabled to observe Bacteria of putrid material, tartar of teeth, etc. Some of the forms were figured and described. He says[2]: "Mit grosser Bewunderung sah ich, dass uberall in den genannten Material viele sehr winzige Thierchen enthalten waren, welche sich auf die ergoetzlichste Weise bewegten." From his figures and descriptions one cannot doubt but that he was dealing with bacteria. We cannot here give in detail the conclusions reached by Vallisneri, Goiffon, Nicholas Andry and Varro, but they concluded that these organisms caused disease. The celebrated Linnaeus[3] could not dispel from his mind that certain living organisms caused disease. The learned Viennese physician, Marcus Antonius Plenciz, discussed in a clear and logical way the cause of contagious diseases. He

[1]Vorlesungen ueber die geschichtliche entwickelung der Lehre von den Bacterien fur Aerzte und Studirende, Erster Theil bis zum Jahre 1878, 37 figures and 3 plates pp 252, Leipzig, F. C. W. Vogel, 1887.

[2]Loeffler l. c. p. 5.

[3]Loeffler l. c. p. 8.

argued that a period of incubation must occur for each disease, and as wheat seed only produces wheat, so too the particular seminia of a disease only produces that disease. He too argued that decomposition is brought about when sown with material, that this material propagates and grows.

In 1820 Ozanam wrote a learned dissertation on epidemic and epizootic diseases, in which he says it is not neceesary to show that the theories of Plenciz and others, are purely hypothetical and erroneous. Notwithstanding that Ozanam doubted the correctness of the view of Plenciz on the contagious nature of diseases, others continued to carefully study the organisms of water, etc. Russworm designated them by their form, and, although he carefully studied them, this subject advanced but little. A host of scientists studied these so-called animals because it afforded great amusement. Little, however, was added till the celebrated Danish investigator, Otto Friederich Mueller, of Copenhagen, in 1776, made an exhaustive study of these so called Infusoria. He recognized the great difficulty in the study of these organisms, for he says "the certain and clear distinction of these requires so much time and sharp discrimination with the eyes, as well as excellent judgment and so much evenness of mind and patience that scarcely anything else equals it." He described ten species of the genus Monas and thirty-one of the genus Vibrio. He used such characters as motion, biological characteristics, Morphology and habitat. These germs were accurately figured so that it has been possible to recognize some of the species. But we must rapidly pass in review the work of Paula Schrank, who divided these vibriones into those with motion and motionless. Bory de St. Vincent placed these low forms in the family Vibrionides, deriving some of his characters from Auguillula. He recognized five genera.

SPONTANEOUS GENERATION.

The theory of spontaneous generation long held sway in the popular mind. During the middle of the eighteenth century the defenders of this theory promulgated their doctrines and for a long time the field was held undisputed. In this cause were enlisted such men as Needham, who observed the development of living organisms from grains of wheat and barley.

Although this material had been boiled and heated for a time and the vessel closed, still they developed. The arguments seemed impregnable and Buffon, and Wrisberg, Treviranus and others during the early decades of this animated discussion championed the cause of abiogenesis with a great deal of emphasis. During the fifties and sixties and in the seventies and even down in the eighties abiogenesis has had its defenders in such men as Pouchet, Joly, Musset, Wyman, Mantegazza, Huizinga, Bastian, and Wigand[4]. It is strange that the clear and logical thinker Wigand should, as late as 1884, assert that bacteria can arise independently without pre-existing forms from an organic substance *e. g.* spontaneously.

This, it seems to me, shows a lack of the proper methods of experimentation. Wigand had scarcely reached the stage of experimental work, where it was left by Spallanzani in 1769, who, as some one has said, was the most celebrated experimenter of that century. We may also mention Bonnet who was in thorough accord with this celebrated exper.menter. With Spallanzani began the system of sterilization and making of tests to set aside spontaneous generation. It led Appert to utilize heat in the preservation of organic substances and has opened the way for glorious modern achievements.

Later investigators held that Spallanzani's experiments were not above criticism,

[4] Entstehung und Fermentwirkung der Bakterien vorlaufige Mittheilung. Zweite Auflage, N. G. Elwertssche Verlagsbuchhadulung. 1884. pp. 40 Seep. 5.

but they were fortified and strengthened by Schwann, who demonstrated that fermentation could not occur unless germs were present. The presence of these organisms was not denied. Braconnet (1831), Berzelius (1827) and Liebig, that brilliant, but conservative chemist, strongly held that these ferments simply accompanied the process of fermentation. Some held that the action of these ferments was entirely catalytic. Schwann, however, showed that various substances heated sufficiently under ordinary conditions will decompose, but if the air before having had access is heated, putrifaction did not occur. Schroeder and von Dusch were able to show that these precautions are not necessary, since a cotton plug will completely filter out all germs, and owing to this, which now seems a small matter, bacteriology has accomplished wonders in modern medicine and the arts. Hoffmann, Chevreul and Pasteur demonstrated that cotton is not essential for holding out germs. This can be done by simply drawing a tube out and bending it. As the germs simply follow the law of gravity they cannot enter.

In rapid succession the work of Pasteur, Klebs, Lister, Rindfleisch, Burden-Sanderson set at rest the theories of spontaneous generation. They are no longer advocated. All existing bacteria arise from pre-existing forms; so much is settled.

Bacteria are, no doubt, subject to the same general laws as to the origin of species as other living beings are; their growth and reproduction is determined in a measure by surrounding conditions. Bacteria are, no doubt, modified by climate and environment as are other living plants, but as yet we know little about this.

We may now ask, what are bacteria? Undoubtedly, plants amongthe lowest in the vegetable kingdom. In form, method of growth, and reproduction, they strongly resemble *Schizophyceæ*. Chlorophyll is absent. A few of the species described by Engelmann[5] and Van Tiegham[6] like *Bacillus chlorinum* and *B. virens* have Chlorophyll, and hence assimilate, but it may be doubted whether these forms are bacteria. They are, no doubt, closely related, and are important links in the chain of evidence showing the relation of bacteria to some of the algæ. With these exceptions they are fungi which do not form true hyphæ. nor do they make a true apical growth or branch; pseudobranching occurs in forms like Cladothrix. In shape bacteria are round, elliptical, rod-like comma, and spiral, sometimes growing in threads, and now and then certain aberrant forms. A peculiar group is found in Dr. Thaxter's[7] Myxobacteriaceae, which resemble Myxomycetes. "These consist of motile, rod-like organisms, multiplying by fission, secreting a gelatinous base and forming pseudoplasmodium-like aggregations before passing into a highly developed cyst-producing resting state, in which the rods may become encysted in groups without modification or may be converted into spore masses." Bacteria reproduce by division, the cell divides and two new individuals are formed. Many species form spores; these are usually of the endogenous character; a few form arthrospores, as in *Leuconostoc* and *Cladothrix*. In this genus we have the curious anomoly that *C. intricata*, Russell, branches like *Cladothrix* and forms endospores like *Bacillus*[8].

The cells are all provided with a cell-wall which appears to be made up of cellulose. Many of the species have motion, and this is in all cases probably due to

5 Bot. Zeitung, 1882, p. 321.

6 See Fluegge Mikroorganisms, p. 289; DeBary Bacteria, p. 4.

7 On the Myxobacteriaceæ, a new order of Schizomycetes, Contributions from the Cryptogamic Laboratory of Harvard University, XVIII. Bot. Gazette, vol. XVII., pp. 389, 406, with plates XXII.-XXV.

8 Zeitschrift fur Hygiene Vol. XI., 1891, p. 192.

cilia which may be numerous, coming from the periphery, as in Typhoid fever Bacillus, or several from the end, or a single one at one end of the extremities. Motion has recently been observed in a *Micrococus*. In some cases the cell-wall is extensible, some species are provided with a gelatinous envelope, the thickness and composition varies in different species. In some this sheath is a carbohydrate nearly like cellulose or in some putrefactive species, it is an albuminoid known as mycoprotein. In some cases these sheaths contain iron, other colors are sometimes found in the sheath, blue, yellow, red, etc., but it may be questioned whether these colors in all cases really belong to the sheath, although they do in some cases.

The contents consist of protoplasm which in some cases appears to be nearly homogeneous, but in a number it contains albuminoid bodies. In *Beggiatoa roseo persicina* it is colored according to Lankester[8a]. In *Clostridium butyricun* small refrigent granules occur that color blue on the application of iodine, in that respect they are similar to the granulose of starch. *Beggiatoa alba* and others contain highly refrigent granules of sulphur which are readily made out. Nucleus occurs as Buetschli[9] and others have shown. These authors believe that the nucleus is large. Minot[10] says, "This important discovery in conjunction with the extraordinary power of proliferation in bacteria confirms our generalization that a small proportion of protoplasm is essential to rapid growth." Koch, however, holds that the nucleus is not distinctly separated from the remainder of the protoplasmic mass.

Bacteria are among the smallest of plants, they vary in size from 0.0001 millimeter (Iu) or less, to 0.004 (*Bacillus crassus*) in width, length varies greatly. Bacteria are ubiqutous occurring in soil, air, water, ice, snow, dust, animals' plants. They are especially common in filthy and putrid substances; their use in such places is so important that we shall discuss this at greater length in the proper place.

SYSTEMATIC POSITION.

It will be seen from what has previously been said that the earliest investigators variously arranged bacteria. It seemed certain to them, that they were animals, for had they not motion? The learned Ehrenberg in 1838 ascribed to some, complicated digestive organs, owing to the way in which coloring matter was taken up. He recognized the division Monadina and Vibrionia.

We may now mention another systematist who still adhered to the animal nature theory: Felix Dujardin in his "Historre naturelle des Zoophytes," 1841, admirably figured the species in some cases, and it is worthy of note that this man observed that these "Infusoria" brought about certain chemical changes. He found that oxalate of ammonia which had been added to his culture material entirely disappeared when the germs had been growing in it for a time.

Perty, in 1852, indicated that some of these so-called animals were plants. Two years later Cohn published an admirable paper on the microscopic algae and plants in which he clearly indicated that the organisms in question were plants and not animals. Nægeli had previously recognized that some of the colorless forms found on algae were fungi, they did not assimilate like algae. In 1857 he brought all these forms together and called them Schizomycetes, a term generally adopted by bacteriologists at the present time.

8a Quart. Jour. Mic. Science, Vol. XIII, 1873, Vol. XVI.

9 Ueber den Bau der Bacterien, 1890.

10 Proc. American Association Adv. of Science, Indianopolis meeting, 1890, p. 284.

We may now briefly discuss the later classifications of bacteriologists. These begin with Davaine in 1868, who placed them in the following genera. *Bacterium, Vibrio, Bacteridium* and *Spirillum*. Hoffmann (1869) also adopted form as a leading character. He lays stress upon the fact that motility is not a good character, that this character may be absent or present depending somewhat on the conditions of the medium and temperature. As he was not dealing with pure cultures his observations in this respect are of little value. Ferdinand Cohn[11], of Breslau, who devoted himself largely to a study of bacteria since 1853 formulated and adopted an excellent system of classification which was largely followed, till better methods of culture were in vogue. Cohn's work made a profound impression on the chaotic condition of the science at that time. Cohn was too able an investigator to rely exclusively on the morophology of these organisms, for he states that germs cannot be separated morphologically, since they will show different chemical and physiological characters. He was not able to use many of these characters, since culture methods were very crude at that time. How far his predictions have held is only too well known to workers in this field at the present time. He made three groups—Chromogenic, Zymogenic !and Pathogenic, characters which certainly find use in our present systems of classifications. Cohn believed that species of bacteria could be established just as well in this group of plants as in more highly developed organisms. The views of Cohn were not left unchallenged, for in 1874 Billroth published his researches on *Coccobacteria septica*, an organism which he obtained from milk serum. He argued that in different media the same species varies greatly; he says "es gibt bis jetzt Keinerlei morophologische Kennzeichen irgend einer Micrococcus-oder Bacterien form, aus welcher man schliessen konnte, das-sie sich nur bei dieser oder bei jener Krankheit in oder am lebenden Korper entwickeln konnte." Lister, who has achieved such renown because of the introduction of antiseptic treatment of wounds, believed that morphological characters used by systematists from Ehrenberg's to Cohn's time were not to be relied upon, because he thought species changed in different media. Thus he held that his *Bacterium lactis* when grown in decoction of beets, urine and other media presented quite different morphological characters. In some media it had motion, in some it had not. He overlooked the fact that this single drop of milk contained many organisms. The accomplished bacteriologist, Buchner, at a much later day, thought *Bacillus subtilis*, a harmless species, could be converted under different conditions into *Bacillus anthracis*, a virulent pathogenic germ. Dealing with such small objects and methods of culture in vogue at that time caused a mixture of the two species. Is it to be wondered at that mistakes should have been made and wrong conclusions drawn?

We may conveniently now refer to the work of Hallier, a German botanist, who became greatly impressed with the work of DeBary and Tulasne on the polymorphism of higher fungi. Why should not this polymorphism occur in these small organisms? Luders had indeed advanced the theory that they were connected with higher fungi. Hallier constructed a culture apparatus in which his isolated germs were grown. Moulds of all kinds appeared, and the same common moulds appeared in widely different cultures. He concluded that the medium is the most important element in showing this polymorphism. He states that it is nonsencical to describe separate species of yeasts and bacteria with long names. His study of Asiatic cholera, diphtheria, glanders and other contagious diseases convinced him that they had their origin in a Micrococcus

[11]Untersuchung ueber Bacterien, Beitraege zur Biologie der Prflanzan, Vol. I., 1877, p. 127.

which was derived from higher fungi or algae. Many physicians and scientists were inclined to accept these wild doctrines. Was not the evidence good? Had he not the microscopical and culture demonstrations? Opposing these theories were two eminent botanists, DeBary and Hoffmann, the latter a strong believer in polymorphism, both were able investigators, the former one of the most brilliant botanists of our time. They held that species of bacteria could not be changed into higher fungi.

DeBary maintained that the first canon had not been observed, namely, watching the development of these forms. Hoffmann went so far as to state that polymorphism does not occur in bacteria. But we cannot close this part of the subject without referring to the work of Nægeli, an eminent German botanist and author of a celebrated work on "Die Niederen Pilze," who maintained that species of *Schizomycetes* cannot be defined by morphological characters.

DETERMINATION OF SPECIES.

For several years the writer has been studying the flora of butter, cheese, milk and cream. Many species have been found, and of these but few could be located, largely due to the inperfect descriptions; the chromogenes were much easier because more attention has been given to them and their color affords good characters. Saccardo[11] in his Sylloge Fungorum, gives descriptions of a large number of species. This work of De Toni is, of course, largely a compilation, the descriptions are largely abbreviated so that it is a hopeless task to properly or even approach the species. The tables of Eisenberg[12] are much more satisfactory, though even these are sometimes wanting in fullness. Nevertheless Eisenberg's tables are samples of what should be done in this line of study. The works of Flugge[13], Sims, Woodhead[14], Crookshank[15], will enable one to locate some of the more common species. Of special importance in this connection I may mention the paper by Edwin O. Jordan[15a] on the Bacteria of Sewage. The descriptions of the species found there are especially full. The paper by Welz[16] on the bacteriological examination of air, contains excellent descriptions of several species. A paper by Dr. H. L. Russell[17], on the bacteria occurring in the water of the Bay of Naples, is certainly a model in its way.

The imperfect descriptions of pathogenic organisms are not so numerous because of the importance of the subject from a hygienic standpoint. In some cases these contain many valuable notes on the biology of the organisms, as Kruse and Pansini[18] on the Diplococcus of Pneumonia and related Streptococci. The excellent papers of Dr. Theobald Smith[19] that are replete with biological and

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11 Sylloge Fungorum, vol. VIII, pp. 923-1087.

12 Bakteriologische Diagnostik Hilfstabellen zum praktischen Arbeiten, second edition, pp. 159. Leopold Voss, 1888.

13 Die Mikroorganismen, mit besonderer Beruecksichtigung der Aetiologie der Infections Krankheiten, pp. 692, with 144 figures. Second edition, Vogel, Leipzig, 1886.

14 Bacteria and their products, pp. 459, with 20 photo-micrographs, London, Walter Scott, 1892.

15 Manual of Bacteriology.

15a A report on certain species of bacteria observed in Sewage. Mass. State Board of Health, 1890, Pt. II, p. 821.

16 Bacteriologische Untersuchungen der Luft in Freiburg und die Umgebung. Zeitschrift fur Hygieine und Infectionskrankheiten. Vol. XI, p. 121.

17 Unterschungen ueber im Golf von Neapel lebende Bacterien. Zeitschrift fur Hygiene und Infectionskrankheiten. Vol. XI, pp. 165-206, plates XII-XIII and three figures.

18 Unterschungen ueber den Diplococcus pneumoniae and verwandte Streptokokken. Zeitschrift fur Hygiene und Infectionskrankheiten. vol XI, p. 227.

19 Hog Cholera Report, 1889. Swine Plague Report, 1891, U. S. Dept. of Agrl., etc.

physiological observations. Dr. Sternberg[20] has also recorded a very large number of observations on the bacteria found in connection with yellow fever.

One of the most important works of its kind ever issued is Sternberg's[21] Manual of Bacteriology. This should be in the hands of every bacteriologist. The descriptions are so thorough that little more need be desired. Most of the species are easily identified by the diagnostic found at the end of the volume, while the descriptions are very thorough and complete.

CHARACTERS IN BACTERIA.

It is convenient here to discuss what characters should be used in the description of bacteria.

Those who have given any attention to the classification of *Schizomycetes* are aware that the work of purely systematic botanists like Winter[22], and Burrill's[23] translation of the same; Trevisan[24], DeToni, Cohn cannot be used or offer, in sufcient data, since morphological characters to separate species are not reliable. Many species are of the same size and shape. The species, however, seem to be quite constant in their morphological characters as shape and size do not appear to vary much within a species. Cohn[25] largely used shape and color in the determination of species, but this was largely pioneer work and many of the species defined by him cannot be recognized, and this is worse as we go back in the history of this science. Zopf[26] has been an earnest advocate of pleomorphism of species, and his classification rests on this doctrine. But pleomorphism is not so general as was at first supposed by Zopf. It is true that some species produce resting spores that resemble cocci as in Anthrax and other bacilli, but they never vegetate as such. But pleomorphism does exist in certain forms as in the group to which *Cladothrix*, *Beggiatoa*, and *Crenothrix* belong. These are truly pleomorphic, at least if we are to trust the work of those who have given the subject attention. In some forms, culture experiments have shown that a certain amount of pleomorphism does exist as in *Cladothrix intricata*, Russell. But in many cases the facts of pleomorphism have not been brought forth by culture experiments as was at first supposed. Fraenkel[27] makes the statement that these organisms (*Cladothrix*, *Beggiatoa*) do not belong to bacteria, although they may be closely allied to them. "We may therefore maintain that, thus far at least a many formed species of bacteria has not been observed, and the rule one can distinguish by the growth and from clearly recognizable genera and species of bacteria, which do not run into each other."

Morphologically then, the different species are distinct, quite constant, although many species are similar. Our main reliance must be on physiological characters. And this is used nowhere else in the vegetable kingdom. Physiological characters are sometimes used in the classification of animals, as in the *Hexacorallinna*. The *Madroporiæ* secrete stony skeletons while the *Actinariæ* do not. In other

20Report on Etiology and Prevention of Yellow Fever, U. S. Marine Hospital Service. Washington, Government Printing office, 1890. See p. 181.

21A Manual of Bacteriology, pp. 886. Illustrated by heliotype and chromo lithographic plates and two hundred and sixty-eight engravings. New York, Wm. Wood & Co., 1892.

22 Die Pilze.

23 The Bacteria, an account of their nature and effects, together with systematic description of the species. Eleventh report Board of Trustees, Illinois State University, pp. 92-157.

24 Genera e. Spec. delle Batteriaceæ, 1889.

25 Beitraege zur Biologie der Pflanzen, Vol. II, p. 130.

26 Die Spaltpilze, pp. 101 with 34 figures, Breslau, E. Trewendt, 1884.

27 Text book of Bacteriology, English translation.

respects they are essentially alike. Prof. Osborn further calls my attention to the fact that in gall insects the character of the gall produced by the insect is of great importance in separating species.

I may be permitted in this connection to briefly quote from several prominent writers on this question. Trealease[28] summarized the characters as follows: 1. Morphological characters, mode of growth in which cultures show full range of variability of each species, behavior of cells to staining fluids, motion of the cells. 2. Physiological characters, production of pigment, specific fermentation and liquefaction of gelatin are apparently reliable. 3. Pathogenic characters for the most part are unreliable to render species which depend at all upon them above suspicion, though they may offer valuable collateral evidence. Any physiological characters therefore to be useful in the delimitation of species of bacteria, must be reasonably constant as well as pronounced. The fact is with our present means of cultivating bacteria, strictly parasitic, like the *Spirochæta* of relapsing fever; that it grows with great difficulty in artificial cultures, like the Micrococcus of gonorrhoea, that it dies after a short time when cultivated, unless re-innoculated like the swine plague bacillus of the Germans and our Department of Agriculture all the pecularities have at least a suggestive value." Fraenkel[29] writes: "Were the microscopical examination of the bacteria as they occur in their natural state, the only means at our disposal for studying them, our knowledge of bacteriology would never get beyond the experimental stage of certain very narrow limits." H. Marshall Ward[30] in an admirable article says that before new species are described the following points should be clearly made out: 1st. Habitat, air, soil, milk, etc. 2d. Nutrient medium agar, gelatin, potatoes, broth, saccharine liquids, etc. 3d. Gaseous environment, aerobic, anaerobic, whether carbon dioxide, nitrogen or hydrogen affect the growth. 4th. Temperature-optimum is the most important though maximum and minimum should also be recorded. 5th. Morphology and life-history, shape, size, mode of union, presence of sheaths and capsules, spores, endospores and arthrospores, cilia, involution forms, etc. 6th. Special behavior. Does the germ peptonize and liquefy gelatin? 7th. What is the shape and course of the area? What is the shape of the colony? 8th. Pathogenic properties. But before we can do a great deal in this line some general code should be adopted.

From these observations it will be seen that it is not an easy matter to recognize species; partial descriptions must be entirely ignored. I will admit with H. Marshall Ward that some general standard should be set up. But it would seem to me that we should soon begin to do something more on the biological characters of many species. Many of these points in our species are still in a somewhat uncertain state. They have, in fact, not been determined.

Much bacteriological work can be done with little equipment, but the systematic portion of this work can not be done without the literature at hand. To work out our bacteriological flora is needed, but it may be a long time before this work is accomplished. What is needed is a thorough scrutinizing of species to determine how many of these are synonyms. Marshall Ward[31] has attempted this for a good many of the species occurring in water, and he has what appears to me, placed together some species which are distinct. Marshall Ward is however, a most careful investigator, who discriminates with great care. This part of the work can

[28] The Weekly Medical Review, Vol. XIX, March 23, 1889, p. 315. St. Louis

[29] Text Book of Bacteriology.

[30] On the Characters, or Marks, employed for classifying the Schizomycetes, Annals of Botany, Vol. VI, No. XXI, April, 1892, pp. 103-144.

[31] Philosophical Transactions, 1892 or 1893.

not be done by a novice. I am greatly inclined to believe that many species have been described, as was true in many cases, of early systematic efforts with higher plants, without looking up the literature or carefully comparing specimens. It is out of the question in smaller institutions where library facilities are so meager that they should have access to much of the literature, and this is especially true where many of the species are described in out of the way journals. It seems to me that it would be expedient to describe species only in well recognized journals devoted to this line of work like Zeitschrift fur Hygiene, Centralblatt fur Bakteriologie und Parasitenkunde. The Botanical Gazette, Bulletin of the Torrey Botanical Club, or possibly the American Monthly Microscopical Journal might undertake to do this line of work on this side of the Atlantic.

BACTERIA AND THEIR RELATION TO THE DISEASES IN MAN AND LOWER ANIMALS.

The subject of Bacteriology has become so important in modern medicine that no physician can claim recognition as an authority in zymotic diseases unless he treats it from the standpoint of the modern advancement in this the newest of sciences. The author who ignores the facts of bacteriology can no longer find place as an authority in the library of a physician. Facts are being established however, so rapidly that even the best of works soon become obsolete.

Dr. Baumgarten says[33]: "In a study of diseases, the aetiology must not be considered by itself, when in this case we are dealing with organic beings——, bacteria and animal life, which bear certain relations to each other, the success in treatment cannot be controlled by a single factor."

Patrick Geddes[34], in that most charming of books, Chapters in Modern Botany, says: "Most important, however, is the fact expressed in the germ theory that bacteria are constantly and intimately associated with some of the most fatal of human diseases, such as consumption, diphtheria, small pox, or typhoid, malaria or leprosy. Bacteria, in fact, will kill most of us."

DeBary[35] says: "It is not necessary to enlarge upon the manifold interest attached to these organisms at a time when the statement urged daily on the educated public does not fall short of saying, that a large part of all health and disease in the world is dependent on bacteria."

So long as the old ways of looking at the nature of contagious diseases was in vogue, little could be expected, since it was before the advent of the cotton air filter by Schrœder and Von Dusch (1854) methods of sterilization, used by Schwann and others of his time, and perfected by Pasteur, Koch and modern workers, the use of analine dyes to stain bacteria, the introduction of culture media by Cohn, Pasteur, Brefeld, Schroeter, and the plate method of separating germs first used by Koch; these landmarks have, in a large measure, helped to give us a clear understanding and knowledge of the contagious nature of diseases.

We have seen that several authors believed that diseases like anthrax and cholera were supposed to be carried by specific organisms. In some cases, as in anthrax, Davaine had observed, in 1850, that the blood of anthrax animals contained stiff rods of the anthrax bacillus. Pollender observed the same rods in 1849. In 1863 and 1864 Davaine presented to the French academy the results of his innoculation experi-

[33]Lehrbuch der Pathologischen Mykologie Vorlesungen fur Aerzte und Studirende. pp. 973, with 108 figures, Harald Bruhn. Braunuschweig 1890, see p. VII.

[34]Chapters in Modern Botany, New York, Chas. Scribner's Sons, 1893, pp. 201, with 8 figures.

[35]Lectures on Bacteria, second improved edition, English translation by Henry E. F. Garnsey, revised by Isaac Bayley Balfour, pp. 193 with 20 figures. Clarendon Press, Oxford, 1887.

ments with the blood of diseased animals. It was also shown as early as 1865 that sputum taken from tubercular patients would produce tuberculosis. As yet, however, the evidence was not conclusive. In 1877 Koch published the results of his work on this disease, in which he showed conclusively that this special bacillus, which he had isolated from diseased animals and cultivated outside of the animal body, produced typical anthrax; that in the animal only the vegetative condition occurred, but when the animal dies these rods break up into spores; that infection in cattle and sheep commonly results from the taking up of spores while grazing in an infected pasture. The organism thus lives a dual life, one in the animal and one in the field.

In ordinary cultures, spores are readily formed and these retain their vitality for a long time. The writer has found that these when kept in silk threads retain their vitality for at least six years. We mention this disease in particular because it shows what rules must be followed in bacteriological research. The classic canons of Koch must ever be observed, and these are, first, constant presence of the germ with the disease; second, isolation and cultivation of the germ; third, successful innoculation experiments with the germ isolated, and followed by the same disease; fourth, this germ must be the same as in the original diseased animals. Dr. Russell[36] well says that these canons are just as applicable to phytopathology as in animal diseases. For my own part, I am sorry to say that so many bacterial diseases of plants have been described in which these canons have not been observed. But to follow through in detail the various stages of the history of this part of bacteriology, however interesting it is, would make this paper entirely too long. We shall therefore touch only upon the more important points.

Let us briefly consider the pyogenic organisms and their relation to septic infection. The lengthy disputes between different investigators on the subject of septic infection and the causal relation to the same and definite micro-organisms had a most excellent champion in Weigert,[37] who, in an able paper, set aside the generally accepted theories, that septic infection resulted from poisonous products of ordinary saprophytic germs, or that certain changes occurred in the body before the germs could develop. It was the old story of Justus von Liebig,[38] who strongly argued that germs and fungi follow a diseased condition. Weigert especially emphasized the importance of recognizing bacteria in different diseases. He should receive much credit for having done a great deal towards perfecting methods of staining bacteria.

The pyogenic microbes have been a rich field for investigators. For is not this subject of great importance to the physician? Almost daily he meets with the germs in question. They are concerned in such diseases as septicæmia, pyæmia and erysipelas. Then, too, these cocci are found in diphtheria. The forms of septicæmia occurring in lower animals are numerous, as Koch[39] first showed. A form of *Micrococcus* commonly placed in the genus *Streptococcus* is widely distributed in nature, and also produce septicæmia in lower animals. Dr. V. A. Moore has

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[36]Bacteria in their relation to vegetable tissues. Dissertation presented to the Board of University studies for the degree of Doctor of Philosophy, Johns Hopkins University. Freidenwald Company, Baltimore, 1892; pp. 41.

[37]Ueber pockenaehnliche Gebilde in parenchymatosen Organen und deren Beziehung zu Bacteriencolnien, Breslau, 1875. See Loeffer Die Geschichtliche Entw, etc, p. 203.

[38]Chemistry, in its application to Agriculture and Physiology, edited by Lyon Playfair, Philadelphia. T. B. Peterson, Part Second, pp. 87, 119.

[39]Wundinfectionskrankheiten, Leipzig, 1878. Mith. d. kais- Ges. Amts Vol. I.

isolated twenty-eight species of this genus. Five of them are pathogenic to common mice.[40] Many of these Streptococci are not, however, pyogenic.

Ever since Ogston, Rosenbach and Passet demonstrated the presence of *Staphylococci* and *Streptococci* in pus, it has been universally held that they had some causal relation to the formation of pus. But, it is also a well established fact that pus may be formed without germs as was first demonstrated by Grawitz and later by Scheurlen and others. The aseptic introduction of turpentine, nitrate of silver, and sterilized pus cultures under the skin will give rise to pus. That certain other pathogenic bacilli and some saprophytic bacteria when sterilized can cause the formation of pus seems also to be reasonably well demonstrated. So universally are these pyogenic micro-organisms distributed that unless the greatest precautions are taken, they gain entrance to the wound and, the surgeon finds his patient not recovering as rapidly as he should. These pus organisms have a low thermal death point. The *Streptococcus pyogenes*[41], 52–57.4° C.

Staphylococcus pyogenes var. *aureus*[42] according to Sternberg is killed at 56° C., but Mr. Wade found in the writer's laboratory that it is somewhat higher, perhaps a different race[43]. This is a relatively low thermal death point since many species especially the anthrax bacillus produce resistent spores which stand 100° C. for several minutes. Some of the germs commonly found in the air like *Sarcina lutea* which do not form spores are only destroyed above 70° C. when heated for ten minutes.

There are few diseases which have awakened a deeper interest than tuberculosis in man and lower animals. The announcement of the discovery of the Bacillus was made by Koch[44] in 1882 and independently, about the same time, Baumgarten[45] discovered a specific Bacillus as the cause of tuberculosis. Villemin[46] as early as 1865 had shown that tuberculosis might be induced in healthy animals by innoculation of tuberculous material. These results were later confirmed by Cohnheim,[47] Salomonsen[48] and others. Baumgarten and Koch demonstrated the identity of tuberculosis in bovine animals and man. Later it was shown by Ernst and others[48] that milk from tuberculosis animals was infectious.

There was much hesitancy at first to accept the conclusions of Koch in regard to the infectious nature of tuberculosis, for the theory that tuberculosis was an

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[40]Veranus A. Moore in a paper on Miscellaneous Investigations concerning Infectious and Parasitic Diseases of Domesticated animals. Bulletin No. 3, Bureau of Animal Industry, U. S. Dept. of Agriculture, pp. 9-30, gives an interesting account of the biology of some of these Streptecocci and also refers to the work of Smith, Salmon, Rosenbach and others.

[41]Sternberg's Manual of Bacteriology, p, 274.

[42]l. c. p. 267.

[43]It is possible that in this species as in *Bacillus pyocyaneus* there are different races as has been shown by several investigators.

[44]Die Aetiologie der Tuberculose, Berlin Klinische Wochenschrift, 1882, No. 5.

[45]See Baumgarten Lehrbuch der Pathologischen Mykologie Vorlesungen fur Aerzte und Studirende, Harold Bruhn, Braunschweig, pp. 973 with 100 figures. See page 535.

[46]Etude sur la tuberculose, Paris, 1868.

[47]Uebertragberkeit der Tuberculose, Berlin, 1877.

[48]How far may a cow be tuberculous before her milk becomes dangerous as an article of food, Hatch. Experiment Station Mass. Agricultural College Bulletin No. 8, April, 1890. Bang. Proc. Inter-nat. Medical Congress, Copenhagen, Vol. I., Path. Sect. p. II. 1884. McFadeyean and Woodhead, see Woodhead, Bacteria and their Products, p. 224.

Smith & Schroeder, Bull. No. 3, Bureau of Animal Industry, U. S. Dept. of Agriculture.

A contribution to the question of the danger of infection with tuberculosis through ordinary milk. The Journal of Comp. Path. and Therap., Vol. VI, p. 97.

inherited disease, was too strongly intrenched in the minds of physicians and people generally. But Koch brought such conclusive evidence in his first paper that the contagious nature of the disease could not be doubted and is now almost universally accepted. Physicians to-day use the methods proposed by Koch, Ziehl, Ehrlich and others for determining the presence of tubercle bacilli in sputum, lupus and other forms of the disease. A subject that was widely commented upon a few years ago in the press of the whole civilized world was the discovery of a toxic product, *tuberculin* in cultures of tubercle bacillus. This product discovered by Koch is soluble in glycerine. It is a powerful therapeutical agent. In very minute doses, when injected subcutaneously into tuberculous animals, it produces febrile and other decided symptoms. Dr. Sternberg[50] says: "This discovery must rank as one of the first importance in scientific medicine whatever the final verdict may be as to its therapeutic value in tubercular diseases in man." Numerous experiments have been made to determine its value as an agent in diagnosis of tuberculosis in bovine animals. These investigations have not only been carried on in Europe, but in our own country Dr. Pearson[54] has shown how valuable it is in cases of this kind. I may also refer to the value of another product, *mallein*, which Dr. Theobold Smith[55] and others have used with great success in diagnosis of glanders.

These and other results which have been obtained along the lines of bacteriology have been of inestimable value to the world at large. We cannot overlook the great work of Pasteur in affording immunity to persons bitten by mad dogs. Hydrophobia, that strange malady which has baffled medical skill will, it is to be hoped, be held in check by the work of this savant.

Although the cause of this strange and fatal disease is still a mystery, the benefits resulting from a series of innoculations are beyond dispute.

SUSCEPTIBILITY AND IMMUNITY.

We can now discuss briefly susceptibility and immunity. No question in general medicine and biology is more interesting than those which relate to susceptibility and immunity from disease in plants and animals. Certain animals and plants are much more subject to some diseases than others. Tuberculosis is common to man, bovine animals, apes and small herbivorous animals. Anthrax is most common in cattle and sheep; it may be communicated to man, guinea pigs, rabbits and mice. Rats, dogs, and birds are generally exempt. Glanders is most common in equine animals, occasionally forms a loathsome disease in man, but mice, rabbits and cattle are generally exempt. But this difference of a disease is not confined to different species; it often occurs in different individuals of the same species. Thus hog cholera of the U. S. Department of Agriculture[56] nearly always takes away a majority of the animals, but a few will not take the disease.

A case has come under my observation in which various pathogenic germs were innoculated into a rabbit, but all without avail. Again common laboratory experience shows that very young animals are much more liable to resist diseases than

Weitere Mittheilungen ueber das Tuberkulin, Deutsche Med. Wochenschrift, 1891, No. 43.

50 Manual of Bacteriology, p. 387.

54 Bull. No. 21, Pennsylvania Agrl. Experiment Station. E. P. Niles, Tuberculosis and the Koch test, Virginia Agrl. Exp. Station, vol. II, N. S. No. 3.

55 W. B. Niles, Bull. No. 20, p. 729, Iowa Agrl. Exp. Station.

56 Hog Cholera: Its history, nature and treatment, as determined by the inquiries and investigations of the Bureau of Animal Industry, pp. 199, with 16 plates. Government Printing office, Washington, D. C. See p. 34.

older animals. The same thing holds true in the human race, and very properly the term "children's diseases" is used for a number which are common to children and not older people. In older people some diseases are rapidly fatal, while other persons are exempt. The negro race is much more subject to tuberculous troubles than the white race. Small-pox is much more severe in dark races than fair skinned. The negro and latin races of tropical climates are more exempt from yellow fever than northern people. It is said on good authority that where cholera is indigenous, that the percentage of death is smaller than where it is not.[57]

Dr. Sternberg says:[58] "The tendency of continuous or repeated exposures to the same pathogenic agent will evidently be to establish a race tolerance; and there is reason to believe that such has been the effect in the case of some of the more common infectious diseases of man, which have been noticed to prevail with special severity when first introduced among a virgin population, as in the islands of the Pacific, etc."

In bacterial diseases of plants the same thing has been noticed; every horticulturist is familiar with the fact that some varieties of apples are more subject to the attacks of blight (*Bacillus amylovorus*) than others. It is certain that this susceptibility must depend on certain conditions in the animal body or plant, either favorable or unfavorable for the development of the pathogenic organism. It may be that the temperature fluids, of the body, or the blood serum as Buchner[59], Hankin[60] and others claim have valuable germicidal properties. The products of certain glands like the thymal are said to afford immunity. Fokker[60a] has recently published results which show that fresh milk has germicidal properties. It may be that the tissues of plants or structure of parts of cells, or the fluids of the plant are different from those attacked. Immunity from subsequent attacks varies in different diseases, and the time also varies. The theories advanced for immunity are the exhaustive theory, which holds that the organism growing in the animal exhausts the supply of some substance essential for its growth. But this has been set aside by Sternberg[61] and others.

The retention theory, proposed by Chauveau: This investigator holds that certain products formed during the development of the germ in the body accumulate and are retained. The vital resistance theory of Sternberg[62] explains immunity upon an acquired tolerance to the toxic products of pathogenic bacteria. There is much evidence to support this theory. The theory of phagocytosis, first prominently advocated by Metchnikoff, and sometimes called the Metchnikoff theory, is based on the fact that bacteria in the blood are picked up by the leucocytes. That immunity depends upon the power possessed by these leucocytes in destroying bacteria. There is no longer any doubt that the leucocytes pick up and destroy microorganisms in animals, for since the germs found in these leucocytes are often corroded, and finally disappear entirely when health has been restored. Hankin[63] believes there is found in the body, as a result of disease, antitoxine, and these substances which are found in immune animals, he calls "defensive proteids;" these are clas-

57 Sims Woodhead, Bacteria and their Products, Chapters VIII and IX.

58 Manual of Bactierology, p. 227.

59 Centralblatt fur Bakt, und Parasitenkunde Vol. V, p. 817; Vol. VI, p. 1.

60 Proc. Royal Soc., London, 1890, May 22.

60a Fortschritt der Medicin Vol. VIII, p. 7.

61 Journal of Medical Sciences, April, 1881; Manual of Bacteriology, p. 238.

62 American Journal of Medical Sciences, April, 1881. Manual of Bacteriology, p. 240.

63 See Sternberg's Manual of Bacteriology, p. 260.

sified according to whether they occur in normal animals, *sozins;* second, those occurring in animals which have acquired an immunity, *phylaxins*. Sternberg,[64] than whom there is no higher authority in this country, says: "The experimental evidence detailed gives strong support te the view that acquired immunity depends upon the formation of antitoxine in the bodies of immune animals; as secondary factors, it is probable that tolerance to toxic products of pathogenic bacteria and phagocytosis have considerable importance, but it is evident that the principle role cannot be assigned to these agencies."

Sims Woodhead[65] thus summarizes immunity: "It appears probable that both the antagonistic action and this summative action are due to the bringing into play, or the depressing, of certain specific functions of the protoplasms of the cells by the products of different micro-organisms. It is not necessary that these functions should always be manifesting themselves; after being once evoked and exercised they may remain latent for a considerable period, and only be again called into action under the regular specific stimulus. It is a case of writing on the looking-glass with ink and with French chalk—the ink is always in evidence, and we might say that it corresponds to the enzyme, or the peptonizing functions exerted by certain cells, animal and vegetable, whilst the French chalk, though always there, is only brought out when the glass is breathed upon."

BACTERIA OF THE INTESTINAL TRACT.

In a previous paragraph I referred to studies made by Hallier and others on Asiatic cholera, and the pleomorphism of bacteria. This disease, which for centuries has carried away thousands of human lives every year, is certainly worthy of the deepest and most profound studies of physicians and bacteriologists. That the disease is contagious in its nature has long been recognized. The distinguished investigator, von Pettenkofer, long worked in vain for the specific cause. His work on the spread and distribution of the disease is a most important contribution to the literature of the subject, especially his researches on the relation of ground water and the "drying zone" to cholera epidemics. The splendid achievements of Robert Koch who was sent by the German government in 1883 to study cholera in Egypt and India made his name famous. On this mission he demonstrated a specific micro-organism which he called the "comma bacillus," but which belongs to the spiral forms and is known as *Spirillum choleræ asiaticæ*. This germ was found in the dejecta of patients suffering from this disease, in cesspools and water which received the dejecta, in milk, etc. It was not as easy to convince scientists and physicians that the germ found by Koch was the cause of Asiatic cholera, since Finkler and Pryor[66] found a germ in Cholera nostras which appeared to be identical, and Deneke[67] found apparently the same germ in old cheese.

Miller[68] found a comma bacillus in the human mouth; moreover, Klein, an eminent English authority, claimed that Koch's material was entirely harmless. Although the evidence of a specific germ is not so conclusive in this disease as in anthrax and tuberculosis, yet the accidental innoculation of a young physician in

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64 Manual of Bacteriology, p. 262.

65 Bacteria and Their Products, p. 379.

66 Untersuchungen uber cholera nostras. Deut. med. Wochenschr, 1884. No. 36. etc.

67 Ueber eine neue den Choleraspirillen ahnliche Spaltpilzart. Deut. med. Wochenschr, No. 3. 1885.

68 Kommaformiger Bacillus aus der Mundhole. Deut. Med. Woch, 1855. No. 5. Micro-organisms of the Human Mouth. Philadelphia, 1890.

Koch's laboratory in Berlin with this germ, who became sick and had the symptoms of genuine cholera, the experiments of Ferran, Koch, Gamaleia and others with guinea pigs, leave no doubt as to the causal connection of organism and Asiatic cholera. It is generally recognized now as the cause of this disease. There are many apparent anomalies as shown in the distribution of cholera and von Pettenkofer's "ground water theory," which are fully set forth in Dr. Shakespeare's[69] splendid monograph on cholera. If the contagious nature of the disease and the biological questions are taken into account, these conditions can be accounted for. The history and spread of this disease all show how important it is to take heed of sanitary conditions. It shows that the disease spreads most rapidly where effluvia and excreta contaminate the water; food, too, may be an important item. That old habit of using sewage water to sprinkle over vegetables, or the use of night soil for growing vegetables is an extremely dangerous thing.

WATER ANALYSIS.

This brings up the question of making bacteriological analysis of water and in this connection we may discuss typhoid fever. It is a well recognized fact that this disease is caused largely through the use of water and food that contains the active virus. The causal connection of the Koch Eberth bacillus and typhoid fever is generally conceded, but the proofs are not as certain as in some of the other contagious diseases, since bacteriologists have not been successful in producing typical typhoid fever in lower animals. This is not surprising since there are no animals that take this disease as man does. But it is pathogenic to mice and lower animals. A study of the typhoid fever bacillus is not an easy matter since there are several closely related species like *Bacillus coli-communis* which normally occur in the colon of man, other forms of this species occur in dysentery, cholera infantum, catarrhal enteritis, gastro-enteric catarrh, peritonitis and other diseases. Other germs of this general character are quite common in decaying substances, and some are pathogenic. The hog cholera germ, swine plague; the *Bacillus coli-communis* are well known for their pathogenic properties. Dr. Theobold Smith[69] has, however called attention to some important characters of the germs when grown in the fermentation tube, which enables us to separate *coli-communius* from nearly allied forms.

It has long been customary to regard a chemical analysis of water sufficient to determine whether water is good for drinking purposes or not. There seems however, to be a rapidly growing tendency to move along biological lines. I would not underrate chemical analysis, it should go hand in hand with this biological work. There are so many problems that the biologist cannot explain unless the chemist is at his elbow. Dr. Stevens says: "It is perhaps enough to say that a chemist is not of necessity a sanitarian, nor is his work the most important basis upon which a sound or safe conclusion is built as to the proper hygienic value of water for potable uses." Mr. Rafter[74] a well known sanitary engineer says: "Attention should be called moreover to the general proposition that the chemical methods are so refined in their nature that a slight error is liable to invalidate the results; whereas the microscopic analysis has the advantage of making the bulk of the organic contaminating material visible to the sense of sight." The chemist can determine that

[69]Report on cholera in Europe and India, pp. 945, with numerous charts and diagrams. Washington, Government Printing Office, 1890.

[69]Centralbatt fur Bakteriologie und Parasitenkunde, Vol. XII, p. 367.

[74]On the micro-organisms in Hemlock water. The quotation from Stevens is taken from this paper.

there is an organic impurity, the bacteriologist can tell what the impurity is. Bacteriologists have made many analyses of water and sewage. The methods used are still open for improvement. Water analysis is indeed a difficult problem.

Prof. Sedgwick,[75] in an exhaustive treatise on purification of water and sewage in report of the Massachusetts State Board of Health, says: "Although microscopical analyses (so-called) of water or sewage have often enough been undertaken the methods employed have hitherto been so imperfect that little importance has been attached either to the examinations themselves or to the results."

There are two ways in which water may be examined: First, microscopically; second, cultures. The former was the method chiefly in vogue before the use of the Koch system of cultivating germs. This method was employed by Cohn [76] and Radelkofer [77] in making examination in Breslau and Muenich. The bacterial examination of water requires cultures, and this is a very important part of the work. But I do not believe that culture examination is sufficient for this work. The Massachusetts State Board of Health employed Dr. Sedgwick, a well known authority in biological research, to make a biological study of sewage and drinking water. A new method was introduced as the combined work of Kean, Sedgwick and Rafter [78] which makes it a comparatively easy matter to determine approximately the microscopical organisms.

Jœrgensen[70] has well stated that the exclusive use of gelatine in this branch of biology may introduce sources of error. Hansen's work, as well as that of Jœrgensen, was more especially intended for zymotechnical purposes, and yet I believe it is equally applicable in hygiene. It may be well to start a series of cultures in small flasks that contain sterilized sewage or water with some organic matter. For a study of these germs the Hansen method may be used. I believe that good results may be obtained by using liquid media. Miquel's[71] work certainly shows good results. The use of the fermentation tube, as suggested by Dr. Theobald Smith,[72] is a most excellent device. Many of the bacteria found in faeces are gas generators and by use of the fermentation tube which contains bouillion and sugar, the kind and quantity of gas produced may be determined readily. Stoller[73] has recently used this apparatus extensively with some success in arriving at the quantity of faecal bacteria in water.

The most important methods in bacteriological examination of water are those of the Koch school. In this method a known quantity of water, a fraction of a cubic centimeter is put in gelatin or agar and the number of germs which develop are counted. Obviously the smaller the fraction the more danger there will be of making errors in giving the result of the number of germs per cubic centimeter.

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[75] A report of the Biological work of the Lawrence experiment station of Massachusetts State Board of Health, 1888-1890.

[76] Ueber den Brunnenfaden (*Chrenothrix polyspora*) mit Bemerkungen ueber die Mikroscopische Analyse des Brunnenwassers, Beitraege zur Biologie der Pflanzen I, p. 108 Breslau 1870.

[77] Mikroskopische Untersuchung der Organischen substanzen im Brunnenwasser, Zeitschrift fur Biologie I (1865), p. 26.

[78] Experimental investigations, Mass. State Board of Health, 1888, 1890, Pt. II, pp. 803. 811. Recent Progress in Biological Water Analysis, Journal of the New England Water Works Association, September 1889. The Biological Examination of Potable Water, Proceedings Rochester Academy of Sciences, 1890.

[70] L c, p 48.

[71] Annuaire del' Observatoire de Montsouris 1877-1890. Not seen in the original.

[72] Centrallblatt bur Bakteriologie und Parasitenkunde. Vol. VII, p. 302, and Vol XII, p. 367.

[73] Science, Vol. XXII, No. 564, p. 286.

Various bacteriological analyses made in Europe and the United States show that the bacterial contents differ greatly. Dr. Gruber[79] sets the maximum number of colonies to be found in spring water from 40 to 50, in well water 300 to 500 per c. c. Frænkel states that good drinking water should not have more than fifty germs per cubic centimeter. Many bacteriologists place the limit at 1,000 germs per c. c. It is stated that water taken from the Croton reservoir, New York, contained from 5,000 to 15,000 germs per c. c., and Messrs. McCall and Patton found in well water from a well near the Iowa Agricultural College, 320 germs per c. c. Spring college water supply only contained 56 germs per c. c. Water taken from the Muenich supply contained from 305 to 12,606 germs per c. c. Frænkel[80] estimated the number of germs in the water supply of Berlin at 6,140, while below the city there was a great increase, the number being 243,000 per c. c. The Kiel water supply, according to Breuning[80a], has from 62 to 1,712 germs per .5 c. c., the number of liquefying species varying from 4 to 188. Wells in the same city in some cases had more than 26,000.

Sewage, of course, contains an enormous number. Out of 126 analyses of Lawrence sewage, the number was 708,000 per c. c.; the minimum was 102,400; and maximum, 3,963,000. Fourteen analyses show more than 1,000,000 per c. c. It is not strange that sewage should contain such large numbers, since the putrefying material is especially favorable for their development. Nor is it strange that well water should often contain large numbers, since the upper strata of the soil teem with bacteria, and it is especially easy for water from the surface to find its way into the well. In bacteriological analysis of water it is not so important to determine the number as it is the quality of the germ. It is of special importance to take into account the pathogenic organisms, like the typhoid fever bacillus, and the spirillum of Asiatic cholera, in cases of epidemics of the latter disease. The liquefying species, such as peptonize gelatin, are more important than those which do not, since many of these give rise to very disagreeable odors, and perhaps poisonous products. What becomes of the germs found in sewage? It is certainly important to know whether they will continue to contaminate cities using the same water and lying farther down the stream.

Water may be purified in two ways: 1. Self-purification; 2. Purification by filtration. In this paper we are only concerned in the first. Destruction by various small animals, chemical action, sedimentation, and direct sunlight. The chemical action is perhaps due largely to oxidation; the mechanical effects of the small particles in the water must act to a considerable degree on the germs; the sediment carries with it much organic matter; this sediment, as experiments have shown, contain pathogenic germs. Perhaps the most powerful agent is sunlight. Buchner,[81] Marshall Ward, and others, have shown that exposure of typhoid bacillus, anthrax and other germs to direct sunlight destroys their pathogenic properties and inhibits their growth very materially. That there is a constant decrease in the number of germs at some distance below the point where sewage empties into the stream, numerous analyses have shown.

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[79]Schrank. Anleitung zur Ausfuehrung bacteriologischer Untersuchungen zum Gebrauche fur Aerzte, Thieraerzte, Nahturungsmittel—, Agricultur und Gaehrungs-chemiker, Apotheker und Bautechniker, pp. 255, with 137 figures. Leipzig und Vienna. Franz Denhicke, 1894.

[80]l. c. p. 820.

[80a]Bacteriologische Untersuchung des Trinkwassers derStadt Kiel im August und September, 1887. Inaugural Diss., pp. 38. Kiel, A. F. Jensen.

[81] Bot. Centralblatt Vol. LII., pp. 61, 398.

DISEASES OF PLANTS AND INSECTS.

In this lengthy sketch on pathogenic germs the relations to hygiene have been touched on sufficiently. I have not discussed many of the diseases, but with such a vast subject, it is impossible to do so. Before I proceed to discuss the uses of bacteria to agriculture, let me briefly refer to a few of the diseases they cause in plants. Scarcely a decade ago DeBary,[82] Hartig[83] and other phytopathologists believed that the acid reaction of higher plants was detrimental to the growth of bacteria in living tissues. Since then it has been shown that many bacteria find acid media an excellent medium; moreover European, but more especially American investigations have shown that quite a number of plant diseases are caused by these minute organisms. The pioneer work in fact in this direction was paved by Americans. Most European authors like Kramer[84] and other bacteriologists scarcely enumerate the work done by Americans.

The only writers who have fully comprehended the subject are Ludwig of Greiz,[85] and Comes[86], of Italy, yet more than a decade ago Professor Burrill[87] worked out the causal relation between pear blight and *Bacillus amylovorus*. This was soon followed by the work of Prof. Arthur[88] on the same disease, and finally some excellent work by Waite. Then followed the investigation of Burrill[89] on sorghum blight, the work of Kellerman and Swingle[90] on the same disease. Tuberculosis of the olive by Savastano[91], blight in oats by Prof. Galloway[92] and Wakker's[93] Yellows of Hyacinths has become quite familiar to phytopathologists of Europe.

It has been demonstrated that there are other plant diseases caused by micro-organisms. These have been tabulated in an interesting paper by Dr. Russell[94].

Not the least value may be expected from the part that micro-organisms play in causing diseases of insects. Flacherie of the silkworm (*Streptococcus bombycis*) long ago studied by Bechamp[95] and Pebrine (*Nosema bombycis*) discovered by Cornalia and carefully studied by Pasteur and Naegeli are the oldest among the known diseases caused by bacteria. Both are most troublesome enemies of silk culture. Pasteur rendered this industry most important aids in suggesting the separation of the moths in pairs in isolated numbered cells, and a microscopical examination of the mates after they had deposited their eggs. The eggs from diseased insects are not to be used for breeding purposes. Whether this organism is to be classed with Bacteria or is one of the *Sporozoa* is still undetermined. Metchnikoff classifies it with *Sporozoa*.

Foul brood of bees, a most troublesome disease in the apiary, is caused by *Bacillus*

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[82] Lectures on Bacteria, 1887.

[83] Lehrbuch der Baumkrankheiten.

[84] Die Bakteriologie in ihren Beziehungen zur Landwirtschaft und den Landw. Technischen Gewerben. Pt. I, pp. 171. Pt. II, pp. 178. Carl Gerold's Sohn Vienna. 1890-1892.

[85] Lehrbuch der niederen Kryptogamen, 1892.

[88] Annual Report New York State Agr. Experiment Station, 1884, p. 357.

[89] Eighth Ann. Meeting Soc. Prom. Agrl. Sci., p. 30.

[90] Annual Report Kansas Agr. Experiment Station, 1889.

[91] Ann. D. R. Scuola. Sup. d'Agri. in Portici, Vol. V, fasc. IV, 1887.

[92] Journal of Mycology, vol. VI. 1890.

[93] Bot. Centralblatt, Vol. XIV, 1883, p. 315.

[94] l. c. pp. 35-41.

[95] Bechamp.: Compt rend., Vol. LXIV.

Pasteur: Etudes sur les Maladies des vers a soie, Paris, 1870.

Balbiani, Lecons, sur les Sporozoairies, Paris, 1884.

alvei. The causal connection of this germ and "foul blood" was first established by Watson Cheyne.[96]

Many bacterial diseases of insects are beneficial, like "flacherie" of the cabbage butterfly (*Pieris rapae*) the bacterial disease of "chinch bugs" (*Streptococus insectorum*) carries large numbers of this troublesome pest away. In this country Prof. Forbes[97] was the first to study "flacherie" and other bacterial diseases of insects. That these spread rapidly was shown by Prof. Osborn[98] who introduced diseased worms of the cabbage butterfly from Illinois. Later, C. V. Riley.[99] and under him F. W. Mally,[100] carried on some experiments with contagious germs to determine whether the "boll worm" could be held in check. Prof. Snow[101] of the University of Kansas. has also carried on a long series of experiments with the "chinch bug" disease. From the results obtained by these investigators there is no doubt that if the germs are carried over successfully either by the insects, or cultivated in nutrient media, that they may be utilized with advantage. Of course the insects must be gregarious, so that the disease can be spread easily. It is too soon to make any general predictions concerning the application of this work in holding insects in check, but we may confidently expect that it will find application in applied entomology.

We may note in this connection that Loeffler has successfully spread a disease of field mice, *Bacillus typhi-murinum*, in Southern Russia, and in this way materially checked this plague.

BACTERIA OF SOIL.

Let us briefly turn our attention now to a consideration of the bacteria of soil and the decomposition of organic matter, the formation of nitrates and nitrites. It has well been said that while bacteria cause much misery in the world they are great benefactors. Without them there would hardly be any rot nor decay. Our beautiful landscapes could not exist. The earth, garnished with the bloom of flowers, the green herb, its magnificent forests, our cereals and food plants, would not have the material from which to build up their fabric, except for these tiny plants. The nitrogen so essential for all living plants is only made ready for the use of most green plants by these wonderful micro-organisms.

Nitrification formerly meant the production of niter, a natural product of certain soils and rocks, but modern chemists have given to the word a wider meaning. It concerns the formation of nitrates and nitrites.

The older theories are discussed in various works on agricultural chemistry[102].

The first suggestion that nitrification was caused by a ferment was made by Mueller[103], but the true nature of nitrification was worked out by the French

96 Frank R. Chesire and Watson Cheyne, Journal of the Royal Microscopical Soc. 1885, p. 11.

J. J. MacKenzie, The Foul Brood Bacillus, *B. alvei;* its vitality and development, 18th Annual Report Ontario Agricultural College and Exp. Farm, 1892, pp. 267-273.

97 Contagious diseases of insects, Ill. State Laboratory of Natural History. Bulletin

98 Iowa Horticultural Report, 1885, Insect Life, Vol. III, p. 143.

99 The Outlook for Applied Entomology, Insect Life, Vol. III., p. 197.

100 Report on Boll Worm of Cotton, Bull. No. 29, Division of Entomology U. S. Department of Agriculture, 1893.

101 Insect Life, Vol. III., p. 279.

102 Johnson, How crops grow, p. 391, New York, Orange Judd Co., 1888; Storer, Agriculture in its relation to chemistry, etc., etc.; Warrington, six lectures on the investigations at Rothansted Experimental Station, delivered under the provisions of the Lawes Agricultural Trust, before the Ass. Am. Agrl. College and Experiment Stations, Washington, Aug. 12-18, 1891; Experiment Station Bulletin No. 8, office of Experiment Stations U. S. Dept. of Agrl., Washington, Government Printing office.

103 Landw. Versuchs Stat. Vol. XVI, p. 233.

chemists, Schloesing and Muentz[104], who announced, in 1877, that they had established, by a series of experiments, that nitrates in the soil were formed by a micro-organism. They showed that 212 degrees Fahr. for one hour was sufficient to destroy the agent that caused nitrification. Further experiments made by these investigators show the importance of taking into consideration the temperature of the soil. In summer the temperature is more favorable for nitrification. The absence of strong light is a necessary condition for this same process. An alkaline condition of the medium is essential, but the amount, as Warrington says, is injurious if anything beyond a small proportion, and a large amount will prevent the action altogether.

The present theory of nitrification is that there are two stages, and each process is brought about by a distinct organism. At least this is true in the nitrification of ammonia, and the nitrification of nitrogenous matter falls under the same head. Warrington,[105] in an admirable paper, says: "By one organism the ammonia is converted into nitrites; by the other the nitrite is converted into nitrate. The existence of these two distinct agents, each of which has special conditions favorable or unfavorable to its development, explains at once the particular formation of nitrous or nitric acid, so frequently observed in laboratory experiments on nitrification." In the soil these two different organisms are abundant; the conditions for their growth being similar, they work together. The most interesting point in connection with these organisms is their growth in nutrient media. Isolation has been attended with much difficulty. The first attempt to grow them was made by Schloesing and Muentz; although they may have had the nitrifying agent, they worked with material that contained other germs. Koch's methods of growing bacteria in solid media, like agar and gelatin, wholly failed to accomplish the desired result. The first success in cultivating the nitrifying organism was made by D. P. F. Frankland[106] His cultures were started in an ammonical solution, and by the dilution method he finally succeeded in obtaining a single species.

Warrington[107] by the same method succeeded in isolating the organism in the same way. Winogradsky[108] also succeeded in isolating and growing the germ. So much for the isolation of the nitrous organism. The separation of the nitric organism has been attended with equal difficulty, but Winogradsky[109] by an ingenious method has succeeded in growing the nitric organism on gelatinous silica. A most interesting feature of these organisms, the nitrous and nitric, is that they grow in inorganic fluids. Warrington[110] says: "That an organism unprovided with chlorophyll and growing in darkness, should be able to construct organic matter out of ammoniacal carbonate is certainly of the highest interest." Connected with the subject of nitrification is that of denitrification. Numerous investigators have called attention to the breaking up of nitrates in sewage. In some cases as in *Bacterium denitrificans*[111] the nitrate is changed into nitrogen gas. But these nitrogen gas species are evidently not common. The species which reduces the nitrates are numerous as shown by various recent investigations.

[104] Compt. Rend. Vol. LXXXIV, p. 301.
[105] l. c., p. 63.
[106] Phil. Trans. Roy. Soc., 1890. B., p. 107.
[107] Transactions Chem. Soc. 1891, p. 502.
[108] Ann. d l' Institut Pasteur, 1890, p. 213.
[109] Compt. Rend., Vol. CXIII, 1891, p. 89.
[110] J. M. N. Munro, Trans. Chem. Soc., 1886, p. 651.
Warrington l. c. p. 49.
Winogradsky, Ann. d l' Institut Pasteur, 1890, p. 268.
[111] Gayon and Dupetit, Ann. de la Science Agronomique I (1885), p. 226.

Warrington found 37; Jordan[112] has also found several in the sewage of Boston water supply. Prof. G. E. Patrick made an examination for the writer of eight species; of these five were energetic reducers of nitrates to nitrites. This property was not confined to facultative anaerobes. *Sarcina lutea, Streptococcus cinnabareus* are both aerobic, and yet are energetic reducers.

This field of bacteriology is a most fascinating and an important one. The whole subject of decomposition of organic matter might well engage the attention of many investigators. The results of Schlœsing and Muentz on nitrification and the erosion of rocks through the agents of bacteria, the brilliant achievements of Winogradsky, Warrington and others on these questions should be brought to the attention of agriculturists. These problems are important in the production of crops, and may well stimulate for a knowledge of things that seem hidden.

Let us now consider the appropriation of nitrogen in leguminous plants. Leguminous plants as renovators of our soils has been an established axiom in agriculture for years, but it is only within recent times that this was properly accounted for. Did not Boussingault show that plants cannot take up the free nitrogen of the air through the leaves of plants?

Scientists generally opposed Ville's idea that some plants have the power of taking up free nitrogen, but after nearly half a century of investigation, the world at large has come to accept his conclusions. The various phases of the appropriation of atmospheric nitrogen because of the nitrogen found in the tubercles, and the symbiotic relation to the plants in question, has received wide discussion in the agricultural and scientific papers. It is because the economic and scientific phases are so important and interesting from practical and chemico-physiological standpoints that they have been considered in this way. The practical farmer is interested in the accumulation of nitrogen in soil through the decay of tubercles and the appropriation of nitrogen by the plant. It makes his soil more productive. The chemist and biologist are interested in finding out facts in regard to how this is accomplished, the structure, form and relationship of the organisms in question.

I presume most of you are familiar with the earlier work. At one time they were supposed to be insect galls. Bivona[113] thought they were fungi and placed them in the genus *Selerotium*. Tulasne, with his great knowledge of fungi, cast them out of this group of plants. Later they were held to be normal structures of the plants, "swollen lateral roots," "imperfect buds," normal structures of the roots for the storage of reserve food material. Prof. Atkinson,[114] who has made a most excellent summary of the investigations, reviews the status of the question in three periods, early, middle and recent. During the middle period the preponderance of evidence seems to have been to regard them as normal structures for the storage of reserve food material, although the views of some authors were diametrically opposed. Frank, who at first supposed them to be fungi, related to the genus *Protomyces*, established by De Bary, later entirely abandoned this view and thought they were simply for the storage of proteid material. In this he was supported by Brunchorst, Tschirch and Van Tieghem. Woronin, Kny and others held that they were living structures related to *Plasmodium brassicæ*. Later

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[112] l. c.

[113] Quoted by Atkinson. Contribution to the Biology of the organism causing leguminous tubercles, Bot. Gazette. Vol. XVIII, pp. 158, 226, 257, where there is a most excellent bibliography. There is also a good review by Conn. Experiment Station Record, Vol. II, pp. 686-693.

[114] l. c.

researches made by Ward[115], Hellriegel and Wilfarth[116], Laws and Gilbert[117], Beyerinck[118], Prazmowski[119], Laurent[120], Frank[121], Atkinson, and a host of others, leaves no doubt as to the organisms found in the tubercles.

The results of these later investigations show that in sterilized soil, leguminous plants make but little growth and the tubercles will not develop. The results have been further supplemented by the successful culture of the organisms by Frank, Prazmowski, Laurent, Atkinson and others. There is much conflicting testimony as to the true nature of the changes produced and the structure of the organism. Atkinson says: "The important question is, can these various conflicting notions of the biology of the microsymbiont be harmonized? Leaving out of consideration for the present the real nature of the organism it will be admitted by those who take the trouble to familiarize themselves with the scope of the work covered by the most important investigations that the organism in question consists of an elongated thread-like structure, which branches freely within the tubercle and possesses enlarged portions which present a more or less finely lobed surface; and very much smaller forms which must exist to some extent within the tubercle, are capable of multiplying in artificial media, and when transplanted from artificial media to the roots of leguminous plants, are capable under these more natural conditions and the stimulus of the microsymbiont, of growing out again into the threadlike structures."

As to the place of the organism in the system of plants there is much diversity of opinion. Laurent, as well as Ward, concluded that they were not bacteria but low fungi. Atkinson says: "While in some characters, as noted above, the tubercle organism is very much like *Claodochytrium tenue*, yet in the sum of essential characters it departs too widely from that genus, so that even if it should eventually be clearly shown to be one of the *Chytridiaceæ*, it would still be referable to *Phytomyxa*."

Frank, Prazmowski, and others placed it with bacteria.

Whatever the final disposition will be, Atkinson, it seems to me, has good grounds for calling it *Phytomyxa*.

It is not my purpose to discuss at length the chemical problem, but it may be well to give the opinions of the more recent investigations. J. H. Gilbert[122] says: "The facts at command did not favor the idea that the plant was enabled to fix this free nitrogen by its leaves. It seemed more consistent, both with experimental results and with general ideas, to suppose that the nodule bacteria fixed free nitrogen within the plant, and that the higher plant absorbed the nitrogenous compounds produced." Atwater and Woods[123], while they show that there is an acqui-

115 On the tubercular swellings on the roots of Vicia Faba. Phil. Trans. Royal Society, CLXXVIII (1887), pp. 139.

116 Untersuchungen ueber die Stickstoffnahrung der Gramineen und Leguminosen. Beilageheft z. d. Zeitschr. f. d. Rubenzucker Ind. d. D. R. Berlin, Nov., 1888. Review in Bot., Central b. XXXIX. (1889). 138.

117 On the present question of the sources of the nitrogen of vegetation, etc. Phil. Trans. Royal Society, CLXXX. B. 1-107.

118 Die Papilionaceenknoellchen, Bot. Zeit. 1888, p. 725-735, 741-750, 757-771, 780-790, 797-804.

119 Das Wesen und die biologische Bedeutung der Wurzelknœllchen der Erbse. Bot. Central b. XXXIX. (1889). 356-362.

120 Ann. d. l'Institut Pasteur. V. (1891). 105-139.

121 Ueber die Pilzsymbiose der Leguminoseen. Berlin, 1890.

122 Experiment Station Record, Vol. III, p. 333.

123 Atmospheric nitrogen as plant food. Bull. No. 5, Storr's School Agrl. Exp. Station, Conn., Oct., 1889.

sition of nitrogen in leguminous plants above that found in the soil, are certain of the symbiotic relation of the plant and organism. They leave the question how it is done an unsolved problem. Nobbe, Schmid, Hiltner and Hotter[124] are of the opinion that the nitrogen which the plant contains comes from metabolic processes.

Whatever the future may decide, it is certain that the tubercles are widely distributed on exotic and indigenous, leguminous plants[125].

The ground seems to be gaining that certain low forms of plants[126], including bacteria, have the power of greatly enriching the soil in nitrogen, and we may add that Frank believes that many higher plants can appropriate free nitrogen without tubercles. Frank's general conclusions are not generally accepted by botanists and agricultural chemists.

We have another most interesting case of symbiosis among bacteria. Professor H. Marshall Ward[127] who studied the fermentation of ginger beer finds that a number of micro-organisms are concerned in this fermentation. Ginger beer as most of you know is made by adding to saccharine solutions a quantity of ginger, and a ferment, the latter changes to an effervescing beverage. This alcoholic and viscous fermentation contain moulds, yeast-fungi and a constant bacterium. The yeast-fungus concerned in this fermentation is *Saccharmyees pyriformis*, the Schizomycete is *Bacterium vermiforme*. This according to Prof. Ward originates from the ginger. The vermiform bacterium is enclosed in hyaline, swollen gelatinous sheaths. This organism imprisons the yeast. The anaerobic bacterium only produces the gelatinous sheaths in saccharine liquid in the absence of oxygen. Now Ward has shown experimentally that only when these two species occur together can the ginger beer be produced.

BACTERIA IN THE DAIRY.

One of the greatest achievements in modern science is the application of scientific principles and utilize them in the arts and industries. Since time immemorial yeast has been used for the manufacture of beer[128], known to the ancients as barley or Pelusian wine. Its manufacture evidently spread from Egypt over Europe. Much advancement has been made. Beginning with Pasteur's Studies on Fermentations, the subject was treated from a rational and scientific standpoint, culminating in the brilliant researches of Emil Christian Hansen and Joergensen of the Copenhagen school. The nomadic tribes of Tartary since time immemorial have prepared a fermented drink from mares' milk known as koumiss. The kefir, another fermented drink of milk has long been made by the inhabitants of the Caucasus. Scientists were made familiar with this drink as early as 1784, but it devolved upon modern scientific investigation to rationally explain the causes of this fermentation. There are other ways in which a study of bacteriology is rendering important aid to our modern industries. We need not go far back in the history of bacteriology when it was supposed that the souring of milk was a purely chemical process. Sheele had discovered lactic acid in whey in 1780. Pelouze and Guy Lussac

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124 Landw. Vers. Stat., Vol. XXIX, pp. 327-354.

125 H. L. Bolley, Agricultural Science, Vol. VII, p. 58; records them on twenty-eight indigenous and sixteen exotic plants in North Dakota.

126 Berthelot. Compt. rend., Vol. CXVI, pp. 841-849. Experiment Station Record Vol. IV, p. 854.

127 The ginger beer plant and the organisms composing it. Phil. Trans. Roy. Soc Vol. CLXXXIII, p. 125.

128 Pasteur, Studies on Fermentation. The Diseases of Beer, their causes, and the means of preventing them. English translation, Faulkner and Robt. Landon. Macmillan & Co , 1879, p. 418, with 85 figures and 12 plates, see pages 1 and 17.

solated lactic acid in milk in 1833; Turpin in 1837, supposed that the cause of souring milk came from the mammary gland and was contained in the fat globules. Schwann and Latour, 1837, had laid the foundations to rationally explain the process of fermentation, making it certain that organized living beings caused the changes observed in a fermenting substance. Fuchs[129] was the first in modern times to examine milk microscopically. He found two germs; one he termed monas and the other infusor. Blandeau, 1847, incorrectly ascribed lactic acid fermentation to yeast (*Torula*) and the common blue mould (*Penicillium*). Liebig supposed that fermentation was a property of all albuminoids and this view gained credence in many quarters. But we must pass over these stumbling blocks in the history of this work and give in rapid succession the vital points which have made it possible to put the fermentations of milk on a high road to a successful use in practice. Pasteur, in 1837, thought souring of milk was due to an organized *Ferment lactique;* he also recognized that other organisms were present; to distinguish the two, he called it *Leveure lactique* caused by his *Vibrio butyricus*[130]. This germ was capable of standing a much higher temperature than the lactic acid organisms. In 1874 Lister, by using bacteriological methods, separated his *Bacillus lactis*, which we have seen led him to erroneous ideas.

Hueppe[131] somewhat later, 1884, made a thorough study of souring milk and referred Lister's *Bacillus lactis* to one which he described as *Bacillus acidi lactici*. In a second paper he concluded that souring was not caused alone by this species, but several. Marpmann,[132] Conn,[133] Storch,[134] Weigmann[135] and others have all shown that species of lactic acid germs are numerous. The power of changing milk sugar to lactic acid is not confined to Saprophytic species, but some of the pathogenic, like the Micrococcus of osteo-myelitis[136] has the power coagulating the casein of milk. Some of the chromogenes are very active in this direction. The *Bacillus prodigiosus* which often causes red milk in Europe, has this power. It is the famous blood-portent, connected with several superstitions, and certain lesions of the teats, which were supposed to cause bloody milk, is due to nothing more than the development of this bacterium, which may form lactic acid. Schottelius and Wood[137] have pointed out the interesting fact that as the temperature rises the power of forming pigment is lost "and, if it is grown on potato or bread paste, for example, in an incubator at blood heat instead of at the temperature of the room, the color is gradually lost and the culture no longer smells of herring brine, but the power of forming lactic acid from milk sugar, with the accompanying precipitation of casein, is frequently increased, so that it would appear that the energy required for building up pigment was, in this case, directed

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129 Mag. f. d. Ges. Thierheilkunde, 1841.

130 Hoffmann, 1869, also described two species, a motile and a non-motile; the latter he thought caused the souring of milk.

131 Untersuchungen uber die Zersetzungen der Milch durch Mikro-organismen mitth, aus dem K, Gesundheitsamte, Vol. II., 1884, Deutsche Med, Wochenscrh, 1884, No. 48.

132 Ueber die Erreger der Milchsaeure Gaehrung Ergaenzungshefte, Z., Centrallblatt f Allg, Gesundheitspflege, Vol. II., p. 117.

133 Storrs' School, Conn, Agr. Exp. Station, 1889, p. 82: 1890, p. 136; 1891, p. 192.

134 Nogle Undersogelser over Flodens Syrning, etc.

135 Die Bakteriologie im Dieuste der Milchwirtschaft Milch Zeitung, 1891, Nos. 19 and 20.

136 Krause, see Alfred Jorgensen Micro-organisms and Fermentation, English translation, p. 63.

137 Biologische Untersuchungen ueber den Mikrokkus prodigiosus, Leipzig, 1887, p 185. See Sims Woolhead Bacteria, etc., p. 11.

into another channel, and lactic acid and, perhaps, other substances are produced in place of the usual pigment."

Investigation has shown that the flora of milk is a variable one, owing to circumstances under which they make their entrance.

The normal milk from a healthy cow contains no germs. This is easily determined by using a sterilized catheter. The pails and water used to clean milking vessels and cans, the stable, hair from cows, and hands of milker, all have germs that find their way into the milk. The species found are not only abundant, as shown by various bacteriological studies of milk, but both good and bad occur.

Cnopf and Escherich,[137] found from 60,000 to 100,000 per c. c., in milk a few hours after milking. Mr. B. F. White, in the writer's laboratory, found that when milk was obtained in the ordinary way, and cultures made soon thereafter, it contained 40,000 germs per c. c. Milk coming to the creamery had, in some cases, as high as 1,976,000 per c. c. Prof. Conn[138] interestingly shows the enormous number in milk, as well as the great increase. The writer[139] has also brought together the results obtained by Miquel, Weigmann, and others, on the enormous increase, when milk is kept under favorable conditions for their development. That our milk supply of cities contains an enormous number has been shown by Sedgwick and Batchelder.[140] It is not to be wondered at that milk will sour in the course of a few hours on a hot day in summer.

The fact that different samples of milk left standing in a warm room will develop quite different odors is due to particular germs. The practical dairyman is well aware that he cannot always make butter of uniform quality, and this is owing to injurious species. Experiments made during the last few years have shown that by Pasteurizing milk and using the germs that have the right odor, butter of uniform and high quality may be produced. These results were first brought to notice by Storch, of Copenhagen. Weigmann, of Kiel, has also experimented with these germs in a practical way, sending them out to creameries. Prof. Conn, of Middletown, Conn., writes me that he has had success in using one of his own germs.

No one questions the fact that odors and products of bacteria are very characistic. Storch has called attention to butter that had a flavor of beets, but the animal from which the milk came had never been fed on beets. Dr. Jansen[141] refers to a bacillus which was found in milk that produced a very fetid odor, his *Bacillus fœtidus*.

The writer has isolated a Bacillus which he has called *Bacillus aromaticus*,[142] because of the powerful volatile odor produced. In some media it has an odor characteristic of walnuts. Again it resembles limburger cheese, and a more interesting fact is that it tastes like cheese.

The importance of bacteria in ripening cream is very important, since cheese will not ripen unless Bacteria are present. Duclaux,[143] Adametz,[144] Freudenreich,[145] and

137 Abst. Centralb. Agrl. Chm., 1890, p. 575.

138 The Fermentations of Milk, Office of Experiment Stations. Bull. No. 9, U. S. Dept. of Agrl pp. 75, see p. 30.

139 The Bacteria of Milk, Cream and Cheese. Report Fifteenth Annual Convention of the Iowa Dairy Association, held at Waverly, 1891, p. 81.

140 A Bacteriological Examination of the Boston Milk Supply. Boston Med. and Surgical Journal, 1892, p. 25.

141 Centralblatt Bakt u Parasitenkunde, Vol. XI p. 409.

142 Bull. No. 21, Iowa Agrl. Experiment Station, pp. 792-796.

143 Le Lait etudes chimiques et microbiologiques, Paris, 1887.

144 Bakteriologische Unteruschungen ueber den Reifungsprocess der Kæse Landw Jahrbucher, Vol. XVIII. p. 228.

145 Landw, Jahrbuch der Schweiz, Vol. V, p. 16, Vol. IV, p. 17.

others have studied the flora of cheese. All find an abundance of bacteria present. They are ærobic and anærobic. Bacteria are very important to the cheesemaker. Cheese without bacteria cannot be made. First of all, in most cases it is necessary for the milk to sour so that the whey can be removed. Again it must pass through a stage of ripening before it becomes digestible. The species differ for different kinds of cheese, and there are several kinds connected with every cheese. As in milk, cheese has its enemies in bacteria. Some that cause abnormal ripening, or color it black, yellow or red.[144] Bacteria always play an important part in the formation of Koumiss. Kefir and other alcoholic fermentations come from Asia and Europe. Mix has shown that forms of alcoholic fermentation of milk occur in North America. The so-called Kephir grains contain the organisms essential for fermented drink Kephir. Yeasts and bacteria have been found. Kern[144] considers that *Diospora caucasica* causes the fermentation. Recent investigations leave much doubt in regard to its being an organism at all. Little is known concerning Koumiss, but that it is caused by some living ferment cannot be doubted. The nomadic tribes of Tartary prepared it from mares' milk, which readily undergoes alcoholic fermentation, Ordinarily it is prepared by adding a little Koumiss or sour, to the sweet milk.

Another interesting group of organisms found in milk are the slime forming bacteria. These organisms cause milk to become very viscous and 'ropy.' It can be drawn out in long threads. This slime, a product from the cell-wall, is analagous to the zoogloea formation in certain bacteria, and comes from the decomposition of sugar. Some of the species that can cause this are *Bacillus mesentericus, B. viscosus, and Micrococcus discosus*, Bechamp the so-called Frog-spawn (*Leuconostoc mesenterioides*) found in molasses, etc. The species are not uncommon.

Lastly I should mention that bacteria are indispensable to housewives in the making of bread. In this case they are aided very materially by yeasts. Miss Golden[149] has made a contribution to our knowledge of this process and the role bacteria play in bread-making. Miss Golden concludes that bacteria as well as yeast separately can cause bread to rise but that both usually act together. Laurent[148] believes that his *Bacillius panificans* causes the rising of bread besides forming lactic, acetic, and butyric acids.

In conclusion, you will pardon me for having consumed so much of your time. In fact as I look over this question I cannot but think that the subject is so vast that one address will scarcely touch upon the many important problems. The subject of ptomaines and various products of bacteria, disinfection and other points have not been touched up, except incidentally. I venture to say that any one of the topics taken up in this address might very appropriately have consumed the entire time. I shall, however, feel repaid in preparation of this paper if some of the popular notions concerning these baneful and useful organisms, stand corrected.

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[144] Adametz ueber die ursachen und erreger der abnormalen Reifungsvorgange beim Kæse pp. 70. with 6 illustrations. Bremen, 1893, M. Heinsius nachfolger.

[145] Contributions from the Cryptogamic Laboratory, Harvard University.

[146] Ueber ein Milchferment, Bot, Zietung, 1882, p. 264.

[149] Bot. Gazette, Vol. XV, p. 204.

[148] See Centralblatt f. Bakt. und Parasitenkunde, 1887, p. 504.

POWDERY MILDEW OF THE APPLE.

BY L. H. PAMMEL.

(Abstract.)

The past season was very favorable for the development of the Powdery Mildews. During the month of September Mr. G. W. Carver, a special student in the botanical laboratory, brought in a fine lot of The Apple Powdery Mildew. An *Erysiphe* and the common Powdery Mildew of the cherry, *Podosphaora oxyacanthæ*, have been reported on *Pyrus malus*.* But our fungus does not belong to either of these genera. It agrees with the descriptions given for *Sphærotheca mali* (Duby) Burrill. It is easily recognized by its persistent perithecia, two kinds of appendages. The long appendages come from the upper end; they are straight or curved, rigid, usually septate, and occasionally forked at the end The base is deeply colored. The rudimentary appendages are floccose and attached to the smaller end of the pyriform perithecium. Prof. Burrill records this species abundant at times in the Mississippi valley, and first referred it correctly to Duby's *Erysiphe mali*. Bot Gall, p. 869.

FURTHER NOTES ON CLADOSPORIUM CARPOPHILUM—VON THUEMEN.

L. H. PAMMEL.

(Abstract.)

This fungus was first recorded on the native plum *(Prunus americana)*, in a short note presented to the Academy some years ago.

I thought at first that the fungus on the plum and cherry might prove to be a new species, but I cannot see how the fungus differs materially from that found on the peach.

This fungus has become a source of considerable annoyance to the cultivation of the *americana* plums, in many sections of the United States and Canada. Most of the commonly cultivated forms of this specie are affected in Iowa. The DeSoto, Rollingstone and Speer, being attacked with special severity.

The Wolf plum, which is a variety of *Prunus americana*, is but little subject to the attacks of this fungus. *Prunus angustifolia* and *Prunus domestica* are not affected. Some varieties of *Prunus cerasus* are also affected.

*Ellis and Everhart: North American Pyrenomycetes, p. 6.

An interesting feature connected with the attacks of this fungus and different parts is that a hybrid of *Prunus americana* (DeSoto) and Oregon Plum, (*Prunus domestica* or possibly a Japan Plum) show the disease in a very marked form. This is interesting as indicating that the mother plant was strongly prepotent in carrying over a tendency to take a disease.

The fungus, or what appears to be the same thing, has been cultivated in nutrient agar, but innoculation experiments tried on matured plums did not show the characteristic appearance. The fungus grown in agar is either different or it attacks plums before the epidermal cells are uncuticularized. Field observations indicate that plums become affected early and that these spots increase in size as the season advances.

NOTES FROM THE BOTANICAL LABORATORY OF IOWA AGRICULTURAL COLLEGE.

BY L. H. PAMMEL.

It is a good plan to make a permanent record of some of the work done by undergraduate students, provided the observations are carefully made and recorded. During the winter of 1892 and 1893 there was a serious epidemic of typhoid fever in La Crosse, Wisconsin, which came to my notice through my brother, H. A. Pammel. I was asked to make a bacteriological examination of the water and report. It was impossible for me to do so because of other work on hand at that time. Two senior students, Messrs. McCall and Patton, then at work in the bacteriological laboratory, consented to work it up for their thesis. My brother collected the samples on May 2. They were placed in thoroughly scalded bottles and sent to me by express. Most of the samples of water were submitted to an analysis on May 10.

It is an extremely difficult matter to get satisfactory results made in this way. Some of the successful results in obtaining the typhoid fever bacillus of polluted water have been reported by Mr. Rafter and Dr. H. C. Ernst[1] in this country, and my friend, Dr. Ravold has reported some from Mississippi water taken at St. Louis. The number of successful cultures of this organism from polluted water is, however, somewhat limited, and in some cases, at least, there are doubts as to whether the investigators had the Koch Eberth bacillus or some closely related species. Cassedebat[2], who made an extended study of the river water at Marseilles, found several species closely related to it, but the true typhoid fever bacillus could not be found. This uncertainty is also indicated by the results of Babe's work[3].

The tabulated results of the work of Messrs. McCall and Patton show the number of colonies present to be as follows:

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[1]Report on an epidemic of typhoid fever at the village of Springwater, N. Y., in October and November, 1889.

[2]Zur un bacille pseudo typhique trouve dans les eaux de riviere Compt. rend. Acad. des Sci. Vol. CX, 1889. Le bacille d' Eberth-Gaffky et les bacillis pseudotyphiques dans les eaux de riviere, Ann. d l'Institut Pasteur, 1890, p. 625.

[3]Ueber variabilitat und varietaten des typhus-bacillus, Zeitschrift fur Hygiene, Vol. IX, 1890, p. 823.

Upon an outbreak of typhoid fever in Iron Mountain, Michigan, see Vaughan and Novy: The Medical News, 1888, p. 92. On the detection of typhoid fever bacillus see Foote: Medical Record, New York, 1891, p. 506.

DATE OF EXAMINATION.	NUMBER OF SAMPLE AND SOURCE.	Number of colonies per c. c.	LIQUEFACTION OF GELATINE.	KIND OF ORGANISM MOST ABUNDANT.	COLOR.	Pathogenesis.	Typhoid fever bacillus.	
No. 1. May 10.	Hydrant on Fourth street.	4,000	None.	Bacillus 4.5x1.2u. odorless, without formation of gas. Facult., anaerobes.	Yellow.	Not.	None.	
No. 1. August 16. Water kept on ice.	do.	2,750				Not.	None.	
No. 2. May 10.	Well No. 1128, Third and State streets.	5,725	Both kinds. No. 1 liquefying, No. 2 not.	Bacillus No. 1 2.25 u. in length; No. 2, 2.3u.x 1.5u.	White.	Not.	None.	
No. 2. August 16.	do.	3,600	.			Not.	None.	
No. 3. May 10.	Mississippi river.	3,000	Both kinds. No. 1 liquefying.	Bacillus, 1.5x.5; strong odor. No. 2, 4x2.3.	White.	Not.	None.	
No. 3. August 17.	do.	1,240				Not.	None.	
No. 4. May 10.	State and Eleventh streets. Well 100 feet deep.	7,804	Liquefying.	Baccillus No. 1, 1.5x.4u. No. 2, 1x3u.	Yellowish white and white; medium greenish.	Not.	None.	
No. 4. August 17.	do.	4,000				Not.	None.	
No. 5. June 2.	Well on Fourth street, Dr. Tillman's residence.	1,345	Both. No. 1 liquefying: No. 2 non-liquefying.	Bacillus, 1.5x6u.; No. 2, 2x.4u.	White. No. 1 greenish tinge.	Not.	None.	
No. 5. August 21.	do.	1,250				Not.	None.	

No. 6. May 10.	Artesian well supply.	6,804	Bacillus, liquefying. Micrococcus, non-liquefying.	Bacillus No. 1, 5x.4u. Micrococcus, .3u.	White. B., medium greenish tinge. M., white.	Not.	None.	Bacillus had odor of stale eggs.
No. 6. August 21.	do.	3,560				Not.	None.	
No. 7. September 1.	Creamery supply. I. A. C. hydrant.	320				Not.		
No. 7. September 13.	Farm house.	56				Not.		

Some experiments were also made in filtering germs out with the following results:

Water from veterinary hospital filtered through two, three and five thicknesses of filter paper, funnel, flasks and filter paper previously sterilized:

	Unfiltered.	Filtered.
Two filter papers	250 germs per c. c.	129 germs per c. c.
Three filter papers...............	250 germs per c. c.	24 germs per c. c.
Five filter papers.................	250 germs per c. c.	4 germs per c. c.

College water supply from main building filtered through a Pasteur-Chamberland filter after sterilization:

Unfiltered.	Filtered.
Fifty germs per c. c.	Sample No. 1, 4 germs per c. c. Sample No. 2, none.

Water supply of North Hall standing in tank partially open, filtered through sterilized asbestos:

Unfiltered.	Filtered.
Six hundred and fifty germs per c. c.	4 germs per c. c.

October 11th. Water taken from farm barn and filtered through sterilized glass wool.

Unfiltered.	Filtered.
Four hundred and eighty germs per c. c.	Sample No. 1, 120 germs per c. c. Sample No. 2, 100 germs per c. c.

These results show that so far as studying the Bacillus of Typhoid Fever, samples should be collected on the spot; examinations and cultures should be made immediately. A good many species were obtained, but none of these could be identified with the *Bacillus typhi-abdominalis*. Nor were any pathogenic germs present. Water kept in a cool place showed that in the course of several months, there was considerable diminution in the number of germs, but the number was still large for potable purposes. Water can be advantageously filtered by the Pasteur-Chamberland filter, ordinary glass wool; asbestos, and filter papers also remove many of the germs.

BACTERIOLOGICAL STUDY OF MILK AND ITS RELATION TO PUBLIC HYGIENE.

We present here also a very brief report of the work done by Mr. B. F. White on the above topic. By ordinary methods it is an extremely difficult matter to get milk from cows without germs. This, however, was accomplished quite easily by using sterilized milking tubes. The number of germs was determined by taking .25 c. c. of milk and pouring it in a known quantity of agar, making three dilutions. Each tube was poured out on sterilized glass plates and allowed to stand from 48 to 72 hours. They were then counted and some of the species cultivated in the usual media.

The following table shows the results of the work:

Number of sample.	Date of collection.		Number of germs per. c. c.	REMARKS.
1	August	27	540,000	Fresh milk in sterilized flask, without precautions, from College farm.
2	September	15	1,976,000	Skim milk from veterinary barn, brought from I. A. C. creamery.
3	September	26	2,246,400	Buttermilk, I. A. C. creamery.
4	September	27	1,701,000	Morning and evening milk brought to I. A. C. creamery. Six hours on road.
5	September	28	1,200,000	Milk from I. A. C. creamery.
6	October	2	3,510,000	College kitchen milk kept in room over night.

Many of the species were cultivated and tests were made with several species and different disinfectants. Corrosive sublimate, 1-1,000; pyoktanin, 1-1,000. They were left in the solution for 30 seconds, 5 minutes and 10 minutes. The material was taken up on the end of a platinum loop and placed in the disinfectant solution with the following results:

A COMMON BACILLUS.

	THIRTY SECONDS.	FIVE MINUTES.	TEN MINUTES.
CORROSIVE SUBLIMATE.	Rapid growth.	Slow.	Very slow.
PYOKTANIN.	Rapid growth.	Quite rapidly.	Very slow.

It was evident from the work that the material in direct contact with the disinfectant was destroyed, but that in the interior of the mass was less readily acted on, and grew, after a longer time, the disinfectant having not destroyed, but merely inhibited the growth of the germ.

Another experiment was tried in this case. The germs were thoroughly distributed in the solution and allowed to remain for a given length of time. A platinum loop full of the material was added to a known quantity of agar, and poured. The plates were allowed to stand twenty-four hours, with the following results:

CORROSIVE SUBLIMATE.

1-1000	Ten minutes.	No growth.
1-2000	Ten minutes.	No growth.
1-3000	Ten minutes.	No growth.
1-4000	Ten minutes.	No growth.

PYOKTANIN.

1-1000	Ten minutes.	No growth.
1-2000	Ten minutes.	No growth.
1-3000	Ten minutes.	No growth.
1-4000	Ten minutes.	Not all destroyed.

NOTES ON THE POLLINATION OF SOME LILIACEÆ AND A FEW OTHER PLANTS.

BY MARY C. ROLFS.

It will not be necessary in this connection to refer to the literature. This may be obtained from such works as Herman Mueller and Darcy W. Thompson. In the identification of insects help was obtained from Prof. Osborn and Miss Beach.

Erythonium albidum, Nuttall. This is the earliest of the *Liliaceæ* to come in flower, in fact one of the earliest of our spring flowers. Owing to numerous rains last spring it was difficult to study the species, and insect visitors were few. Flowers perfect. Nectar is secreted near the base of the inner divisions of the perianth. Two small beetles were found feeding near base of the perianth. Ants were found as incidental visitors often walking over stamens and pistil.

Visitors—HEMIPTERA—*Capsidae*, *Lygeus pratensis*, was also found in the flower. Mr. Charles Robertson reports twenty-two for Carlinville, Illinois.

Smilacina stellata, Desf. Found growing in low moist places. Flower perfect. Visited during early part of the day by flies feeding upon the pollen. The flowers opening in the early part of the spring, and are visited at first by *Diptera* almost entirely, but later its visitors were increased. The pistil has a three cleft stigma, ripens simultaneously with the stamens. They are of the same length. Insects in seeking the nectar, which is secreted at the base of the corolla, leave some of the pollen from another flower on the stigma.

Visitors— DIPTERA— *Muscidae: Musca domestica, Scatophago squalida, Tachina flavicaudla. Syrphidae:* Syrphus fly. *Bibionidae: Bibio albipennis Lyretta pipens* and *Mesograpta marginata* (feeding on the pollen), HYMENOPTERA *Apidae: Halictus albipennis, Halictus tegularia, H. zephyras. Nomada bisignata. Augochlora pura* and *Agapostemon radiatus* feeding on the nectar.

Polygonatum biflorum, Ell. Grows on shaded hillsides in large patches, perennial herb with simple curving stem, from creeping root stock. Flowers axillary greenish and nodding. Perianth cylindrical oblong, six lobed at summit. The six stamens are inserted on or near the middle of the segments of perianth, with introrse anthers. Style slender, obtuse, slightly three lobed stigma. Flower perfect. The perianth is about half an inch in length and the summit, or top of the tube, is filled by the anthers and pistil, thus warding off uninvited guests. The insect is guided to the flower by the odor and to the nectar by the slightly yellowish color near the base of the inner segments of the perianth. Insects feeding on the nectar alight on the flower and force their way to it by pushing aside the anthers; in so doing the pollen falls upon the insect, and, when it searches for food on some other plant, it comes in contact with the pistil and leaves some of the pollen. It is mostly visited by large insects, such as the bumble bee.

Visitors—HYMENOPTERA—*Apidæ: Bombus Americanus. B. vagans, Halictus coriaceus, H. fasciata, H. tegularia, Ceratina dupla. Stelis lateralis, Augochlora pura, Vespidæ: Odynerus foraminatus.* COLEOPTERA—*Capsidæ: Lygus pratensis,* feeding upon the pollen. DIPTERA—*Syrphidæ: Platycheirus hyperboreus,* feeding on pollen. LEPIDOPTERA—*Pamphila zabulun.*

Allium cepa. Flowers in umbels from a one or two-leaved spathe, which soon becomes dry. Flowers with a six parted perianth; segments white, with a single green rib or nerve. Stamens six, style slender with single stigma, which receives pollen from its own and neighboring stamens, but pollination is also often brought about by insects. The insects are attracted by color and the alliaceous odor which is peculiar to the plant.

Visitors—HYMENOPTERA—*Apidae: Bombus Americanus* hurriedly ran over several of the heads. *Megachile centuncularis* collected nectar and pollen. *Halictus coriaceus, H. gracilis* collecting nectar and pollen. DIPTERA *Muscidae Musca domestica. Tachina flavicaulda. Syrphidae:* Syrphus fly, with two or three other species, all feeding on pollen and aiding in pollination.

Asparagus officicinatis. L In flower during the latter part of spring and in the early part of summer, but it also blossoms later in the season in August and September, when it produces but one kind of flower, and consequently no seeds are formed. The flowers are small, green and axillary. Perianth six parted, spreading above, six stamens attached to its base, anthers turned inwards, style short, stigma three cleft. Flowers are of two kinds; that is, it has both staminate and pistillate flowers. Rudimentary stamens are found in the pistillate flowers, and rudimentary pistil in the staminate flowers. Flowers have a pleasant odor, and in spite of their green color they can easily be seen at a distance, the male flower being more conspicuous than the female. The insect is first attracted to the male flower, after which it visits the female, and leaves some of the pollen which has adhered to its body, on the pistil; thus the flower is pollinated.

Visitors—HYMENOPTERA—*Apidae, Megachile centuncularis, Halictus tegularis, H. Cressonii, Agapostemon radiatus,* these are all the insects which I was able to secure or took note of. Hermann Mueller gives the following list: HYMENOPETERA—*Apidae: Apis mellifica, Osmia rufa, Prosopis ammilaris, Halictus sexnotatus,* collecting pollen and looking here and there in female flowers, and effecting pollination occasionally.

COMPOSITÆ.

Helianthus annuus, L. In Compositæ the flowers, being in such close proximity, it is not difficult for pollination to take place. The flowers of sunflowers are perfect, but proterandrous. The insect creeps over the head and thus causes pollination. It also, in its efforts to obtain honey, dusts some pollen on its head and thus carries it to another flower.

Visitors—HYMENOPTERA *Apidæ: Apis mellifica* collecting pollen and nectar. *Megachile centuncularis,* collecting pollen. *Nomada luteola. Perdita sp. Eucera sp.*

Helianthus tuberosus, L. Visitors—LEPIDIPTERA—*Chryspophanus thoe.* DIPTERA — *Bombylidæ: Bombyius.* HYMENOPTERA—*Apidæ: Nomada luteola,* gathering honey. *Halictus Leronxii. Melissodes perplexa,* gathering pollen and sucking honey. *Vespidæ: Odyneris foraminatus.*

Solidago speciosa. Nutt. Visitors—HYMENOPTERA— *Apidae: Bombus Virginicus,* sucking honey *Apis mellifica* sucking honey (quite abundant.) *Halictus coriaceus, Augochlora pura, Cilissa Americana, Caliopsis Andreniformis.*

Sphegidae: Crabro sp. *Ammophila conditor. Ichneumonidae: Tryphon* sp. *Lana montana* (?) *Coleoptera Meloidae: Epicauta Pennsylvanica* feeding on pollen. Hemiptera— *Phymata Wolfii. Diptera— Muscidae: Stomoxys. Mesograpta marginata.*

Cnicus altissimus. Willd. Var. *discolor*. Gray. Visitors. HYMENOPTERA—*Apidae: Bombus fervidus, B. Americanus, B. vagans. Megachile centuncularis Apis mellifica, Ceratina dupla, Melissodes bimaculata.*

MISCELLANEOUS PLANTS.

Polygonum acre. H. B. K. Small spiked flowers. Insects are attracted by its pinkish color. Flowers perfect.

Visitors—DIPTERA—*Muscidae: Calliphora vomitoria.* HYMENOPTERA—*Apidae; Halictus tegularis. Calliopsis andreniformis, Pimpla inquisitor. Sphegidae; Ammophila conditor.* HYMENOPTERA feed on honey secreted at the base of the corolla, while DIPTERA feed on both nectar and pollen.

Sedum Telephium, L. Flowers—compound cymes; petals white.

Visitors—HYMENOPTERA—*Apidae: Halictus tegularis, Sphegidæ; Ammophila conditor.*

Pontederia cordata L. Blue; spike dense, from a spathe-like bract. Perianth funnel form; two-lipped, three upper divisions united to form the three-lobed upper lip; the three lower ones spreading. The upper lobe of perianth is marked by a pair of yellow spots, which aid the insect in finding the nectar. Stamens six, the three anterior long, exserted; the posterior three with very short filaments unequally inserted lower down. Anthers versatile, oval and blue. Pistil one, with stigma turned upward.

Visitor—HYMENOPTERA—*Apidae: Halictus tegularis* feeding on nectar.

OBSERVATIONS ON THE POLLINATION OF SOME OF THE COMPOSITÆ.

BY MARY ALICE NICHOLS.

The brilliant appearance of our western roadsides and prairies from July to October, invites an extended study of the anatomy and physiology of the *Compositæ*. The wide distribution and rapid increase of this family naturally call attention to dissemination and pollination. Darwin, Herman Mueller, and others, have shown at length, the direct relation between special adaptations for cross-pollination and the race stability of plants. The question now arises, what are the opportunities for cross-pollination in *Compositae*, and to what extent is this agent a factor on the increase and distribution of the family? No attempt is here made to go into a discussion in full of these questions for the entire Family, but simply to present a few facts relative thereto, gathered from representatives of the subtribes *Heliantheae* and *Asterineae*.

A few observations on the common cultivated sunflower, *Helianthus annuus*, will apply equally well to all members of this conspicuous genus. First among these may be noted the mechanism of flowering. Immediately following the bursting of the tubular corolla, the anther tube formed by the lateral union of the five anthers and enclosing the stigma, is protruded, its entire length appearing beyond the corolla tube. The anthers now dehisce liberating the stigma which forcibly protrudes itself, at the same time recurving and carrying with it, lodged in its papillose projections, numerous pollen grains. The filaments then retract drawing the empty anther tube again within the corolla. Furthermore the disk flowers open from circumference to center. Were the pollen of the outer row not potent in the fertilization of its own stigma, it must be conceded to be entirely useless so far as individual disks are concerned. Moreover, if the flowers at the center of the disk which open after the retraction of the anther tubes in the outer rows, were wholly dependent upon cross-fertilization, we might expect to find them in many cases sterile. No evidence of such a condition occurs. Hence, we conclude from its complete mechanism and from results exhibited, that in the sunflower ample provision is made for self-fertilization. But the fact that the flower is thus well equipped for its own perpetuity does not exclude the possibility of the co-operation of outside agents. The evidences of cross-fertilization by means of insects are equally numerous and conclusive. While the flowers around the border are opening, the center of the disk, glabrous with odorous resin, is a favorite resort for various *Hymenoptera*. The nectar of the flower appears to be secreted at the base of the corolla, where the style is attached. To reach the nectar it is not necessary that the proboscis of the insect be inserted inside the anther tube. Hence, it would seem at first thought quite probable that it might escape without carrying any pollen. This may in some instances be true, but it is to be further noticed that the slightest mechanical pressure at the base of the style, before dehiscence, thrusts the stigma out with an explosive effect so that a bee entering the flower at this point would be completely dusted with pollen. The complete exposure of the stigmas of older flowers would insure the deposit of some of this pollen upon them as the bee passes over. Furthermore, the fact of the legs of the insect being sticky from the resin so abundant on the disk, together with the abundance of pollen produced, would afford reasonable grounds for the conclusion that pollen is thus transported. Actual observation confirms this view and it is a well known fact that flowers of this family are subject to frequent visits from both nectar and pollen gatherers.

Sir John Lubbock in his "British Wild Flowers" shows the *Compositæ* to be specially adapted for fertilization by insects from the facts that (1) the heads are conspicuous, (2) the honey easily obtained, and (3) the small size of the florets insures the touching of many by one insect and hence effectual pollination.

Hermann Mueller also recognizes this agency and notes the special modification of certain parts in the insect for this purpose.

It is not the purpose of this paper to furnish complete lists of the insects which have been found on the species cited, but rather to point out some of those most persistent about certain flowers and determine, if possible, something as to their importance in pollination.

On *Helianthus annuus* L. by far the most frequent visitor was the common honey bee (*Apis mellifica*). This was especially true of plants growing near hives of bees, but was also true of plants observed in other localities. *Bombus Pennsylvanicus* was also a frequent visitor. It was sometimes found with its legs heavily laden with pollen, but usually it was packed into a sort of wax. This was also true, many times, of the honey bee, but in both cases loose pollen grains were found scattered abundantly over the head and body of the insect, in a position to be easily brushed off. Other visitors were *Mellisodes obliquus*, closely resembling the bees just described, and *Diabrotica longicornis*, whose proboscis and antennæ were frequently found sticky with nectar or resin, to which numerous pollen grains adhered.

On *Helianthus grosse serratus* Martens, a very showy species which flowers in September and forms corymb like clusters, the following were found: *Diabrotica longicornis*, *Bombylini*, whose downy body and barbed proboscis were admirably adapted for transportation of pollen, and *Mordellestina comata*, a small brown beetle found in great numbers buried deep in the disk both before and after the opening of the disk flowers. The legs and antennae are slightly downy and in some cases adherent pollen occurs.

On *H. rigidus* the common visitors were *Bombylini*, *Bombus*, and *Apis mellifica*. In addition to these, Hermann Mueller gives for *H. multiflorae*: *Megachile centuncularia*, *Halictus zonulus*, *Eristalis tenax*, *Syrphus pyrastie*, and *Syrphus ribesii*.

On *H. laetiflorus* Pers. were found *Bombus Pennsylvanicus*, and *Diabrotica longicornis*. On this, as on several other members of the genus, grasshoppers frequently appeared. They were very destructive, to the ray flowers, but apparently played no part in the process of pollination.

The genera *Lepachys* and *Rudbeckia* stand so close, structurally, to *Helanithus*, as to need no special description.

On *Lepachys pinnata* Torr. and Gr., *Mellisodes obliquus* and *Phymata wolfii*, were found.

On *Rudbeckia hirta* and *R. triloba*, the only common visitor observed was *Phymata wolfii*. Since these are abundant and widely distributed species, and since this insect is one of slow movement; and, moreover, one on which no pollen was at any time detected, it seems reasonable to conclude the species of this genus are largely self-pollinating; *R. subtomentosa*, however, being sweet-scented, is frequently visited by bees (*Apis mellifica*).

In smaller heads, but scarcely less showy than the *Helianthoideæ*, is the extensive genus *Solidago*, of the *Asteroideæ*. The flowering mechanism of *Solidago* and *Helianthus* are practically the same, except that in *Solidago* the anther tube remains protruded for some time before dehiscence, and in the meantime the corolla fades. Hence the most showy period of the flower's existence occurs before the maturity of either stigma or anther. Its less attractive appearance is, perhaps, overbalanced by the distinct odor which seems intensified by the beginning of the process of decay.

Insects were observed on the following species: *Solidago speciosa* and *S. lanceolata*. The frequent visitors were *Acinandero pulchella*, *Ammophila*, and *Epicauta pennsylvanica*. Of these, the last named is so common as to be intimately associated with the flower in the minds of the most casual observers. It appears usually, soon after the deshiscence of the anther—occasionally before—and plies industriously from flower to flower, apparently finding nectar at the base of the pistil, and industriously bearing pollen from floret to floret, and from head to head.

Ammophila flits very rapidly, alighting but for an instant here and there, and affording no opportunity for observations on its motives or operations.

On other species, Mueller furnishes the following more complete lists:

On *Solidago Canadensis*.—*Eristalis arbustorum E. nemorum. Syritta pipiens*, *Sarcophaga carnaria*, and numerous small *Muscidae*. On *Solidago virga-aurea* (L.):—

Ap s mellifica, *Bombus rupestris*, *B. campestris*, *B terrestris*, *Andrena denticulata*, *Eristalis arbustorum*, *E. nemorum* and *Thecla ilicis*.

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ADDITIONS TO IOWA FLORA.

PROF. B. FINK, FAYETTE, IOWA.

In my collecting last summer about Fayette, I found the following plants, some of which, so far as I know, have not been reported for Iowa. Those marked with a "star" have been examined by various botanists. The others I report on my own determination:

* *Habenaria tridentata*, Hook. Borders of woods; rare.

* *H. psycodes*, Gray. Wet river banks; rare, new.

* *H. hookeri*, Torr. var. *oblongifolia*, Paine. As common as the type here; new.

Dicentra Canadensis, D. C. Woods, rare. Also reported from Decorah by E. D. W. Holway. (Proceedings Iowa Academy of Sciences, Vol. I, Pt. II, p. 16.)

MILDEWS.

In this list I have adopted the synomony given by Prof. Burrill in North American Pyrenomycetes.

SPHAEROTHECA HUMULI (D C) Burrill on *Agrimonia Eupatoria*.

S. PANNOSA, (Wallr.) Lev. on *Rosa blanda*.

*S. MALI, (Duby.) Burrill on *Pyrus Malus* also reported from Ames, by Prof. L. H. Pammel and G. W. Carver abundant on young suckers, New.

S. MORS-UVAE, (Schw.) B. and C. on *Ribes*.

S. CASTAGNEI, Lev. on *Sonchus oleraceus*.

ERYSIPHE COMMUNIS, (Wallr.) Fr. on *Astragalus Canadensis*.

E. CICHORACEARUM, D C on *Phlox Drumondii*.

*E. GALEOPSIDIS, D C on *Scutellaria lateriflora*, New.

E. GRAMIMIS, D C on *Poa pratensis*.

UNCINULA CLINTONII, Peck, on *Tilia Americana*.

U. NECATOR (Schw.) Burrill on cultivated grapes (*Vitis labruscœ*).

U. CIRCINATA, C. & P., *Acer barbatum*.

U. MACROSPORA, Peck, on *Alnus Americana*.

U. SALICIS, (D C), on *Populus tremuloides*.

PHYLLACTINIA SUFFULTA (Reb.) Sacc. on *Cornus stolonifer*, *Xanthoxylum Americanum*.

PODASPHÆRA OXYACANTHÆ (D C), Duby on *Prunus Cerasus.*
MICROSPHÆRA RUSSELII, Clinton on *Oxalis corniculata* var. *stricta.*
*M. GROSSULARIÆ (Wallr.) Lev. on *Sambucus Canadensis.* New.
M. EUPHORBIÆ (Peck), B. & C. on *Euphorbia corollata.* New.
M. ALNI (D C), Winter on *Viburnnm lentago, Syringia vulgaris.*
M. QUERCINA, (Schw.) Burrill on *Quercus rubra.*

THE PARAFFINE METHOD APPLIED TO THE STUDY OF THE EMBRYOLOGY OF THE FLOWERING PLANTS.

BY H. W. NORRIS.

These few notes are given, not that they contain much if anything new, but simply as the record of a year's experimenting. The difficulties connected with the use of paraffine in the sectioning of plant tissue are well known to all students in botanical microscopy. The cutin, cork, etc. of the cell wall resist penetration. The heat necessary to melt paraffine often renders the tissue too hard and brittle for successful manipulation. Free-hand sectioning is often the only available method. Frequently this is all sufficient. Celloidin (or collodion) is available for imbedding young and soft tissues, requires no heat and its general cleanliness and easy manipulation recommends its use whenever possible. But many plant tissues are of too firm and resisting a structure to render the use of celloidin even possible. Seeds in their mature condition, will not permit the use of celloidin, and seem to almost defy the penetration of paraffine.

In attempting to study the development of ovule in the Compositæ, I was led to find some way of obtaining perfect series of sections through the flower. The forms studied were *Grindelia squarrosa, Helianthus annuus,* and a cultivated species of *Ageratum.* In most of the Compositæ the tissues of the flower become very resistant to the section knife, even at an early period. The testa of the seed is not easily penetrated by reagents. The peculiar structure of the ovule found in many Compositæ, called *éndodermis* by Hegelmaier, becomes very hard and brittle on application of heat.

Rowlee[1] obtained good sections of ripe seeds by the paraffine method, after first soaking them in water twenty-four hours before dehydration. Having seen his sections I determined to try some modification of his method. As I did not study the mature condition of the ovule, I did not soak any of the material in water.

The tissue was hardened first in 25% and then 50% alcohol, and preserved in the latter. Then as material was needed it was dehydrated in a Schultze's dehydrating apparatus into 95% alcohol, then placed in the following substances successively, one to several days each: 95% alcohol and

[1]Imbedding and Sectioning Mature Seeds, Proceedings American Society Microscopists, 1890.

chloroform equal parts, pure chloroform, chloroform with a small per cent of paraffine dissolved, increasing the percentage of paraffine from time to time, using just heat enough to to keep the solution a liquid, "soft" melted parafine, finally "hard" melted paraffine. The time required for the process was sometimes two to three weeks, but with the younger tissue, much less. As will be seen, I followed the ordinary method, but used more time. I am satisfied that many of the so-called insuperable difficulties connected with paraffine infiltration can be overcome by patience and time-serving.

Turpentine, I did not find as satisfactory a reagent as chloroform, probably because the latter will penetrate even if dehydration is not complete. I find alcohol a stisfactory hardening reagent. McClatchie recommends the use of chromic acid in hardening plant tissue. I failed to see its superiority over alcohol.

The staining was done mostly on the slide. Most of the ordinary nuclear stains worked well. The most satisfactory stains all around were Czokor's Alum Cochineal for the nucleus, and an alcoholic solution of bismarck brown for the cell wall. When managed properly saffranin gave most beautiful results. Alum-cochineal, borax-carmine, saffranin, haematoxylin, fuchsin, and picro-carmine utterly failed to penetrate the specimens in mass. Orth's lithium-picro-carmine was the only stain that penetrated in mass enough to differentiate the structure of the embryo-sac.

THE DEVELOPMENT OF THE AUDITORY VESICLE IN NECTURUS.

BY H. W. NORRIS.

Owing to the lack of a complete series of embryos, I have been unable to trace the earlier stages of the development of the ear. In all the Amphibia, so far as studied, unless we except the species of Axolotl figured by Houssay, and he was doubtless in error, the ear arises as a differentiation of the inner of the two layers into which the ectoderm is early divided. This inner sensory layer thickens on each side of the head so as to form a small sensory tract, the *anlage* of the ear, closely analogous, if not homologous, in formation to the lateral line sense organs. An ingrowth or inpushing of the thickened ectoderm results in the formation of a pit. The outer layer of indifferent ectoderm takes no share in the formation of the auditory vesicle, but it is slightly involuted into the opening of the pit. The pit deepens, its edges approach each other until the pit becomes a closed vesicle. This description applies to development of the ear of the frog as studied by Villy[1] and of the salamander, Amblystoma, as studied by myself[2].

[1] Development of the Ear and Accessory Organs of the Frog. Quart. Jour. Mic. Sci., No. CXX., 1890.

[2] Development of the Ear of Amblystoma. Jour. Morph., Vol. VII, No. 1, 1892.

The earliest stage that I have as yet found in the development of the ear of Necturus is that shown in Fig. 1. The auditory involution has just begun. In Fig. 2 the growth has proceeded so far that the pit is nearly closed. After the complete differentiation of the vesicle the ear is of a pyriform shape with the apex directed toward the dorsal part of the brain (Fig. 5). The apical portion soon becomes distinctly marked off from the rest of the vesicle as the *recessus labyrinthi* (Fig. 6). In Amblystoma I observed that the dorsal side of the primitive pit was the last to close up, thus giving support to the belief that the recessus of the Amphibian ear is strictly homologous to the recessus of the Elasmobranch ear, in which the primitive connection with the exterior is maintained through life. Just the reverse process is said, by Villy, to occur in the frog. In Necturus I have not satisfactorily decided how the recessus is formed. As the vesicle increases in size the recessus becomes more distinctly marked off, its apex grows dorsally till it lies over and upon the brain. Instead of opening into the dorsal portion of the vesicle its aperture is situated on the median side close to the brain (Figs. 8 and 10). The semi-circular canals are formed in the typical manner. As in Amblystoma the horizontal canal is the first to make its appearance. Folds of the walls of the vesicle grow in so as to imperfectly divide the ear into a number of parts: sacculus, utriculus, semi-circular canals, etc. The beginnings of the processes that result in the differentiation of the various parts of the ear are shown in Figs. 8 and 10.

The later stages have not been studied in detail, owing partly to lack of material. But this much may be stated with certainty: The ear of Necturus in its morphology and ontogeny does not differ in any important respect from that of Amblystoma. Necturus is regarded as representing a more ancestral type than Amblystoma; hence we should expect to find its organs more generalized. But it is usually unsafe to base sweeping comparisons in relationship on the similarities or dissimilarities of single organs. The sense organs connected with the various parts of the ear correspond to those in Amblystoma. But of the existence of the *pars basilaris* I can state nothing. Retzius[3] denies its existence in Proteus, the near relative of Necturus.

The orders of recent Amphibia are three. Each order has its peculiar modification of the membranous part of the ear. The ear of the Caecilians seems to be the most primitive of these, from the research of the Sarasin Brothers[4]. I find in Necturus no vestiges of the peculiarities of the Caecilian ear.

The material on which this paper is based was obtained from Miss Julia B. Platt, of Chicago University.

Explanation of figures and abbreviations used:

Au auditory involution, auditory vesicle, ear; *aug* auditory ganglion; *br* brain; *ca* anterior semi-circular canal; *ch* chorda; *ei* indifferent layer of ectoderm; *ent* entoderm, roof of mouth; *es* sensory layer of ectoderm; *mes* mesoderm; *nr* neural ridge; *opt* eye; *o* aorta; *r* recessus; *sed* dorsal fold of septum of horizontal canal; *sev* ventral fold of septum of horizontal canal.

Figs. 1, 2, 5, 6, 8 and 10 are camera lucida drawings of sections. Figs. 3, 4, 7, 9 and 11 were drawn under the writer's direction from alcoholic material, by Mr. H. G. Willard.

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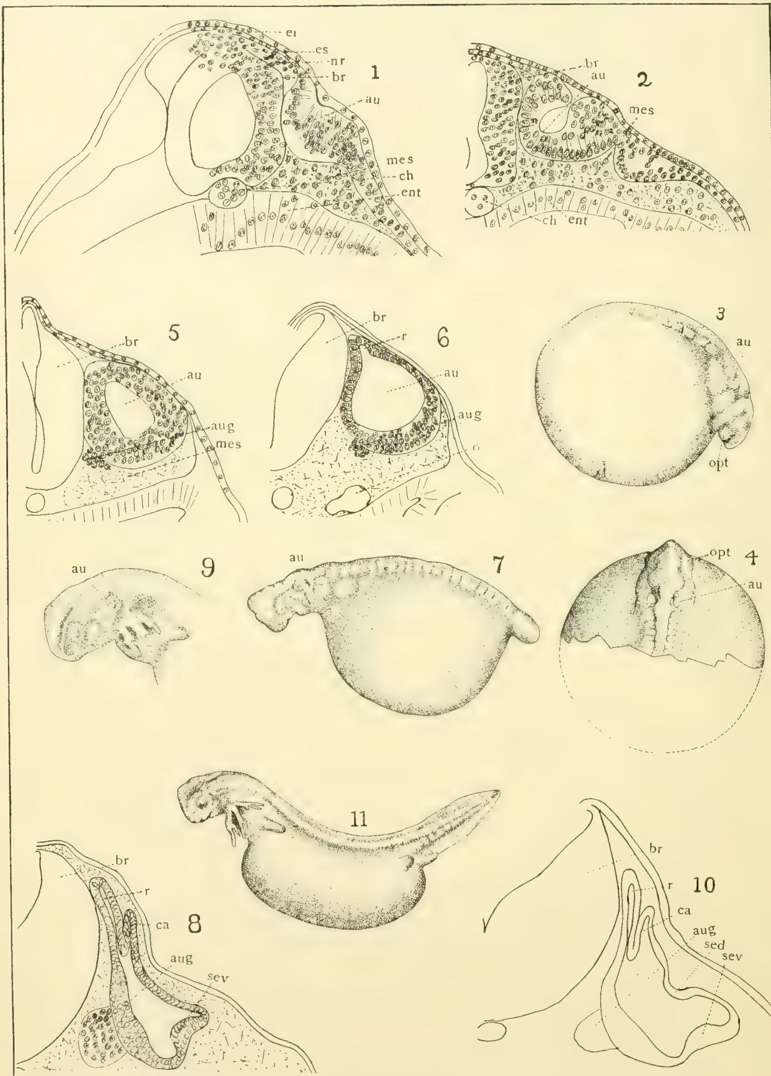
[3]Das Gehororgan der Wirbelthiere, Stockholm, 1881-84.

[4]Ueber das Gehororgan der Caeciliiden, Anat. Anz., Nos. 25 and 26, 1892.



Norris & Willard del.

PLATE I.

Fig. 1. Transection of head through auditory region at time auditory involution is just beginning.

Fig. 2. Similar section of embryo of the age of the one shown in Figs. 3 and 4.

Fig. 5. Similar section of somewhat older embryo.

Fig. 6. Similar section of embryo shown in Fig. 7.

Fig. 8. Similar section of embryo shown in Fig. 9.

Fig. 10. Similar section of embryo shown in Fig. 11.

Figs. 1, 2, 5, 6, 8 and 10 are magnified 50 diameters; Figs. 3 and 4 five and one-third diameters; Figs. 7 and 9 four diameters; Fig. 11 three diameters.

AN INSTANCE OF THE PERSISTENCE OF THE DUCTUS VENOSUS IN THE DOMESTIC CAT.

BY H. W. NORRIS.

After injecting with starch-mass through the right femoral vein it was found that the entire arterial system of the cat was filled with starch. Investigation showed the presence of good sized functional ductus venosus through which the arterial and venous systems communicated. The individual possessing this peculiarity was, in life, troubled with what is vulgarly called "fits," whatever that may have been in this particular case. I should be loth to admit any relation between "fits" and the presence of a functional ductus venosus without more extended data.

ADDITIONAL NOTES ON IOWA MOLLUSCA.

BY B. SHIMEK.

About five years ago the writer published an annotated list of Iowa *Mollusca** under the title "*The Mollusca of Eastern Iowa.*" Material has been secured since by which many of the species have been traced across the entire State, and which also throws much additional light on the synonymy of some of the species.

Without an attempt at a thorough and complete revision of the former list a few notes on species heretofore mentioned are presented, and a number of species which have been collected or recognized in the State since the

*Bulletin from the Lab. of Nat. Hist. of the State University of Iowa, Vol. I, No. 1, November, 1888.

former publication, are included. These notes are presented in the following annotated list:

Family STREPOMATIDÆ.

Genus Goniobasis.

G. livescens, Menke.—In the former list *G. cubicoides*, Anth. is reported on the authority of Prof. Witter. Mr. Keyes also reports it*. Since the publication of the name about 100 specimens of a *Goniobasis* which was collected in the Des Moines river, at Humboldt, by Mr. L. B. Elliott. were received. Most of them agree exactly with the description of *G. cubicoides*, but a comparison of the entire set with authenticated specimens of *G. livescens*, Mke. from Michigan, Indiana, and New York leaves no doubt that they are the same. The specimens from Humboldt are, therefore, referred to *G. livescens*, Mke.

Family RISSOIDÆ.

Genus Pyrgulopsis.

P. scalariformis, Wolf.—The identity of *P. mississippiensis*, Call and Pilsbry, reported heretofore, and Wolf's species have already been established by me.†

Family VIVIPARIDÆ.

Genus Campeloma.

In the former list three species were admitted: *C. decisum*, Say, *C. subsolidum*, Anth., and *C. rufum*. If we accept Call's revision of the genus‡ two other specimens (?) should be admitted, namely *C. integrum*, Say, and *C. obesum*, Lewis. I cannot, however, see any valid reason for recognizing all these "species" and feel like exclaiming with Mr. Simpson: "Why name anything that has neither beginning nor end?" These shells form a series of which the narrower, more elongated *C. subsolidum* and *decisum* form one extreme, *C. integrum* is a form usually intermediate and *C. rufum* and *obesum*, proportionately wide forms, represent the other extreme. Extreme, or "type" forms are apparently distinct, it is true, but there is such a gradual transition from one form to the other that the student who would attempt to separate a large number of specimens soon becomes inextricably tangled. In this connection I would speak with the least assurance of *C. decisum* as it is possible that the Iowa forms which have been variously referred to in this species are merelv variations of *C. subsolidum*. *C. subsolidum* and *C. obesum* connect closely by intermediate forms, and *C. integrum* cannot be separated from either satisfactorily.

C. rufum, in its extreme development, seems to be very distinct, but in a large series of the form obtained at Cedar Rapids, where I have collected it in the Cedar river during almost every one of the past eleven years, the pink color of the apex and interior of the aperture and the sculpturing of the surface are by no means the reliable characters which they are represented to be, and the form grades insensibly into *C. obesum*. It seems that Mr. Binney's disposition of these forms‖ is still the best, and that all should

*An Annotated Catalogue of the Mollusca of Iowa.—Charles R. Keyes, in Bulletin of the Essex Institute, Vol. XX, 1889.

†Bull. Lab. Nat. Hist. S. Univ. of Iowa, Vol. I, No. 2, June, 1892.

‡On the Genus Campeloma, R. Ellsworth Call—Bull. Wash. Call. Lab. Vol. I. No. 5.

‖*Land and Fr. Water Shells* of *N. Am.*, part III.

be grouped under *C. decisum*, Say, if that form is a part of the series, or under *C. integrum*, Say, if the former is distinct. Reversed specimens of *C. rufum*, *subsolidum* and *obesum* have been collected.

Family ZONITIDÆ.

Genus Zonites.

The Lœss fossil which was reported in the former list under the name *Z. limatulus*, Ward with the suggestion that it is probably distinct has since been described by Mr. H. A. Pilsbry, under the name *Z. shimekii*. A large series collected in the Lœss of Iowa and Nebraska shows this to be very constant in its characters.

Family HELICIDÆ.

Genus Vallonia.

In the former list two forms were reported: *V. pulchella*, Muell, and *V. pulchella costata*, Muell. Dr. Victor Sterki, who has recently published an extensive monograph of the genus* recognizes four species among the forms occurring in Iowa. They are:

V. Pulchella, Muell—The large, smooth (ecostate) form with nucleus smooth.

V. gracilicosta, Reinhard—Equally large or larger, but with distinct costæ and nucleus spirally marked with faint ribs or lines.

V. *parvula*, Sterki—Small; ribs prominent; nucleus with fine revolving lines; body-whorl not descending to aperture above. Lip reflexed.

V. perspectiva, Sterki—Small; ribs prominent; nucleus without lines; body-whorl descending to aperture; lip none, or only slightly expanded.

Of these *V. pulchella* is the form formerly recognized by that name, while the last three were collectively included under the *var costata*, specimens of *gracilicosta* being also mingled with *V. pulchella*.

I have specimens of *V. pulchella* as here restricted from Iowa City and Muscatine.

V. gracilicosta, Reinhard, was collected by me at Eastport, in Fremont county.

V. parvula, Sterki, is the form which was most commonly sent out as *var. costata*. It is very common at Davenport, Muscatine, Iowa City and Eastport. This is clearly a distinct species, not like *var. costata*, as comparisons with European specimens of the latter clearly show. It is not at all difficult to distinguish between this and *V. pulchella*, and the only wonder is that they were ever united.

V. perspectiva, Sterki—Four specimens of this species were sent to Dr. Sterki from Eastport. A microscopic examination of a large number of shells shows that the markings of the nucleus and the deflection of the body-whorl are not always satisfactory characters and it may be necessary to consider *V. perspectiva* a variety of *V. parvula* and perhaps *V. gracilicosta* a variety of *V. pulchella*, unless other characters than those enumerated should determine otherwise.

Family PUPIDÆ.

Of the species heretofore reported, the following have been found at Eastport, Fremont county: *Pupa armifera*, *contracta*, *pentodon*, *fallox* and *milium*, and *Vertigo ovata*. *Vertigo milium* should have been *Pupa milium*

*Observations on Vallonia, by Dr. V. Sterki.—Proc. A. Nat. Sc. Phil. May 30, 1893.

and *V. simplex* is *Pupa edentula alticola*, Ingersoll. The following are additional species:

Pupa curvidens, Gld.—Found at Iowa City and Eastport. Rare.

Pupa edentula, Gld.—Two living specimens of this species were found at Iowa City.

Pupa procera, Gld.—This species, which is usually distributed under the name *P. rupicola*, Say, is common in Fremont county at Eastport, and one specimen was found at Iowa City.

Pupa holzingeri, Sterki.—Very common at Iowa City, Davenport (Prof. Sheldon) and Eastport. One specimen from Eastport is reversed.

Vertigo tridentata, Wolf. Rare at Eastport. Not rare at Iowa City. This was reported as *V. gouldi*, Binn.

Vertigo bollesiana, Morse. Iowa City and Eastport. Rare.

Family SUCCINIDÆ.

The form reported as *Succinea higginsi*, Bld. cannot be considered as distinct from *S. ovalis* and should be dropped from the list. The very large form heretofore referred to *S. avara*, which is common in low lands and as a fossil in the Loess, and which sometimes approaches *S. obliqua* in size, is probably entirely distinct from *S. avara* and all described species. A thorough study of the shells and anatomy of this form will be made as soon as possible in order that this point may be settled.

Succinea lineata, W. G B. should be added to the list. It is common in the Loess westward, and a few bleached though probably recent specimens were found near Hamburg, Fremont county.

Family AURICULIDÆ.

Genus Carychium.

C. exiguum var. exile, H. C. Lea. This slender form is common at Iowa City and Eastport, and probably in all other portions of the State in which *C. exiguum* occurs.

Family LIMNÆIDÆ.

Physa lordi, reported on the authority of Call, should be dropped from the list. The specimen proved to be a deformed *P. heterostropha*, Say.

Planorbis albus, Muell., reported as rare and only in the northern part of the State; is common in "Cedar Lake" at Cedar Rapids.

Family CYRENIDÆ.

Genus Sphærium.

Twelve species were reported in the former list, but this number must be cut down. *S. solidulum*, Pr. is without doubt *S. sulcatum*. Extreme forms differ, but a great number of immediate links can easily be found. *S. stamineum*, Con. as reported, were old *S. rhomboideum*. The specimens were named by Call, and included in the list on his authority. Comparison with a series of *S. rhomboideum*, since dredged in the same pond, shows that the shells were old, heavy *S. rhomboideum*.

The true *S. stamineum*, Con. is common at Iowa City, but after an examinaton of several quarts of specimens I cannot distinguish this from *S. striatinum*, and more than that the *S. sulcatum* and *S. striatinum* series often approach so close together that it is almost impossible to satisfactorily place some species.

S. fabulis, as reported, is an extreme form of *S. solidulum*. It should be dropped from the list.

S. partumeium, *S. jayanum*, and *S. sphoericum*, as identified by Prof. Witter, also from one series, and are the same species, *S. sphæricum* being intermediate. Our specimens are not typical *S. partumeium*, but resemble typical *S. jayanum* more nearly. If *S. partumeium* should prove to be a valid species, which is doubtful, then all of our specimens (including *S. sphaericum* as identified by Prof. Witter) must be referred to *S. jayanum*, Prime.

This leaves seven species of *Sphaericum* in the State: *S. sulcatum*, *Lam.*, *S. striatinum*, Lam., *S. rhomboideum*, Say, *S. jayanum*, Prime, *S. transversum*, Say, *S. secure*, Prime, and *S. truncatum*, Lius.

Mr. Charles R. Keyes, in the list already referred to, also reports the following additional epecies:

Tridopsis palliata, Say.
Ancylus tardus, Say.
Ammicola orbiculata, Lea.

VARIATION IN THE SUCCINIDÆ OF THE LOESS.

BY B. SHIMEK.

The recent species of the genus *Succinea* are certainly puzzling, but those which are found as fossils in the loess deposits of the Missouri and Mississippi valleys are positively bewildering. The fossil forms belong principally to the *avara* and *obliqua* groups, but few specimens belonging to the *ovalis* group occurring. Without entering into a detailed discussion of the various forms it may be briefly stated that an examination of the specimens, both recent and fossil, which are herewith submitted, will show the following facts:

The three forms which are commonly found in the loess are *S. obliqua*, Say, *S. avara*, Say *S. lineata*, Binn. A careful weighing of the variation in the recent specimens of these species, supplemented by the almost unbroken series of fossil forms, shows that typical *S. avara* varied through the larger form of the same species to *S. obliqua* in one direction, with a smaller branch running into *S. lineata* in another. In other words, I am convinced that however different these species may appear now, they were once the same, the original stock occurring perhaps just before the loess.

The variation in these forms, or in the original form, was not the result of climatic conditions, for all forms often occur in the same deposit.

It is expected that a more complete report on this variation, with proper plates, will be elaborated in the near future.

It may be of interest to note that our small typical fossil, *S. avara*, is identical with *S. oblonga*, Drap., from the loess of Germany.

THE JOHNS HOPKINS BIOLOGICAL LABORATORY.

W. S. WINDLE.

For the past fifteen years it has been customary for the members of the biological department of Johns Hopkins University to devote their summer vacations to pursuing their studies upon the sea shore, where living marine animal forms may be secured for daily use.

The Johns Hopkins Marine Laboratory, as the organization is called, is under the direction of Prof. W. K. Brooks, and has been confined to no permanent location, but has been moved about from place to place as the wishes of those most interested demanded. The work of many seasons was devoted to the study of forms found in the waters of the Chesapeake Bay. For six years the laboratory was stationed at Beaufort, N. C. Then three summers were spent in the waters which bathe the shores of the Bahamas; Green Turtle and Binning islands having been chosen as stations for biological research. Finally the organization went as far south as the island of Jamaica, upon the coast of which it has spent two seasons.

The site of the present marine laboratory is Port Henderson, a private seaport on the south side of the island. It is a quaint old village of a dozen buildings or more, used as a seaside resort for Jamaicans of leisure and wealth. A more attractive and suitable spot in that vicinity could not have been found for our party of seven.

In the immediate rear of the village Salt Pond Hill rises abruptly to a height of 1,000 feet or more, and upon its highest point are the ruins of an old stone fort known as Rodney's Lookout. Here, in the early days of pirates and buccaneers, Admiral Rodney had his stronghold, whence he could look out upon the harbor and open sea and detect the approach of hostile visitors. From the verandah of our laboratory, which was within a stone's throw of the sea, we were afforded a grand view of Kingston Harbor, in which the entire fleet of the English navy might anchor with safety. To the north of the village the low sandy beach extends past the village of fishermen's cabins, and beyond old Fort Augusta to the Rio Cobra river. Across the harbor, four miles away, Kingston, the capital of the island, appears in dim outline. Across the neck of the harbor, two miles to the southeast, the old town of Port Royal stands upon the end of a low, narrow promontory, known as the Pallisadoes. To the south the shore rises rapidly to form a steep, rocky and dangerous coast. Between this coast and the pallisadoes, the harbor opens out into the deep waters of the Caribbean Sea. The beautiful landscape stretched out thus before us was completed, from an artist's standpoint, by the Blue Mountain range, which formed a dark gray background to the east and north, leaving the boundless sea to meet the horizon in the southeast.

The building which we termed our Marine Lab. was a large one-story stone structure known as the "Sister-Houses." It was light, airy and comfortable, affording ample room for our party of seven. Each member of the company occupied a separate table and upon this his microscope was placed, together with a varied collection of specimens, preserving fluids, dishes, aquaria, scalpels, needles, pipettes, etc., the whole forming a veritable biologist's corner. It was through the kindness of Dr. Brooks that we secured a temporary loan from the Johns Hopkins Biological Dept., of all the necessary chemical reagents, general apparatus, many valuable books of reference, etc., to equip our seaside laboratory very fully and satisfactorily. We had a sloop and light row boat at our command, also the services of a native boatman. While we were supplied with more than that needed for our immediate wants, yet a steam launch and apparatus for deep sea dredging by steam power, would have been very acceptable. It is hoped that these additions will be made during next season.

The location at Port Henderson offers many facilities for biological research. Numerous small coral islands, so called Cays, from two to ten miles out at sea, are rich in Crustaceans, Anemonae, Ophiurans, Astrophytons, Serpula. Terebrella and numerous species of Alcyonaria, Astraea and Madrepora. Near Port Royal were numerous mangrove ponds—where the bushes hang extended into the shoal water so as to form ponds and channels of quiet sea water—we found life very abundant there. Clusters of Clavelina, Simple Ascidians and colonies of hydroids grew upon the mangrove roots in endless profusion, while star fishes, sea urchins and Holothurians were abundant.

A large salt water lagoon two miles south of our laboratory and along the coast was inhabitated by numerous crocodiles and turtles. There we also found a large jelly fish—cassiopoea in abundance; also gasteropods and crustaceans. The surface collections in the bay afford an endless variety of forms for study. Good opportunity for work is also found on land. The hill in the rear and the broad valley ot the Rio Cobra river not far away are stocked with land crabs, lizards, termites, scorpions, etc. Bird life is not so abundant as we had anticipated, and the herpetologist will find no snakes, but only the mongoose in their places. The flora of Jamaica is rich and varied; ferns, palms, crotons and cacti predominating.

By those best acquainted with the coast of Jamaica, the site of Port Henderson is considered to be the most suitable location on the island for a permanent marine laboratory As indicated above, it offers superior advantages for study of animal forms in the tropical waters. Situated in the immediate vicinity of Kingston all the temporary needs of the school may be readily supplied. It is also in direct communication by steamer and cable with New York and Liverpool. The location affords such general satisfaction that prominent biologists at home and abroad have considered plans for establishing a permanent international marine biological station at that place. It is sincerely desired that all preliminary steps taken in this direction may lead ultimately to the establishment of the much needed institution on American shores.

A complete report of the various expeditions taken by our party with detailed accounts of collections taken, also of the work of each student, explaining his methods of preserving and studying material, would require more time than the present occasion admits; suffice it for the present. to submit the following:

PRELIMINARY NOTES ON PELAGIC ANIMALS FOUND IN KINGSTON HARBOR.

The only suitable times in the day for surface collecting were early in the morning or late in the evening, when neither land nor sea breeze disturbed the placid surface of the water. Our outfit was quite simple, consisting of a light row boat, two water pails and two nets of fine silk bolting-cloth. The nets were similar to dip nets in shape; no handle, however, it being replaced by a long cord arranged to draw the net horizontally through the water. When engaged in surface-collecting we usually rowed out upon the bay a half-mile or more from shore, then threw over the nets to drag from the stern of the boat. Richest collections were taken when the rims of the nets extended partly out of the water, so as to skim the surface to a depth of twelve inches.

Huxley recommends following the "plancton streifen" or trails of "dead water," but we found so much debris from the shores in these trails that we abandoned them, although richer in animal and plant life than other places. The nets were emptied every few moments in the pails which were one-half full of fresh sea water. After about an hour's rowing we returned to shore, filled the pails with fresh sea water and repaired directly to the laboratory. The catch was examined in a preliminary way, very hastily, by dipping out small portions in glass dishes. These were held toward the light of a window or lamp, when swarms of pelagic forms appeared, swarming about in great confusion. If desirable specimens appeared they were transferred by means of a wide-mouthed pipette to small aquaria of fresh sea water, or put directly into the fixing reagent previously prepared. Small jelly-fish and Ctenophores were removed very carefully by means of deep watch-glasses.

Among the countless multitudes of varied forms taken we found larval crustaceans predominating. Representatives of the Nauplius, Zoea and Megalops stages were all present, a few only of the best, however. Larvæ of shrimps (Palæmonetes), land crabs (Maji), lobsters (Homarus), rock-crabs (Cancer), Stomatopods, etc., were among those present. Of adult crustaceans we found Copepods, Lucifers, Phyllopods and Ostracods. No Nebalia were taken. Numerous Plutei of Ophiurans and Sea Urchins (Strogylocentrotus), also a few Bipinnaria were collected in early part of July. Sagitta represented the Annelids chiefly, while Appendicularia alone of the Tunicates appeared,—no Salpa being found as at Binning, Woods Holl, and other places. A number of Cœlenterates were always collected in the "tow"—*i. e.*, Medusa of Obelia, sections of Diphyids, Aurelia, a few planulæ, Irene, etc.

Large Ctenophores (Cydippidæ) continually annoyed by their presence. Larval fish, in various stages of development, also minute adults were frequently caught.

It is interesting to note the fact that plant life was richly represented in the "tow" by numerous species of Algæ, Diatoms, species of Protococcaceae, also Trichodema were determined.

In preserving the delicate larval forms alive in aquaria, for study we found difficulty, and only succeeded by using large glass dishes (scrupulously clean) They were kept from direct sunlight and the water was changed or fresh quantities added every three or six hours, as the case might require.

Several methods were adopted for fixing and preserving the material, according to the character of the specimens in hand.

Medusæ were successfully prepared by—

1. Placing into solution, until they sink to bottom:
   $\left\{ \begin{array}{l} 10\%\ CuSO_4 - 100\ c.\ c. \\ \text{Sat. sol. } HgCl_2 - 10\ c.\ c. \end{array} \right.$
2. Into 5% $K_2Cr_2O_7$—1–7 days.
3. Wash thoroughly in water.
4. Graded alcohols, 35–90.

Larger Jelly-fish and Ctenophopes were preserved for histological purposes by using—

1. Erlicki's fluid, 6–10 days.
2. Wash in water slightly acid.
3. Graded Alcohols, 33–90.

Crustacean larva were treated.

1. Sat. aq. sol. $HgCl_2$—5 minutes.
2. Wash with 33% alcohol and transfer through graded alcohols to 90%.

Other methods were tried but best results were obtained by using those above described.

Surface collections from tropical waters are intensely interesting to the student of animal life. There in the surface water of the sea he finds the great nursery of marine forms, both plant and animal. Further, we are informed, sufficient reason warrants the statement that, likewise, all living forms had origin in minute, free-swimming organisms upon the bosom of the ocean in past ages. A candid study of the life histories of typical animals—in which they pass from a simple cell through various metamorphic stages to the adult forms—confirms the doubtful in the doctrine of evolution. And a true conception of relationships existing between members of so called families reveals the truth of the oft repeated statement, that "the ocean is the original haven of all life." The more we become conversant with marine life the more definitely are we impressed with the fact that it is from that source we must ask further information, that shall throw light upon many Biological problems at present unsolved.

THE VASCULAR SUPPLY OF THE TEETH OF THE DOMESTIC CAT.

C. C. NUTTING, IOWA CITY.

After all that has been written about the anatomy of the domestic cat it would seem a hopeless task to find any facts of real importance in a field so carefully gleaned by Wilder and Gage and a host of other writers of the past and present.

While pursuing investigations on the teeth of the mammalia as a preparation for lectures on Comparative Odontography before the Dental Department of the State University of Iowa, the writer became convinced that there were certain radical misconceptions among anatomists and histologists as to the manner in which the blood is distributed to the teeth. It is quite possible that this has already been correctly stated by some writer unknown to me. If such is the case it is evident that little heed has been given to the matter by English and American authorities, among whom I have been unable to find a single clear and lucid, as well as correct account of the vascular supply of the teeth. This, then, is my excuse for adding to the already multitudinous contributions to the anatomy of the domestic cat. Dissections and microscopic preparations of injected decalcified teeth of the cat, and also of the rat, in which the entire jaw with all the teeth has been ground down to the requisite thinness, show conclusively that the manner in which the teeth obtain their vascular supply is not understood or at least not properly expressed by the best authorities accessible to the student.

This matter obtains a further importance in view of the strong probability that there is no great difference between the human and feline anatomy in this particular, and a likelihood that the errors in the one case have been paralleled in the other.

First—What is the present teaching as to the method by which the teeth are supplied with blood? The following quotations will be sufficient to answer this question.

[1] "The pulp contains the nerves and blood vessels of the tooth, which pass into the pulp through the foramen at the point of the fang." [2] "This (the pulp cavity) communicates with the external surface of the tooth by a small aperture at the apex of the root." [3] "The blood vessels and nerves penetrate by a little orifice at the extremity of each root." [4] "The vessels of the pulp are very numerous; three or four arteries enter at the apical foramen." [5] "The lower teeth derive their vascular supply from the branches given off to each tooth by the inferior dental artery, itself a branch of the internal maxillary." [6] "The pulp consists of a soft connective tissue, and some nerve fibres which pass into the pulp cavity along with the blood vessels by a minute canal at the apex of the fang." [7] "The arteries and nerves, which are derived from the internal maxillary and fifth pair respectively enter by the aperture at the point of each fang." [8] "The dental and incisor arteries during their passage through to the substance of the bone give off a few twigs which are lost in the cancellous tissue, and a series of branches which correspond in number to the roots of the teeth; these enter the minute apertures at the extremities of the fangs and supply the pulp of the teeth."

Dr. G V Black, in his work on the periosteum and peridental membrane, comes nearer a correct statement of the manner in which blood is supplied to the teeth than any other writer whom I have been able to consult. He says:

[1]Prof. Wm. Turner, Enc. Brittanica, Vol. VII., p. 234.
[2]Prof. W. H. Flower, Enc. Brittanica, Vol., XV., p. 349.
[3]Human Physiology, Flint. p. 191.
[4]Dental Anatomy, Tomes, p., 106.
[5]Dental Anatomy, Tomes, p 36.
[6]The Essentials of Histology, Schafer, p. 128.
[7]Quain's Anatomy, Ninth Edition, p. 550.
[8]Gray's Anatomy. p. 523.

"The blood supply of the peridental membrane is very bountiful in the young subject. The larger arteries enter the alveolus mostly at the apical space, or rather one or two vessels enter here and immediately break up into smaller ones. One or two of these enter the root canal to supply the pulp of the tooth, while the others, from four to six or eight, pass down along the sides of the root to supply the peridental membrane. In their passage down the membrane these divide into many branches, a considerable number of which enter the haversian canals of the alveolar wall or receive branches from that source."[9] My own sections convey a somewhat different impression. By far the greater number of arteries enter the alveolus in the spaces between the roots, of molars, and none of these, so far as I can discover, go directly to the root canal and thence to the pulp. A very large number of vessels enter the peridental membrane from the entire extent of the alveolus.

Dr. Black seems to have drawn his conclusions largely from sections of teeth of the lower animals, such as the sheep, dog, cat and pig. Indeed, I can find no one who seems to have made a special study of injected human teeth ground down in situ. The extreme difficulty of securing suitable material for such investigations may account for this fact.

From the above quotations, which give all that is said on the subject by a number of our best and most recent authorities, it is evident that they understand the blood to be supplied to the teeth in the following manner:

The internal maxillary and inferior dental arteries supply the teeth of the upper and lower jaws by giving off a branch to each root, the branch entering by a single aperture at the apex of the root. We are also given to understand, although definite statements seem painfully deficient, that the branch which supplies each root passes from the main artery (internal maxillary or inferior dental), directly through the peridental membrane, and thence through the single apical foramen to the pulp. The present writer considers that he has demonstrated an essentially different method of supplying the blood to the teeth; at least of the domestic cat and the rat. The points of special importance are:

First. The inferior dental artery is not a single vessel; on the contrary, after entering the inferior dental foramen, it divides, within the canal, and the divisions anastomose and redivide in the most irregular and perplexing manner.

Second. There is nothing at all resembling the single branches of this artery which are supposed to be given off to supply each root; on the contrary, by far the largest and most numerous branches of this artery pass into the alveolar spaces between the roots of the teeth, and then break up into a maze of small vessels, most of which ultimately pass into the peridental membrane, considerably above the apex of the root.

Third. No vessels, so far as my series of sections shows, pass directly through the peridental membrane below the apex of the root, and thence upward into the pulp. On the contrary, a multitude of vessels enter the peridental membrane throughout its extent and pass downward toward the apices of the roots, where they enter foramina, through which the pulp is reached. The blood is thus distributed, first to the membrane, which is exceedingly vascular, then conducted by vessels in the membrane to the apices of the roots.

[9] Periosteum and peridental membrane, Black, p. 65.

Fourth. The blood does not ordinarily enter each root by means of a single apical foramen as commonly taught. On the contrary there are usually several, sometimes more than a dozen such foramina in a single molar root after the animal has reached maturity.

The above statements indicate such a radical change of view regarding the vascular supply of the teeth that something more satisfactory than mere assertions will doubtless be expected. In order to meet this reasonable expectation the illustrations accompanying this account have been prepared with considerable care. The sections from which the drawings are taken are injected and not decalcified, and were prepared by the writer, who still has them in possession. It will be understood that the views here advanced are based on numerous dissections and sections besides those illustrated by the drawings.

It was found that drawings were more available than photographs, for the reason that the thickness of the sections and the irregularity of the vessels required a depth of focus which could not be secured by use of the camera. Although all drawings are necessarily interpretations of the artists views, it is hoped that there is nothing misleading in the illustrations herewith presented. They may be considered correct in so far as they do not represent a single vessel pursuing a course not found in the sections examined.

In conclusion, your attention is called to the fact that this matter has a practical bearing. The teeth of the Carnivora, as Owen says, so closely correspond in their intricate structure both with each other and with those of the "Quadrumana" as not to require separate discussion. More than this it is highly improbable that there should be any essential difference between the teeth of the cat and those of man in the method of furnishing blood to this important structure.

Dr. A. O. Hunt, dean of the dental faculty of the State University, says that the excessive hemorrhage sometimes attending extraction of the teeth is due to the breaking of the septum between the teeth, which, as my sections show, contains large branches of the dental arteries. If these arteries penetrated directly to the pulp through the root excessive hemorrhage would always result from the pulling of the tooth. It makes a vast practical difference whether a multitude of minute vessels or one large vessel is broken. In the former case, little hemorrhage would result, while in the latter it would be a serious matter. These sections are necessarily thick, as thin sections would fail to show the continuity of the vessels, a vital point in the investigations upon which this paper is based. The sections, although quite thick, were rendered sufficiently translucent by long immersion in benzole, after which they were mounted in Canada balsam.

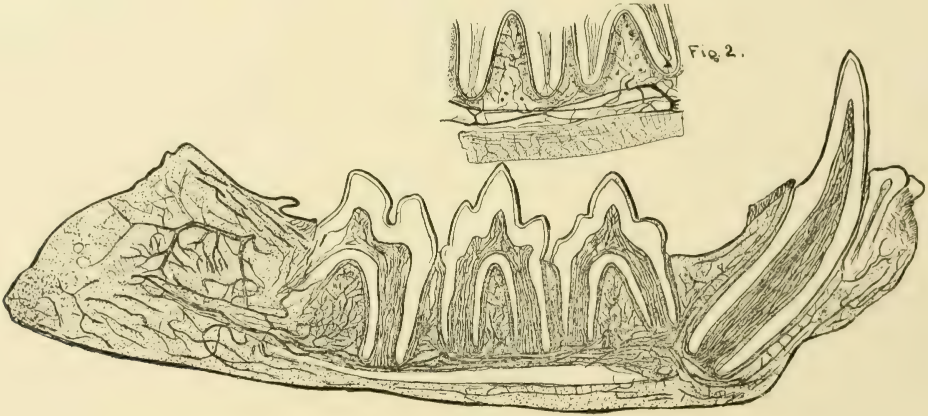


Fig. 2.

Fig. 1.

PLATE II.

FIG. 1. Vertical longitudinal section of lower jaw and teeth of cat, showing vascular supply.

FIG. 2. Vertical longitudinal section of roots of two lower molars and underlying portion of jaw of cat, showing anastomosing branches of the inferior dental artery. Drawn from section made by author.

THE HOMOLOGY OF THE "INCA" BONE.

BY C. C. NUTTING.

About two years ago, while examining the interesting series of prehistoric skulls in the collection of the Davenport Academy of Sciences, the writer became involved in an attempt to account for the supernumerary bone which some one has marked the "inca" bone. What the significance of the name may be, I do not know, but the significance of the *fact* is the object of the inquiry involved in this paper.

In a series of about twenty skulls examined by me there were at least six which exhibited the so-called "inca" bone, which is a portion of the occipital, separated from the remainder by a very distinct suture extending across the bone, following the "superior curved line," and about one-half inch above it. This suture is quite constant in position in every skull showing the "inca" bone.

The portion of the occipital which is thus cut off shows a tendency to itself divide into two or three pieces. But the sutures in this case are not constant in position and may, in fact, occur in almost any portion of the "inca" bone.

In attempting to homologize this peculiar bone, three possibilities occur:

First—The inca bone is the homologue of the supraoccipital of certain of the lower mammalia.

Second—The inca bone may be simply an enormously developed wormian bone.

Third—It may be a persistent embryonic character.

As to the first hypothesis, *i. e.*, that it is the supra occipital, we find that the supraoccipital in lower mammalia reaches to and forms part of the borders of the foramen magnum. The "inca" bone, on the contrary, is always remote from the foramen magnum, being above the superior curved line. It can thus be seen that the bone in question cannot be the supra occipital.

The second hypothesis, *i. e.*, that we have here merely an enormously developed wormian bone, would, at first thought, seem to be unworthy of serious consideration. But Gray[1] says, in his classic Anatomy:

"They (the wormian bones) vary much in size, being in some cases not larger than a pin's head, and confined to the outer table; in other cases so large that one pair of these bones may form the whole of the occipital bone above the superior curved lines."

This is the extent of the "inca" bone in all cases, and in at least one

[1]Gray's Anatomy, Eleventh Edition, p. 181.

skull, No. 9 in the sketches, the inca bone is vertically divided into two by a suture a little to the right of the median line. It is probable that if this particular skull were placed in the hands of Dr. Gray he would consider the "inca" bone enormously developed wormian bones. It seems to me, however, that there is a more natural explanation and one more in accord with the facts.

I have here the tabular portion of the occipital of a well advanced human fœtus. It is what would correspond to the supraoccipital of some of the lower mammalia. The bone is cleft on each side, the fissure being just above what will ultimately be the superior curved line. Looking on the inside of the bone, there are indications that at a still earlier stage of development this bone was separated into two parts, the separation being along a line a little above the superior curved line. This is exactly the condition of affairs found in the skulls with the "inca" bone. In other words, we have in the ordinary human embryo a condition of affairs which we find in the adult skulls of these prehistoric people. It seems likely, therefore, that we have here a persistent embryonic character.

Unfortunately I was unable to find any satisfactory record of these skulls in the catalogue of the Academy. Most of them were simply entered by number. One was marked "De Kalb Co., Ill.," and I was told that it and several others came from prehistoric graves in that locality.

If the "inca bone" was a characteristic of a definite race of human beings, it would certainly be sufficient to constitute a new species of the Genus *Homo*. If it was only an occasional, or even somewhat frequent abnormality, it may be regarded simply as a "reversion" indicating that the race possessing it was of a peculiarly low type.

NOTES ON THE DISTRIBUTION OF HEMIPTERA.

BY HERBERT OSBORN.

During the past few years I have received from a number of different sources, partly by purchase and partly by sets sent me for determination, a number of collections of Hemiptera, and as some of these records extend the known distribution of the species, or give more specific data regarding them, it seems desirable to give them a permanent record.

The principal collections on which the paper is based, aside from my own, are those made by Mr. Wickham in New Mexico, Arizona and California, and in the northwest, and purchased by the Agricultural College or by myself, those from Prof. C. P. Gillette, of Colorado, Prof. Lawrence Bruner in Nebraska, Prof. V. L. Kellogg in Kansas, Dr. C. M Weed in New Hampshire, and others.

The Hemiptera present us with a number of interesting cases of distribution. In some cases apparently dependent upon food plant, in others upon climate or temperature, but in some independent of any apparent condition. With some of the species it may be an endless task to determine the conditions which most affect their geographical distribution, and in such cases it is probably a combination of influences and no single one that determines their range.

Some of these notes were presented in a paper, abstract of which appears in part I, page 64, the full paper never having been published. Since the presentation of that paper, however, I have examined a number of collections and much increased the list of species mentioned, as well as the number of localities recorded.

Eurygaster alternatus Say. Mass., Iowa; Wyoming; Huntington, Oregon. Coeur d'Alene, Idaho; N. H.

Corimelæna atra Am. et Serv. Colorado.

Corimelæna albipennis Say. Colorado. Probably rare. Seems not to have been recognized since Say's description till a specimen came into my hands from Prof. Gillette.

Pangaeus bilineatus Say. Dallas, Oregon.

Amnestus spinifrons Say. Colorado.

Perillus splendidus Uhl. Colorado.

Perillus exaptus Say. Winnipeg.

Perillus claudus Say. Albuquerque, New Mexico; *var.* Huntington, Oregon; *var. c* Say. Colorado.

Podisus cynicus Say. Ill., Tenn., Tex., Colorado.

Podisus placidus Uhl. Colorado.

Podisus spinosus Dallas. Williams, Ariz.

Liotropis humeralis Colorado. Specimens from that state are larger than those collected in Iowa.

Prionosoma podopoides Uhl. Colorado and southwest.

Podops dubius Pal Beauv. Colorado. The specimens from Colorado seem to agree better with dubius than with *cinctipes* which is credited to the United States, while dubius is given in Uhler's check list as belonging to the West Indies.

Brochymena annulata Fab. Colorado.

Cosmopepla carnifex Fab. New Hampshire.

Cosmopepla conspicillaris Dallas. Colorado; Vancouver Island.

Mormidea lugens Fab. New Hampshire.

Euschistus fissilis Uhl. Colorado; Tacoma, Wash.

Euschistus tristigmus Say. Colorado; New Hamphire.

Euschistus impinctiventris Stal. Portland, Oregon.

Euschistus variolarius Pal Beauv. Albuquerque, New Mexico; Colo.

Lioderma ligata Say. Seligman and Williams, Arizona.

Lioderma sayi Stal. Seligman, Arizona.

Peribalus limbolarius Stal. Albuquerque, New Mexico; Colorado.

Thyanta rugulosa Say. Winslow, Arizona; Needles, California.

Thyanta custator Fab. Colorado.

Thyanta perditor Fab. S. Dakota.

Murgantia histrionica Hahn. Barstow, San Diego, Cal.; Albuquerque, New Mexico. This species is distributed very generally over the southern portion of the country extending from New Jersey on the east to southern California on the west. It was at one time feared it would overrun the northern states, and Prof. Riley some twenty years ago and other writers more recently have predicted such a danger but it would surely have as good an opportunity in the Mississippi valley as anywhere and the fact that it has made no advance to speak of in the last twenty-five or thirty years seems good evidence that it has a pretty definite southern limit. It will doubtless remain a serious pest to cruciferous plants through all the southern region and may be expected to become a pest in all settled localities in the southwest portion of the country.

Chariesterus antennator Fab. Colorado.

Leptoglossus cinctus H. Shaf. (?) Colorado.

Anasa tristis DeGreer. Albuquerque, New Mexico. This familiar eastern pest is generally distributed over the southwestern country and will doubtless prove a pest in those regions. I have seen it in destructive numbers in central Kansas.

Alydus conspersus Montandon. New Hampshire; Iowa. This form has been confused with the European *calcaratus* from which Montandon has separated it under the above name and has stated its occurrence in Michigan; Burlington, Iowa; Massachusetts, Colorado and Dakota. It is generally smaller and lighter colored than *eurinus* Say, but specimens can be picked out of any large series which approach that species in size and markings and the two seem to me to be quite closely related, though I believe Montandon is correct in distinguishing them.

Alydus pluto Uhl. (?) This is a large black form, but if my specimens are good examples it might be considered an extreme form of *eurinus* larger and blacker than the average forms.

Scolopocerus secundarius Uhl. Colorado.

Jalysus spinosus Say. Albuquerque, New Mexico; San Diego, California; San Bernardino, California.

Nysius thymi. New Hampshire.

Nysius Angustatus Uhl. Colorado. This species is widely distributed and somewhat variable. It approaches *thymi* in northeastern part of the country and *californicus* of the southwest, and it seems to me to present a very close relationship to the *senicionis* of Europe.

Nysius californicus Stal. Seligman, Ariz.; Albuquerque, New Mexico.

Orsillacis producta. New Hampshire.

Ischnorhynchus didymus Zett. Colorado; Washington; New Hampshire.

Cymus angustatus Stal. New Hampshire.

Cymus claviculus. New Hampshire.

Oedancala dorsalis Say. New Hampshire.

Ligyrocoris sylvestris Linn. Colorado; New Hampshire.

Emblethis arenarius Linn. Barstow, Cal.; Peach Springs, Williams, Ariz.; Colorado.

Eremocoris ferus Say. Colorado.

Peliopelta abbreviata Uhl. Lawrence, Kans.; New Hampshire.

Melanocoryphus bicrucis Say. Colorado. It occurs very rarely at Ames, Iowa.

Melanocoryphus facetus Say. Winslow, Ariz.; Colorado.

Lygæus bistriangularis Say. Seligman, Winslow, Ariz.; Los Angeles, Cal.

Lygæus reclivatus Say. Barstow, San Bernardino, Cal.

Oncopeltus fasciatus Dallas. San Bernardino, Cal.

Largus cinctus H. Schf. Los Angeles, Cal.
Largus succinctus Linn. Colorado.
Trigonotylus ruficornis Fall. Colorado.
Resthenia insitiva Say. Colorado.
Resthenia confraterna Uhl. Colorado.
Resthenia insignis Say. Colorado.
Resthenia rubrovittata Stal. Colorado.
Oncerometopus nigriclavus Reut. Colorado.
Lopidea media Say. Colorado.
Lomatopleura Cæsar Reut. Colorado.
Hadronema militaris Uhl. Colorado.
Hadronema pulverulenta Uhl. Colorado.
Phytocoris colon Say. Colorado.
Neurocolpus nubilus Say. Colorado.
Compsocerocoris annulicornis Reut. New Hampshire.
Calocoris superbus. Colorado, New Mexico.
Oncognathus binotatus Fab. New Hampshire.
Poeciloscytus basalis Reut. Albuquerque, N. M.
Poecilocapsus lineatus Fab. New Hampshire.
Systratiotus americanus Reut. Colorado.
Camptobrochis nebulosus Uhl. Colorado.
Monalocoris filicis Linn. New Hampshire.
Labops hesperius Uhl. New Hampshire. Uhler refers this to the western states, but typical forms and also a short-winged form have been received from Dr. Weed.
Dicyphus californicus Stal. Colorado.
Orectoderus amoenus Uhl. Colorado.
Macrocoleus coagulatus Uhl. Colorado
Neoborus pettiti. New Hampshire.
Piesma cinerea Say. Colorado.
Corythuca arcuata Say. Colorado.
Aradus rectus Say. Colorado.
Aradus debilis Uhl. New Hampshire; Colorado.
Phymata wolfii Stal. Seligman, Ariz.; San Diego, Cal.
Coriscus inscriptus Kirby. New Hampshire.
Coriscus ferus Linn. Colorado.
Sinea diadema Fab. New Hampshire.
Sinea spinipes H. Schf. Albuquerque, N. M.
Sinea conspersa Uhl. Los Angeles, Cal.
Fitchia nigrovittata Stal. Colorado.
Diplodus luridus Santiago. Winslow, Ariz.
Apiomerus spissipes Say. Albuquerque, N. M.
Apiomerus flaviventris H. Schf. Albuquerque, N. M.
Apiomerus ventralis Say. Colorado.
Pelogonus americanus Uhl. Nebraska.
Galgulus oculatus Fab. Albuquerque, N. M.; Colorado.
Zaitha fluminea Say. Needles, Cal.
Serphus dilatatus Say. San Bernardino, Cal.
Notonecta undulata Say. Albuquerque, N. M.
Notonecta mexicana Am. et. Serv.; Peach Springs, Ariz.
Corisa harrisii Albuquerque, N. M.

LABORATORY NOTES IN ZOOLOGY.

HERBERT OSBORN.

It is my purpose, in these notes, to call attention to some matters of experience in laboratory work which may be of service to other teachers and also to place on record the results of some studies by students that appear to be worthy of preservation.

Laboratory work in zoology has been carried on at the Agricultural College since 1876, and for nearly all of that time under my own supervision, so that while my own specialty has kept me busy in other lines some notes from the experience of these years may be of service to teachers who may be situated in similar localities. It is needless to suggest that work in an inland laboratory will naturally take somewhat different lines than a seaside laboratory.

We first began the use of marine material in our laboratory about ten years ago and at that time there was but one place where material suitably prepared and at prices consistent with laboratory work could be secured. Now a number of seaside laboratories as well as individual collectors furnish excellent material and no laboratory need want in this direction. Hydroids, starfishes, sea urchins and squids seem most essential as representatives of groups unknown away from the sea coast. The ease with which such material may now be had, the full treatment of these types in various guides and convenience of dissection may, however, almost be considered a danger as it may tend to the neglect of our common inland forms which it may, possibly, be a little more inconvenient to secure just at the time they are wanted. I believe we should be careful to avoid this danger, for students, especially those who may become teachers themselves, should be impressed with the fact that material for study is available at any point, and so far as they may be representatives of the groups to be studied, the species close at hand should be used.

The protozoans are of course available in every stagnant pool, but it is sometimes desirable to be sure of abundant supply of amoeba and other forms at a certain time, and this may be accomplished by keeping the contents of jars over from year to year, allowing them to dry up before winter or when not in use. For a number of years I kept a particular block of wood that furnished amœba regularly for a number of different classes. It was allowed to dry in autumn, the ooze with which it was coated of course remaining, and then two or three weeks before the material was wanted the jar in which it was kept was partly filled with water, and in due time an abundant crop of amœbæ could be secured.

The earthworm, clam and crayfish are of course standbys, and the only point I might suggest here is to have an abundant supply of these preserved, as it is sometimes difficult to secure these in abundance at just the time they are wanted. It is naturally demoralizing to a class to be short of material. and with classes numbering forty or fifty the question sometimes becomes a serious one. This is especially true in case the time for these subjects falls within a period of drouth when the earthworms may be out of reach except in favored spots, the crayfishes hidden in some very moist corner, or, with the clams, to be found only in some pool that has survived the drouth. Such material may be kept fresh in good sized tanks or aquaria, or preserved in alcohol; some at least should be prepared in the latter way for use in dissecting certain parts. I have a large cement lined tank sunk in the floor of the basement of the building occupied by the laboratory, which is very convenient for keeping clams, crayfishes, frogs and fishes, and it also forms an attractive feature, being as much sought for as the museum cases by visitors, especially by children.

I find in the vicinity of Ames that the common Differential Locust (*Melanoplus differentialis*) forms one of the most available species for laboratory work. It is much larger than the more common *femur-rubrum*, hence more easily studied by the beginner and is more easily collected in quantity than the large species of *Acridium*.

For fishes I generally find it most convenient to order through the meat market undrawn fishes of eight to twelve inches in length. Sometimes we get fresh mackerel or other marine fishes, but more commonly lake or river species.

Snakes and turtles have to be secured as they turn up, but students usually secure enough to answer the purpose. Turtles are not kept on the market with us, and to order them from a distance is rather expensive.

For birds, pigeons, or in case these are wanting, blackbirds or robins serve the purpose.

If classes are not too large the embryology of the chick forms a most entertaining and instructive study, but the work is somewhat difficult to manage except with students somewhat advanced, and even then it is best not to attempt to direct too many at once. The eggs may be incubated artificially, but about the most satisfactory way is to use a hen, especially if a good, persistent setter is available. Sometimes one can be kept busy for five or six weeks and in this time incubate a large number of eggs.

For small mammal the most available, easily secured and satisfactory with us is the striped ground squirrel (*Spermophilus tridecemlineatus*). These are very abundant on the campus, may be caught very quickly by the use of slipnoose cord and without any injury to any part of the body as occurs with rabbits if shot. This makes them available for injection or for any treatment desired. Rats I have seldom used, as with us it is more bother to secure them than squirrels, but of course rats, rabbits, cats and dogs are used on occasion. It seems to me fully as well to use a species different from the one described in the guide, if a guide is used, since it throws the student on his own resources, incites comparative study and prevents too close following of the guide, either in description or drawing, in fact the main object of the guide is to ensure attention to all structures that should be studied, and to avoid waste of material, in case the animal is one not to be had in unlimited quantity. Also to secure careful dissecting and not mere cutting and slashing.

A "Study of the Brain of the Common Striped Squirrel," by Mr. T. J. Kerr of the class of 1890, yielded the following results that may be worthy of record, though it needs the drawings prepared in the study to fully exhibit the results.

The brain was studied especially in comparison with that of the rabbit as described by Parker (Zootomy, pp. 365–379).

The brain in general differs from that of *L. cuniculus* in being a little broader in proportion to its length. The olfactory lobes are smaller, shorter and more angular in outline. As the depressions on the ventral surface between the lobes of the cerebral hemispheres and the white bands connecting the olfactory lobes with the temporal are very shallow, the surface is smoother than that of *L. cuniculus*. The frontal and parietal lobes do not show on the ventral surface as much as they do in the rabbit.

The number of convolutions in each division of the cerebellum varies in different brains. The least number observed in the superior vermix was six, the greatest eleven, the average being about eight. The least number for each lateral lobe seven, the greatest fifteen, the average being about ten. For each flocculus the least number was four, the greatest eight, the average being about six. The vertical longitudinal sections present the usual tree-like appearance or arbor vitæ. The vertical transverse sections are less tree-like in appearance.

In *L. cuniculus* there is a slight elevation on which the pituitary body rests, but in *S. tridecemlineatus* there is a slight depression, a sort of nest.

The corpus callosum is a strong white transverse band connecting the cerebral hemispheres. It is about half as long as the cerebrum, instead of one-third as long, as in *L. cuniculus*.

The peduncles of the pineal body are thin white bands on the posterior two-thirds of the upper surface of the optic thalami, instead of one-half as in *L. cuniculus*. The two peduncles unite at the posterior boundary of the thalami and then pass backward and upward to the pineal body.

The optic lobes or corpora quadrigemina are two pair of rounded lobes lying just above the crura cerebri, just posterior to the optic thalami and third ventricle, just below the hippocampi majores and dorso-posterior part of the parietal lobes and just anterior to the cerebellum. The nates, the larger pair, lie almost entirely above the testes, instead of anterior to, as in *L. cuniculus*. As seen from behind after removing the cerebellum the testes are transversely elongated as in the rabbit.

The brain of the pocket gopher, studied by Mr. W. E. Harriman of the class of 1893, was compared particularly with that of the rabbit, as detailed by Parker (Zootomy, pp. 376-397), and with that of the striped gopher as given by Mr. Kerr in the paper previously quoted.

The brain of the pocket gopher (*Geomys bursarius*) is more nearly the shape of the brain of *L. cuniculus* than of *Spermophilus tridecemlineatus*, its width being less than is the same dimension in *S. tridecemlineatus*. However, it resembles the latter in point of there being comparatively smaller parietal lobes than in *L. cuniculus*. The dimensions, as averaged from measurements of thirteen brains, are as follows: Antero-posterior (from anterior end of olfactory lobe to posterior end of medulla) twenty-six millimeters. Lateral (through base of cerebral hemispheres) seventeen millimeters. Dorso-ventral (through median commisure), eleven millimeters, the largest 30x20x14 mm. The average weight of nine brains is three and five-tenths grams, the heaviest 3.922, lightest, 2.3012.

On the dorsal aspect of the pons at the end of the fourth ventricle is a curtain like affair at right angles to the longitudinal dimension of the ventricle called the valve of Vieussens. In *G. bursarius* this portion is very small. It appears to be attached to the anterior crura of the cerebellum. Anterior to this valve of Vieussens are two bodies, each deeply cleft or lobed into two hemispheres. They correspond to the Corpora quadrigemina of higher animals. The anterior body might be termed the tubercular nates, the posterior the tubercular testes. Still more anteriorally situated are two masses which are longer comparatively in *G. bursarius* than in either *S. tridecemlineatus*, or *L. cuniculus*. They are the Thalami optici. * * *

The cerebellum is rather spheroidal in shape, and in mass compares with the cerebrum as about one to four. In the higher animals this portion of the encephalon is divided into two distinct hemispheres, each hemisphere being in turn cleft into several lobes. But in *G. bursarius* it is more accurate to consider it as composed of three distinct lobes, called respectively, the central lobe and the two lateral lobes. Just lateral to these parts, on either side, is a peculiar body coiled upon itself, somewhat like a snail shell, called the Flocculus. * * *

The surface shows a sort of convolution being traversed in a general transverse direction by numerous curved furrows or sulci, which vary in depth in different parts. In this respect the cerebellum is quite similar to that of higher forms, which is also true of its structure and the arrangement of the gray and white matter which on cross section shows the characteristic arbor vitæ appearance.

On the ventral surface of the cerebrum, extending well forward from about the center of each hemisphere, are the olfactory lobes; they protrude about two to four millimeters beyond the frontal lobes.

The eighth pair, or auditory nerves, are large comparatively, and originate in a groove between the olivary body and restiform bodies at the posterior border of the pons.

The earthworms of the State were studied by Miss Vinnie Williams of class of 1893, with the result of finding, according to her determination, two distinct species in the State.

These were the *Allolobophora turgida*, specimens of which were secured from Tama county, and the *Lumbricus rubellus*, species of which were obtained from Chickasaw and Poweshiek counties.

Doubtless other species occur, but apparently no one has hitherto recorded any determinations. The species most common at Ames is probably the *Allolobophora turgida*, but with ordinary preparation the positive separation of species is difficult and few have been examined when prepared so as to permit rigid examination.

ADDITIONS TO THE KNOWN SPECIES OF IOWA ICHNEUMONIDÆ.

BY ALICE M. BEACH, AMES, IOWA.

The list herewith presented embraces those species taken in Iowa which are not recorded in the Catalogue of Iowa Animals, prepared by Prof. Herbert Osborn and published in 1892:

Ichneumon galenus Cress.
Ichneumon pulcher Brulle.
Ichneumon otiosus Say.
Ichneumon pervagus Cress.
Ichneumon vittifrons Cress.
Ichneumon sp. undetermined.
Ichneumon vinnulus Cress.
Ichneumon longulus Cress.
Amblyteles indistinctus ? Prov.
Amblyteles subrufus Cress.
Herpestomus sp. two, undetermined.
Centeterus tuberculifrons ? Prov.
Phygadeuon subfuscus Cress.
Phygadeuon sp. three, undetermined.
Cryptus sp. undetermined.
Cryptus contiguus Cress.
Joppidium sp. undetermined.
Linoceras sp.
Hemiteles sp. five, undetermined.
Nematopodius sp.
Pezomachus sp.
Nototrachys four, undetermined sp.
Exochilum sp.
Heteropelma two sp., undetermined.
Heteropelma datanæ Cress.
Anomalon sp.
Anomalon ambiguum ? Norton.
Anomalon semirufum Norton.
Campoplex diversus Norton.
Limneria five, undetermined sp.
Cremastus two, undetermined sp.
Angitia six, undetermined sp.
Thersilochus sp.
Exetastes sp.

Mesoleptus sp.
Tryphon four, undetermined sp.
Polyblastes sp.
Bassus two, undetermined sp.
Bassus sychophanta Walsh.
Coleocentrus sp.
Ephialtes sp.
Theronia sp.
Pimpla tenuicornis Cress.
Pimpla inquisitor Say.
Polysphincta sp.
Glypta tuberculifrons Cress.
Glypta rufiscutellaris Cress.
Arenetra ventralis Cress.
Lampronota rufipes Cress.
Xylonomus stigmapterus Say.
Xylonomus albopictus Cress.

A NEW SPECIES OF PEMPHIGUS OCCURRING ON THORN.

BY F. ATWOOD SIRRINE.

Œstlund[1], in describing the characters and work of *Aphis crataegifoliæ* Fitch, says: "Found on leaves of *Crataegus* corrugating them. Specimens taken during May on *Crataegus tomentosa* Linn, were found to curl the leaves very much, and as they turned dark brown or red they became very conspicuous."

The past season what was taken to be the fundatrix of a *Schizoneura*, possibly *crataegi*, was found May 23d corrugating the leaves of *Crataegus tomentosa* (?) and at the same time causing them to turn a bright red or scarlet color. The fondatrici of what was supposed to be *Aphis crataegifoliae* were found at the same time and on the same plants, curling the leaves but not to such an extent as the supposed *Schizoneura*, nor did they cause the leaves to change color.

Later in the season as *Aphis crataegifoliae* increased in numbers they were found in the colored corrugated leaves with the *Schizoneura*? On June 26th winged specimens of the latter were obtained. The venation of the wings proved that they were *Pemphigus* and not *Schizoneura*. By the 10th of July these had all left the Hawthorn. On October 7th, dead, shriveled specimens of *Pemphigus* were found under the rough bark of Hawthorn (*Crataegus tomentosa* Linn.) which agreed in venation with the form taken in the curled leaves in the spring; an oviparous female was also taken, though the latter may have been an oviparous female of *Schizoneura*, as both

[1]Synop. Aphididae of Minn. (Bull. No. 4, Geol. and Nat. Hist. Surv. Minn. p. 51.)

the *Schizoneura* and *Pemphigus* females are known to occur under the rough bark of trees. To the naked eye the form taken in June resemble the color of the corrugated leaves, while older specimens of the fundatrici, being covered with a pulverulent secretion, aside from the flocculent secretion near cauda and sides of the body, are of a bluish purple.

Though this may prove to be the spring migrant of a form already described, and named, as occurring on some other plant, it does not agree with any description of *Pemphigus* to which I have access, moreover no *Pemphigus* has been described as occurring on Hawthorn. Hence the specific name of *corrugatans* from its habit of corrugating the leaves on which it feeds, is proposed for the present, or until its complete life cycle shows it to be one stage of a known species. The following descriptions of the fundatrix, pupa and alate migrant are appended:

Pemphigus corrugatans, n. sp.

Alate Vivip. form, Spring Migrant, from corrugated colored leaves of *Crataegus tomentosa (?)*, June 26th, 1893.

Expanse of wings, 6.52 mm.; length of body, 2.35 mm.; width, 1.10 mm.; length of antennæ, 0.85 mm.; (Joint I., .05 mm.; II., .07 mm.; III, .30 mm.; IV., .13 mm.; V., .17 mm.; VI. plus unguis, .16 mm.); Joint III, with about fifteen transverse sensoria. In some cases part of these are double, making upward of twenty-five in all; IV., with from six to twelve; V., with from three to five; VI., slightly roughened. (These sensoria are situated on raised portions of chitine, so they appear as transverse ridges, but not as complete chitinous rings in any case). Rostrum reaching second pair of coxae. Distance between base of first and second discoidals varies from 0 to .08 mm., in some cases the second discoidal is united with the first for a distance of .20 mm. Distance between base of cubital and second discoidal varies from .05 mm. to .10 mm.; the former subobsolete at base. Stigmal with a simple curve. Distance between apices of all the veins approximately equal; (the apices of the stigmal and cubital may average a trifle nearer than the others). Stigma, .59 mm. by .16 mm., rhomboidal. Distance between discoidals of the posterior wings approximately the same as in anterior pair; costal abruptly curved forward where the discoidals issue.

Color.—(Specimens not mounted, observed with hand lense) antennæ, head and wing callosities black; thorax, yellowish green; eyes, brown; legs, dusky. The two median and the lateral lines of dermal wax glands* secrete the longest flocculent material, so there is a ridge of the latter between the wings, and a margin of the same at the sides of the body. These masses of waxy secretion crowd the wings into an oblique position. (The variation in the length of the secretion from the dermal glands is true for the pupa, and larval fundatrix; those on the latero-caudal portion of the abdomen secreting the longest flocculent material so the body appears flattened.)

(Specimens mounted in balsam and examined with compound microscope) ground color yellowish green, apex of abdomen a shade lighter; wing callosites dusky to black, antennæ and head somewhat darker; pro-

* On the abdomen there is a dermal gland on each segment between the median pair and the one on the lateral margin. As far as observed in *pemphigus* there are a pair of these glands on the head, two pairs to each thoracic segment, a median pair and one on each lateral margin; three pairs to each abdominal segment, median, submedian and lateral. Those on the abdomen are united in some instances, especially toward the cauda.

thorax with a narrow black line on the anterior dorsal margin; eyes brick red; legs dusky; wing insertions yellow, apex of beak dusky, remainder, unicolorus with body. Cauda distinct. The median dorsal glands larger than either the lateral or the submedian.

Pupa—Length of body, 3:09 mm.; width. 1.39 mm.; length of antennæ, .83 mm ; separation between joints, III and IV, not distinct; sensoria, not distinct. Cauda, distinct, .22 mm. long. Rostrum reaches second coxæ, sometimes beyond.

Color—(Unmounted, examined with band lense.) Yellowish green; wing pads, whitish. (Mounted, examined with compound microscope.) Whole body light green with a yellow tinge, sometimes yellowish white, depending on age after moulting; antennæ, wing pads and legs whitish; eyes, brick red. The last abdominal segments are crescent shaped, producing an indenture each side of the cauda.

Fundatrix—Length of body, 3.66 mm.; width, 2.74 mm.; length of antennæ, .87 mm. (Joint I, .087 mm.; II, .12 mm.; III, .24 mm.; IV, .14 mm.; V, .14 mm.; VI with unguis, .15 mm.); separation between III and IV not distinct in immature forms. Beak, barely reaching second coxæ.

Color—(To naked eye) Greenish purple; (mounted, examined with compound microscope) olive green with a yellow tinge.

HACKBERRY PSYLLIDÆ FOUND AT AMES, IOWA.

BY CHAS. W. MALLY.

The insects now under consideration belong to the family *Psyllidae;* sub-family *Psyllinae;* and the genus *Pachypsylla.* The genus, according to Dr. C. V. Riley, "has no equivalent in the European fauna; but some allied, still undescribed, genera occur in the New World."

The species which first attracted attention was *Pachypsylla celtidis-mamma.* Some observations were recorded during the autumn of 1891, but no regular observations were made till March, 1892. At this time the weather was cold, and the adult insects were hidden away in the cracks and creases of the hackberry bark. It was difficult to find them at first, because their general color closely resembles that of the bark. Large numbers of the adults were found on the sticks and pieces of bark that were lying around under the trees. The old hackberry leaves were examined with special reference to the galls that remained over winter, and in no case was a gall found that contained a living larva, proving that in this case, at least, they had issued from the gall in the fall and transformed to the adult stage. Some difficulty was experienced in finding the old leaves as they had probably been carried away by the wind. If any of the larvæ fail to issue in the autumn, the evidence seems to prove that they perish in the galls.

The chief hiding-place of the adults is in the rough sheltering bark of the trunks of trees. Toward the top of the tree the bark is younger, less roughened, and therefore furnishes less protection for the insect. Consequently, very few of the adults are found in the top of the tree and out toward the end of the branches.

During the latter part of March, as the days grew warmer, the adults became active, but moved about very little. During the afternoon ot April 7th, which was warm and pleasant, they were out toward the ends of the limbs; but as night came on most of them went back to the trunk of the tree, only a few remaining on the slight excrescences of the bark, in the angle between two twigs, or at the base of a large bud. They could be removed from the last named places by simply shaking the limbs. Hence, if they settled down for the winter on the twigs, the many fierce winds would soon sweep them off and carry them to destruction.

About April 30th the buds of the trees began to swell and open out for the year's growth. The Psyllidæ now begin to migrate to the buds and probably feed on the juices of the young tissue.

The first eggs were found on the young leaves May 5th. After this time the adult females could be found depositing eggs in the opening buds and on the underside of the expanded leaves. In the opening buds, where the leaf veins are small and close together, they tend to deposit the eggs in rows between the veins; but as the leaves expand to their full size, they are deposited at random and in large numbers.

Adult females of different species are often found depositing eggs on the same leaf. Hence the larvæ, and later on the galls of all the species are found on one leaf. The time of first egg deposition depends largely on the season and the location of the tree. If, for example, a tree is located in a warm, sheltered place, the adults become active, the young leaves put forth and consequently the eggs will be deposited earlier. If the tree is in a cold, exposed place, the development of both tree and insect is retarded. More time is required for the eggs to develop on exposed trees than on those more favorably located. This indicates that a low temperature retards the development of the embryo. In general the eggs seem to develop best at the temperature most favorable to the healthy growth of the leaves. During the month of May eggs are continually deposited. May 27 a number of eggs on one tree were compared, and judging by their general appearance, some were recently deposited, while others were quite well developed. On a tree very favorably located a number of the young larvæ were found on the upper surface of the leaf. After searching sometime for larvæ, a leaf was found bearing a small gall already closed around the insect. On the upper side of the leaf this gall was but slightly raised, having a small cone-shaped projection. On the under side the gall was roundish and covered with a white frosty pubescence. Careful dissection of the gall revealed a young larva which proved to be identical with those on the surface of the leaf.

From the above stated facts we learn that there is a great variation in the hatching of the larvæ. This variation continues throughout the larval stage and greatly augments the difficulty of working out the successive stages in their development.

From May 27 to June 22 the larvæ appeared in great numbers and many galls were starting. From this time till August 16 larvæ developed quite slowly. The galls, however, developed quite rapidly and in a short time the species could be distinguished. Many of the galls contained more than one larva. Some of the typical *P. c. mamma* galls were two-celled. Others had a large cell in the normal position, and three or four smaller ones located just above the normal one and around the cup-like depression. In one or two cases five were found, six being the highest number ever found in one gall.

After the latter part of August the changes in the larva were more rapid the abdominal spines are more rapidly developed, and a short time before changing to the adult stage the larva produces a white cottony substance which is quite abundant on the posterior portion of the abdomen. They also undergo one moult a short time before sawing through the gall. This is quite certain, for cast skins have been found with the larvæ.

THE EGGS.

The eggs are oblong-oval, being widest at the middle, where they measure about .15 mm. Their greatest length is about .3 mm. They are broadly rounded at one end, but taper more strongly at the other, thus giving the eggs a pointed appearance. When deposited on the leaf they have a white, glistening appearance. The first eggs were found May 5th, and the first larvæ May 27th. Judging from this, in a general way, it is safe to say that the eggs hatch in about twenty to twenty-two days.

The Larvæ.—Soon after hatching the young larvæ measure about .15 mm. in length and about the same in greatest width. The head and the divisions of the thorax can be but faintly recognized. The abdomen is drawn cephalad, so that only the first segment is visible for its full width, and only the tip of the seventh and the small eighth or anal segment. The antennæ are invisible at first: tarsi, two-jointed, but very indistinct; claws represented by two very small bladder-like bodies. As the larva grows older, the antennæ make their appearance, at first showing but four joints. The compound eyes soon become larger, and the abdomen develops so that five of the segments are visible. The posterior end of the body now presents a lobed appearance, because the last three segments are very small, and drawn cephalad, pushing the central portion of the first five segments forward, while the sides extend backward, forming a lateral lobe on each side. The lines separating the abdominal segments are most clearly seen on the dorsal surface. In some cases they do not reach the sides as closely defined lines, but seem to terminate in little circular, transparent spots, probably representing the division between the tergum and the pleurum.

From June 1st to June 22d, no very marked changes, except in size, take place. The last three abdominal segments are very slow to develop.

The larvæ examined August 16th showed some important changes. The antennæ increased in comparative length, having from six to ten joints. The compound eyes more prominent, mouth-parts larger, and the different divisions quite distinct; legs much larger, more prominent and furnished with numerous hairs. The two joints of the tarsi are quite inconspicuous, the strong curved claws apparently being attached to the distal end of the tibia rather than the tarsus. The two pairs of wings have begun to develop and appear as small transparent pads arising from the mesothorax and the metathorax respectively, and are immovable. The divisions of the sternum are quite distinct, and the coxæ much more prominent. The abdominal segments are all closely defined; the last three, however, are quite closely united and are more chitinous. The fleshy anal process of the young larva is represented by a chitinous oval spine. On either side of the base of this oval spine can be seen a small tubercle which may represent some of the developing abdominal teeth. Each segment is provided with conspicuous hairs which are shortest at the division of the segment.

Segments seven and eight contain a tube extending longitudinally, and sends out two small, round branches in the seventh segment and terminates in two short curved branches which extend nearly to the tip of the notched oval process. This tube cannot be traced beyond the seventh segment, and probably represents the developing genital organs.

LARVA AND PUPA.

The full grown larva and pupa are described as follows:

Color, in general, bluish green; antennæ and legs more yellowish; "broadly oval in outline; widest at the middle of the abdomen;" head distinctly separated from the pronotum; "including the eyes it is as wide as the mesonotum at middle;" front margin broadly rounded; but not lobed as in the adult, and furnished with numerous hairs. Frontal cones, obsolete; eyes are of a black color, large, reaching the posterior margin of the head, and have a granular appearance. The antennæ differ from the adult form in being thicker and therefore appear to be somewhat shorter. The lateral hairs are more conspicuous. No essential difference in the mouth-parts.

The anterior pair of legs thicker than in the imago; tarsus about the same width as the tibia, and the articulations not so marked as in the adult, thus giving the tibia and tarsus a more blended appearance. The second pair of legs virtually the same as the first, but the third pair has been developed so that in the adult they will be fitted for leaping.

The mesonotum presents three main divisions, as in the adult, but not so clearly defined.

The metanotum is moderately distinct, having the two divisions but faintly marked, and joins the first abdominal segment by a wavy line.

The wing-pads are smooth, shining, and diverge posteriorly, not quite attaining the apex of the second abdominal segment. The anterior ones are larger and wider than the posterior ones, but the latter project internally and posteriorly. During the development of the larva the venation and folding of the wings cannot be seen, but when about to transform the venation and folding are usually quite distinct.

The abdomen is composed of eight segments, is widest at the middle; tapers gradually at the base, but strongly at the top. The first segment is quite short, as wide as the metanotum, and the dorsal surface is ornamented with numerous reddish lines passing obliquely outward and forward from the central portion.

The second segment is nearly twice as long as the first and distinctly separated from it. The third is a little longer and wider than the second, the fourth being widest of all, but about equal in length with the fifth. The last three segments are rather indistinctly separated, much shorter, moreover, and beginning at the latter half of the sixth are more chitinous than the preceding ones. The lateral part of the first five segments especially are separated by slight constrictions, giving them a bulged appearance. The sides of the abdomen are furnished with hairs, which are larger and more numerous on the central portion of each segment, growing smaller and less numerous toward the joint. They are longest on the posterior part of the abdomen, but do not form a fringe. The eighth segment is drawn out into a horny anal process. The last three segments are usually provided with a number of backwardly-directed teeth, which Dr. C. V. Riley has described as follows:

"Sixth joint at middle of hind margin with two or three very small teeth placed transversely, and with no lateral teeth; seventh joint at middle of hind margin with a tranverse row of four teeth, and on each side with two or three (often obsolete) teeth or tubercles; anal joint with the horny process about half as long as the joint and pointed at tip, while at the base of the process, on each side, a lateral row of four small closely placed teeth extends to the underside, and finally on the disk of the joint three teeth, triangularly placed, the posterior being the largest; behind this group, and just above the base of the process, is another tooth, nicked at the tip."

In many specimens the teeth of the sixth segment were simply indicated by a more chitinous texture than the surrounding tissue. In others these teeth are represented by very slight tubercles, while in still others, they were larger, but indistinctly separated.

By examining a large number of specimens it was found that the teeth of the seventh segment were subject to considerable variation. Usually there were three placed transversely. In some there appeared to be four teeth represented, the central one being the largest and most posterior, having a small tooth on one side of its base, and two small ones on the other. In still others there seemed to be five teeth represented. The large one same as before and then two small ones at the base on either side. In the latter case the four basal spines were placed in a gentle curve around the larger tooth.

Is there any way of accounting for the variation in this group of teeth?

In one specimen having four teeth, one of the two basal ones seemed to be very deeply nicked, while the other was not. In the case where five teeth were present we could consider that both of the small basal teeth were very deeply nicked, even to such an extent that the two parts became separated, thus presenting the appearance of four distinct teeth. The first lateral teeth occur on the seventh segment. From a dorsal view some specimens present only one lateral tooth, but further examination reveals two or three. In one case five lateral teeth were found, the central ones being the larger. No important variations were found in the anal segments, although one of the four small teeth on either side of the anal process was difficult to find.

One very attractive feature of the color of the larva is the blending of the bluish-green parts and the rosaceous markings of the abdominal segment.

TRANSFORMATION OF PUPA TO ADULT.

When exposed to the air for a short time the pupa changes to a slightly paler color. Soon the longitudinal muscles of the abdomen begin to contract and draw it forward in the surrounding pupa skin, and thus allowing it gradually to assume its natural position. In this process the displaced portions of the abdomen catch in front of the depressed divisions of the segments, and by tending to assume their former position uses them as points of support from which to force the body forward.

At the same time, irregular movements of the legs and antennae take place. Soon the pupa skin splits on the dorsal side of the head and thorax, and by the longitudinal contractions of the muscles the dorsulum is first forced out, then the head and antennae, the legs, and finally the abdomen is slowly withdrawn and the pupa skin remains attached by the claws.

At first the adults are of a light yellowish green, but soon change to a darker color. Some specimens seem to have great difficulty in starting the tip of the abdomen, it apparently being held by the anal spines.

THE GALLS.

The galls are subject to great variations. The typical gall of *P. c. mamma* has been described by Dr. C. V. Riley as follows: "This gall on the upper side of the leaf is represented by a cup-shaped impression measuring on an average 4.5 mm. across, with the outer rim always regularly circular, and not, or but slightly, elevated above the surface of the leaf; at the bottom of the cup a small medium nipple (often obsolete); walls of the impression greenish, the bottom more yellowish. On the under side of the leaf it is much larger than any of the other leaf galls, conical, either slightly narrowing apically, or, more frequently, slightly enlarged. The sides are vertical or nearly so; the top broadly rounded without medium depression or central nipple, size very variable, averaging in height 6.7 mm. and in diameter at base 4.5 mm. Color, pale greenish yellow, with the tip more brownish; surface opaque, rugosely reticulate; at the base often covered with a whitish pruinescence, rarely with a few scattered hairs at the tip. The walls of the gall are hard and woody, at bottom averaging 1.75 mm., and at roof 0.75 mm. in thickness. The cell is large, and in cross-section much more crescent-shaped than in the preceding species."

The above description is for the typical form for *P. c.-mamma.* But when the galls are compared we find that the shape and size of the gall is not at all constant. Besides those that are enlarged and rounded at tip, we find a great many that taper gradually to the apex which in some is slightly rounded, in others almost truncate, and in still others slightly depressed. Some have the basal half large and rounded, but at middle it contracts rather abruptly and tapers more strongly to the top which is rounded. In another variation the basal half and the apical half are both rounded and subequal, but separated by an acute circular constriction at the middle. In another form the sides of the gall begin to curve outward just as they rise from the leaf, giving the gall a general circular outline.

By collecting a large number of the galls and placing them singly in little pill-boxes, the adults that issued from each gall could be noted. It was found that *P. c–mamma* occurred in all the different variations, thus showing that these variations are not of specific importance.

Besides the typical form of *P. c.–mamma,* a number of variations were found in the galls just mentioned, but as they present such a great number of variations, and no constant characters being found as yet, no attempt will be made to describe these varieties.

DISSEMINATION.

Mention was made of the fact that it was difficult to find the old leaves in sufficient numbers to be of any great value for observation, as they had been carried away by the winds. This is one of the means provided for the dissemination of these insects. In the autumn of 1891 many of the leaves fell to the ground and were carried away by the winds before the larvæ could issue. Many trees are located on the banks of streams into which the leaves may fall, and in case the larvæ has not begun to issue so that the water cannot enter the gall, they may be carried many miles down stream and cast ashore; then the larvæ issue, transform to the adult stage, migrate to the proper host and are in condition to multiply during the following season. In a number of cases the adults have been found in places quite distant from any hackberry trees. At first thought it might be held that a strong wind caught them while on the wing and carried them away. But this is doubtful, since they may have come from leaves that were carried away.

NATURAL ENEMIES.

A number of parasitized larvæ were taken about September 1. At different times small white larvæ were found in the cell with and devouring the Psyllid larva. Upon further examination it was found that the cause for some of the Psyllid larvæ changing to such a brown color and having such a dry, shriveled appearance was that the egg for this white footless larva had been deposited within the Psyllid larva; others were probably deposited outside the Psyllid larva, and so fed externally.

This parasite belongs to the family Chalcididæ in the order Hymenoptera, and attacks all the species found at Ames, Iowa.

Specimens of the Psyllidæ were sent to Dr. C. V. Riley, U. S. Entomologist, Washington, D. C., for determination and the following species were named:

Pachypsylla celtidis-mamma.

Pachypsylla celtidis-minuta.

Pachypsylla celtidis-asteriscus.

Since then specimens of *Pachypsylla celtidis-gemma* have been found, and also a new species that infests the twig of the hackberry, As far as I know, no mention has been made of it, and so liberty will be taken to give the most prominent characters, *i. e.*, those used in determining the species as shown in the table below.

The following is a table prepared by Dr. C. V. Riley for the classification of the three most common species of the genus Pachypsylla.

Perhaps many members of the Academy do not have access to this table, and therefore I take liberty to insert it in this article and also add the characters for separating the species which infest the twig of the hackberry.

"Head and dorsum opaque; front wings submembranaceous or subligatine, not rugose: pterostigma, distinct: both marginal cells very long, narrow, and of about equal size and length: anal style of full-grown larva and pupa long.

Dorsulum and mesonotum alutaceous, glabrous; front wings narrowly rounded at tip, widest in basal half: genital segment of female longer than the rest of the abdomen; anal style of full grown and pupa notched at top.......... .....*venusta*.

Dorsulum and mesonotum rugoso-punctate, with distinct but very short, sparse pubescence: front wings broadly rounded at tip, widest in terminal half; genital segment of female shorter than the rest of the abdomen: anal style of full-grown larva and pupa pointed at tip.. ...*c.-mamma*.

Head and dorsum shining, without pubescence: front wings somewhat convex, basal half not wider than terminal half, broadly rounded at tip, distinctly rugose.

Pterostigma indistinct: marginal cells less narrow, the first shorter and somewhat smaller than the second: genital segment of female shorter than the rest of the body; anal style of full-grown larva and pupa very short, nicked at tip..*c.-gemma.*"

Pterostigma distinct black, marginal cells less narrow, the first being shorter and more nearly V-shaped than the second; head and thorax black, marked with yellow; antennæ black; wings with a smoky band along the anal and apical margins, and extending along the branching of the veins toward the base. Full-grown larva and pupa larger than the preceding one, anal style moderately long and notched at tip. (Galls oblong-oval, and are located in the twig or base of the larger limbs, just beneath the bark)..............................*c.-inteneris*, n. sp.

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