THE

TRANSACTIONS

OF THE

ACADEMY OF SCIENCE

OF ST. LOUIS.

VOL. III.

ST. LOUIS:

R. P. STUDLEY COMPANY, PRINTERS AND BINDERS.

1878.

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LIST OF OFFICERS AND MEMBERS

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Treasurer.

ENNO SANDER, Ph.D.

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Bryant, Wm. M.

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Carpenter, Geo. O.
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Chouteau, C. P.
Clark, Enos
Class, Geo.
Coale, S. A., Jr.
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Conant, A. J.
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Cummings, J. K.

Dixon, B. V. B.

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Engelmann, Geo. J., M.D.
Everett, Ambrose T., M.D.

Fay, Theo.
Fitzpatrick, F. A.
Flad, H., C.E.
Forbes, Isaiah, D.D.S.
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Heisler, Chas.
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Johnson, C. P.
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Judd, H., M.D.

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Knight, S.
Kinner, H., M.D.
Krieckhaus, Aug.

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Leslie, J. H., M.D.
Lemoine, E. S., M.D.
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Link, Theodore C.
Lips, Charles
Long, E. H.
Lucas, Wm.

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Maude, J. B.

McKittrick, H.
Meeker, J. R.
Moses, S. G.
McPheeters, W. M.

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Nipher, F. E., A.M.

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Overstolz, H.

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Pollak, S., M.D.
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Shaw, Henry [U.S.A.
Simpson, Brig.-General J. H.,
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Soldan, L. F.
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Turner, J. W.

Van Court, B. I.
Voelkner, H. A.

Walker, Geo., M.D.
DeWitt T.
Wislizenus, G. A., M.D.
Wielandy, F. E.

Corresponding Members.

☞ All known to be deceased are omitted in the list.

Agard, A. H., M.D. .... Sandusky, O.
Agassiz, Alex., A.A.S. .... Cambridge, Mass.
Ayres, W. O., M.D. .... San Francisco, Cal.
Aughey, Prof. Samuel, Ph.D. .... Lincoln, Neb.

Baird, S. F., Ass't Sec'y S. I. .... Washington, D. C.
Bandelier, Adolph F., Jr. .... Highland, Ills.
Barcena, Mariano .... Mexico, Mex.
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Barrande, Joachim .... Prague, Bohemia.
Barris, Willis H. .... Iowa City, Iowa.
Beebe, Edward A. .... Galena, Ills.
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Blatchford, Thomas W., M.D. .... Troy, N. Y.
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Bunsen, Albert, M.D. .... Belleville, Ills.
Bunsen, Charles .... " "
Bunsen, George .... " "

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Copes, Joseph L., M.D. .... New Orleans, La.
Coues, Elliot, M.D. .... Washington, D. C.

Dall, Rev. C. H., A.M. .... Calcutta, India.
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Engelmann, Henry .... LaSalle, Ills.
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Flagg, Willard C. .... Moro, Ills.
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Fry, Major C. H. .... Ft. Union, Neb.

Gill, Prof. Theodore .... Washington, D. C.
Gilpin, Gov. William .... Denver, Col.
Goodnow, Isaac T. .... Leavenworth, Kas.
Green, Samuel M. .... Cape Girardeau, Mo.

Hall, James, A.A.S., State Geologist .... Albany, N. Y.
Harney, Maj.-Gen. Wm. S. .... St. Louis, Mo.
Hayden, F. V., M.D., U. S. Geologist .... Washington, D. C.
Henry, Joseph, LL.D., Sec. S. I. .... " "
Henry, J. C., M.D. .... Nebraska.
Higginbotham, Rev. John .... Halifax, N. S.
Hilgard, E. W., State Geologist .... Oxford, Minn.
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Hinrichs, Prof. Gustavus .... Iowa City, Iowa.
Hitchcock, C. H., State Geologist .... Concord, N. H.
Hitchcock, George N. .... San Diego, Cal.
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Hough, Hon. Warrick .... Jefferson City, Mo.
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Norwood, Charles J., Ass't Geologist .... Russellville, Ky.

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Parker, J. C. .... San Diego, Cal.
Patrick, John J. B., M.D. .... Belleville, Ills.
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Sheldon, Prof. D. S. ....Davenport, Iowa.
Shepard, Prof. Charles M., M.D., A.A.S. ....Amherst, Mass.
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White, Charles A. ....Burlington, Iowa.
Winchell, Alex., LL.D. ....New York.
Woodruff, William S. ....Marshall, Mich.
Worthen, Amos H., State Geologist ....Springfield, Ills.

Yandell, Prof. L. P. ....Louisville, Ky.
Yoakum, F. L. ....Larissa, Tex.

TRANSACTIONS

OF THE

ACADEMY OF SCIENCE

OF ST. LOUIS.

OFFICERS

OF THE

Academy of Science of St. Louis

For 1873.

PRESIDENT.

JAMES B. EADS.

VICE-PRESIDENTS.

1st—ALBERT TODD.

2d—GEO. ENGELMANN.

TREASURER.

ENNO SANDER.

CORRESPONDING SECRETARY.

NATHANIEL HOLMES.

RECORDING SECRETARY.

CHARLES V. RILEY.

LIBRARIAN.

JOHN J. BAILEY.

CURATOR.

RICHARD HAYES.

PUBLICATION COMMITTEE.

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WM. T. HARRIS,
CHARLES V. RILEY,
NATHANIEL HOLMES.

NOTE.—The Authors of Papers published in the "TRANSACTIONS" are to be considered as individually responsible for the opinions expressed in them.

CHARTER.

AN ACT TO INCORPORATE "THE ACADEMY OF SCIENCE OF ST. LOUIS."

Be it enacted, by the General Assembly of the State of Missouri, as follows:

SECTION 1. That GEORGE ENGELMANN, HIRAM A. PROUT, NATHANIEL HOLMES, BENJAMIN F. SHUMARD, CHARLES W. STEVENS, JAMES B. EADS, MOSES M. PALLEN, ADOLPHUS WISLIZENUS, CHARLES A. POPE, CHARLES P. CHOUTEAU, WILLIAM M. MCPHEETERS, and others—who have heretofore formed an association in the city of St. Louis styled "THE ACADEMY OF SCIENCE OF ST. LOUIS," having for its object the advancement of Science, and the establishment in said city of a Museum and Library for the illustration and study of its various branches—their associates and successors, are hereby declared and created a body corporate by the name and style aforesaid; and by that name they shall have perpetual succession, may sue and be sued, implead and be impleaded, in all courts of competent jurisdiction; may acquire by purchase, gift, or devise, receive and hold, property, real, personal, or mixed, and the same exchange, sell, lease, or otherwise dispose of, as they may deem proper, for the objects and purposes aforesaid, and not otherwise; may have a common seal, and break or alter the same at pleasure; and may make such constitution, regulations, and by-laws, as may be requisite for the government thereof, not being contrary to the laws of the land, and may alter the same at pleasure.

Sec. 2. The constitution and by-laws of said association now in operation shall govern the corporation hereby created until the same shall be regularly altered or repealed, and the present officers of said association shall be officers of this corporation until their respective terms of office shall expire, or be vacated in pursuance thereof.

Sec. 3. The property and effects now belonging to the association aforesaid shall, on acceptance of this charter, thereby become vested in the corporation herein created, and all property owned or held by this corporation shall be exempt from taxation so long as the same shall continue to be held and used in good faith for the objects and purposes aforesaid; but whenever any real estate of the corporation shall be leased to any other person or persons, the leasehold interest therein shall be taxable to the lessee or lessees thereof, as in other cases.

Sec. 4. The members of this association acquire no individual property in the real estate, cabinets, library, or other effects thereto belonging, which are hereby declared to be fully vested in the corporation as such; but the interest of the members therein shall be usufructuary merely, and shall not be transferred, assigned, hypothecated, or otherwise disposed of, than as hereinbefore provided.

Sec. 5. Whenever this corporation shall have failed to answer the purposes for which it was created, or shall suffer its charter to be forfeited by the law of the land, its cabinet collections and library shall revert to and become vested in the City of St. Louis, to be deposited with some public institution in said city, for general use and inspection, under such regulations as the said city may prescribe.

Sec. 6. This act shall be taken as a public act, and be in force from and after its passage.

R. C. HARRISON,
Speaker of the House of Representatives.

H. JACKSON,
President of the Senate.

Approved, January 17, 1857.
TRUSTEN POLK.

CONSTITUTION

OF THE

ACADEMY OF SCIENCE OF ST. LOUIS.

ARTICLE I.

STYLE.

SECTION 1. This Association shall be called "THE ACADEMY OF SCIENCE OF ST. LOUIS."

ARTICLE II.

OBJECTS.

SECTION 1. It shall have for its object the promotion of Science and preëminently the Natural Sciences.

SEC. 2. As means to this end the Academy shall hold meetings for the consideration and discussion of scientific subjects; shall take measures to procure original papers upon such subjects; and shall, as often as may be practicable, publish its Transactions. It shall also establish and maintain a Cabinet of objects illustrative of the several departments of Science, and a Library of works relating to the same. It shall also place itself, by correspondence and otherwise, in relation with other scientific institutions in America and elsewhere.

ARTICLE III.

MEMBERS.

SECTION 1. This Academy shall be composed of two classes of members—associate members and corresponding members.

Sec. 2. The associate members shall constitute the main body of the Academy, and shall exclusively conduct its affairs, elect its officers, admit its members, etc. They shall be men desirous of cultivating one or more branches of Science. They shall pay upon admission an initiation fee of five dollars, and a semi-annual payment of three dollars so long as they continue members.

Sec. 3. Any person elected an associate member may become a life member upon the payment of one hundred dollars, which will exempt him from any further assessments. Life members shall be entitled to all the privileges of associate members, including access to the Library and Cabinet, and shall have free admission to any Lecture or course of Lectures which shall at any time be delivered before or under the auspices of the Academy.

Sec. 4. Corresponding members shall consist of men of science, not living in the city and county of St. Louis, who shall be elected such by virtue of their attainments, and of other persons, not resident in the city of St. Louis, who may be disposed to further the objects of the Academy by original researches, contributions of specimens, or otherwise.

Sec. 5. All candidates for admission into the Academy as associate or corresponding members must be proposed in writing by two associate members at a regular meeting, and be balloted for separately at the next regular meeting thereafter. The affirmative vote of three-fourths of the members present shall be necessary to elect a candidate.

Sec. 6. All members shall have the privilege of attending the regular meetings of the Academy, and shall have access to the Library and Museum, with the privilege of introducing to the same their families and friends.

Sec. 7. If any associate member elect shall not pay the fee of initiation within six months from the date of his election into the Academy, the election shall be null and void; and if any member shall not pay the semi-annual contribution within six months after he has been duly notified that the same has become due, he shall cease to be a member of the Academy: *provided, however*, that every such member who shall be absent from the city or county of St. Louis for the space of six consecutive months, or longer, shall be exonerated from the payment of all dues accruing during his absence.

SEC. 8. If any person shall be balloted for and rejected, or his name be withdrawn previously to the ballot, no entry of said rejection or withdrawal shall be made on the minutes of the Academy.

SEC. 9. No person who has been proposed for membership and who has for any reason failed to be elected, shall be again proposed within the next six months.

SEC. 10. Any member may resign by notifying the Recording Secretary of such intention, provided he produces to the said Secretary a certificate from the Treasurer that all arrears due from him to the Academy have been discharged.

SEC. 11. Members may be expelled from the Academy by a vote of a majority (being not less than twelve) of the members present, at any regular meeting, for any act of flagrant disrespect to the officers or members, or for any intentional violation of the constitution, or for any grossly immoral conduct: *provided, however*, that no member shall be thus expelled without having an opportunity of being heard in his own defence.

ARTICLE IV.

OFFICERS.

SECTION 1. The officers of the Academy shall be chosen from the associate members, and they shall consist of a President, *first* and *second* Vice Presidents, a Corresponding Secretary, a Recording Secretary, a Treasurer, a Board of Curators, and a Librarian. Said officers shall be elected at the first stated meeting in the year, by ballot, and shall hold their offices for one year, or until their successors are elected.

SEC. 2. It shall be the duty of the President to preside over the meetings of the Academy; to nominate all committees other than those specially excepted; to call extraordinary meetings at the request, in writing, of three associate members; to give the casting vote, and to sign all orders on the Treasurer.

SEC. 3. The duties of the 1st Vice President shall be the same as those of the President, during his absence; and of the 2d Vice President, the same during the absence of both President and 1st Vice President.

SEC. 4. It shall be the duty of the Corresponding Secretary to conduct all the correspondence of the Academy; to keep correct copies of all letters written by him in such correspondence, and to make regular reports of the same; and to notify all corresponding members of their election. And it shall be the duty of the Recording Secretary to keep correct minutes of the proceedings and transactions of the Academy; to keep all reports and other papers read before it, unless their disposal shall be otherwise ordered; to notify all associate members of their election; to keep a correct list of the members of the Academy, with the dates of the election, and the dates of resignations, expulsions and deaths that may occur among them; and to keep the constitution and common seal of the Academy.

SEC. 5. It shall be the duty of the Treasurer to take charge of the funds of the Academy, and attend to the collection and payment of money; but no money shall be paid by him except on an order of the Academy, signed by the President and countersigned by one of the Secretaries: he shall keep a clear and detailed statement of all receipts and expenditures, shall keep his books accessible to the proper committees appointed for their examination, and he shall lay before the Academy, at the last stated meeting in the year, a statement of all receipts and expenditures during the year; and he shall give security, satisfactory to the Academy, in the sum of five thousand dollars, for the faithful performance of his duties. And he shall deposit, in the name of the Academy of Science, all funds of the Academy coming to his hands, when amounting to $25.00, in such incorporated bank in the city of St. Louis as shall from time to time be designated by the Academy, by resolution; and the same shall draw from said bank, by check in the name of the Academy of Science, signed by him as Treasurer of said Academy, as needed for the payment of its debts or expenses.

SEC. 6. The Librarian shall take charge of all books belonging to, or deposited with, the Academy, and shall be responsible for the same; he shall keep a catalogue thereof, in which the names of contributors shall be inscribed, with the dates of their reception, conformably to the by-laws that may be established for the regulation of his duties; he shall superintend the publication and distribution of all memoirs, essays and papers, written by members, whenever so ordered by the Academy, and shall attend in the Library at such times as the by-laws may prescribe.

Sec. 7. It shall be the duty of the Curators to have charge of the Museum of the Academy, to supervise the arrangement of all specimens and apparatus belonging to it, to direct the management of it, and to do all things necessary for its preservation and repairs. They shall purchase all articles wanted in the fulfilment of their duties aforesaid, hire janitors, keep the keys of all cases in the Museum, and shall report all additions made to the different departments under their charge, at the last stated meeting in the year.

ARTICLE V.

MEETINGS.

Section 1. The meetings of the Academy shall be held at such times as the by-laws may direct.

ARTICLE VI.

AMENDMENTS.

Section 1. The constitution may be amended in the following manner, viz: Any amendment proposed may be submitted in writing to a regular meeting of the Academy; it shall lie over for consideration four weeks, when it shall be acted upon at the first regular meeting succeeding the expiration of the above named period, and may be adopted as a part of the constitution by a vote of two-thirds of the members present.

BY-LAWS.

ARTICLE I.

COMMITTEES.

SECTION 1. Standing committees shall be appointed on the Cabinet, on the Library, and on Publication.

SEC. 2. These committees shall consist of three members, who shall be appointed at the last regular meeting in January of each year.

SEC. 3. In appointing these committees, the President shall nominate the first member; the first member so nominated shall nominate a second, and the two so nominated shall nominate the third.

SEC. 4. All committees must report in writing, and every report must be signed by a majority of the committee offering it.

SEC. 5. All special committees must report at the regular meeting next succeeding their appointment.

SEC. 6. The standing committee on the Cabinet shall have charge, in conjunction with the Curators, of the collections of the Academy, make exchanges of duplicates, arrange and keep in order all donations and deposits, carefully labelling each article, and keep a correct catalogue of all additions to the Cabinet, and report at the last stated meeting in the year.

ARTICLE II.

LIBRARY.

SECTION 1. The Librarian shall keep a correct catalogue of all books belonging to the Academy, the Library of which shall be open to the inspection and use of members.

SEC. 2. There shall be two sets of keys to the cases containing the books, one of which shall be kept by the Librarian, and the other by the chairman of the Library Committee.

SEC. 3. Members may borrow books, the property of this Academy, from the Librarian, on signing a promissory note for fifty dollars, which shall become void when the book is returned.

SEC. 4. But no works shall be loaned from the hall, on any account whatever, except those marked with an asterisk (*) in the catalogue, unless by an affirmative vote of three-fourths of the members present, at a regular meeting, when the application is made; and in case of deposited books, the written consent of the depositor having previously been obtained; the name of the borrower and the title of the book to be recorded on the minutes, and full security given for its safe return, by note or otherwise, the value whereof shall be determined by the Library Committee.

SEC. 5. No book shall be kept from the Library longer than two weeks. A fine of twenty-five cents shall be imposed for each week that any book is kept over the time laid down in this section.

SEC. 6. No member shall be allowed to renew the loan of a book, if any other member shall be desirous of obtaining it.

SEC. 7. The Librarian and Library Committee shall be responsible for all works committed to their charge.

ARTICLE III.

MUSEUM.

SECTION 1. No specimen or apparatus contained in the Museum of the Academy shall be taken from the hall, under any pretence whatever, unless by vote of the Academy.

SEC. 2. The keys of the cases containing the collections shall be kept by the Curators and members of the respective committees attached to the different departments, who alone shall have liberty to open the cases; and they shall be responsible for all articles committed to their charge. If any member is desirous to inspect more closely the specimens in the collection, for purposes of study or description, he must apply to the Curators, or a member of the committee on that department.

Sec. 3. All articles in the Museum must be kept labelled as far as practicable, and a catalogue of the articles in each department kept by the committee attached to the said department.

Sec. 4. When a member of the Academy deposits in the Museum a sufficient number of articles to fill an entire case, a key of said case shall at all times be at his command.

Sec. 5. Books or objects of Natural History, deposited with the Academy, shall be returned only on a request of the owners, or their representatives, and in all cases a receipt shall be given to the Curators when the articles are returned.

Sec. 6. No specimen which is not capable of being arranged in the cabinet shall be received on deposit, unless the consent of the committee on the department in which the specimen should be classed, and that of the Curators, be first obtained in writing.

Sec. 7. Visitors may be admitted to the Museum at hours to be fixed by the Board of Curators, approved by a vote of the Academy.

Sec. 8. No children under twelve years of age shall be admitted unless accompanied by persons who will become reponsible for their good behavior; and should any damage result to any of the furniture, specimens, or any property of the Academy, through any admitted child, pecuniary remuneration shall be made by the person or persons assuming such responsibility; the damages to be assessed by the Librarian and Curators.

ARTICLE IV.

COMMUNICATIONS.

Section 1. All written communications intended for publication, read before the Academy, shall be referred to special committees, who shall report thereon at the regular meeting next succeeding their appointment.

Sec. 2. All such communications become the property of the Academy, and shall be deposited in the archives, and those deemed suitable for publication shall be published when so ordered by the Academy; a copy, however, of any paper read before the Academy may be taken by the author.

Sec. 3. Original papers, on the subjects before enumerated, may be subject to discussion.

ARTICLE V.

MEETINGS.

SECTION 1. The regular meetings of the Academy shall be held on the first and third Monday evenings of every month, at an hour to be fixed from time to time by the Academy; no change, however, shall be made except after two weeks' notice given at a regular meeting.

SEC. 2. The order of proceeding, at the regular meetings of the Academy, shall be as follows:

1. Minutes of the last meeting read.
2. Reports of committees.
3. Report of the Corresponding Secretary.
4. Donations to the Museum and Library.
5. Written communications.
6. Verbal communications.
7. Deferred business.
8. New business.
9. Elections and proposals for membership.
10. Adjournment.

ARTICLE VI.

AUTHORITY.

SECTION 1. On all points of order that are not provided for in these by-laws, Cushing's Manual shall be the standard authority.

TRANSACTIONS

OF THE

ACADEMY OF SCIENCE OF ST. LOUIS.

Notes on the Genus YUCCA.

By GEORGE ENGELMANN, M.D.

The stately Yuccas of liliaceous alliance and of American origin had attracted the attention of European horticulturists long before Linnaeus classed the then known species, four in number, and, indeed, three of these were based on specimens cultivated in European gardens, two of them, *Yucca aloifolia* and *Yucca Draconis*, on the elegant and very accurate figures of cultivated plants by Dillenius, published some 140 years ago. Ever since then the Yuccas have remained favorite plants in the gardens on account of their palm-like (hence *Palmilla* of the Mexicans), either rigid and pungent, or gracefully curved foliage, shooting up from the ground in pleasingly regular masses, or raised into the air on simple or branching trunks, all overtopped by immense white panicles of hundreds of glorious flower-bells.

It thus happened that these plants fell into the hands of professed horticulturists, and—perhaps because the herbaria could afford only few and very incomplete specimens—scientific botanists rather shunned them, as they did many other such plants, and notably among them the Cacti. With these they share the precious property of being easily propagated from some, perhaps a single, imported specimen ; hence, the individual peculiarities of such specimens, propagated a thousand and a thousand fold in the course of a century (for most of our cultivated Yuccas have been thus long in the hands of nurserymen), at last impress the observer with the dignity of specific characters. But the botanist finds it necessary to fall back on the organs of inflorescence and fructification as the only safe guide in such difficulties; here, however, the cultivated Yuccas leave us in the dark. They yield us flowers, to be sure, but we find the flowers so very similar in many species, and again so dissimilar in different forms of the same species, that evidently but little light can be obtained from their study. And the fruits? Unfortunately the Yuccas scarcely ever have borne fruit in European gardens. The difficulties are increased by the fact, that, as will be shown below, in their native homes these plants vary remarkably in the structure and the form of even their more important organs; and before fuller examination of native forms can be had, we must remain in considerable doubt as to the limits of species.

My attention was drawn to this genus, when, since 1842, Mr. F. Lindheimer sent several then undescribed species from Texas, and Dr. A. Wislizenus, and after him Dr. J. Gregg and Mr. A. Fendler, others from New Mexico and Northern Mexico. A few years later the botanists of the Mexican Boundary Commission and of the Pacific Railroad Exploring Expeditions added to the stock of our knowledge, and within the last decade the explorers of the botany of California and of Arizona filled up some further gaps. Within the last two years an unpretending physician of South Carolina, Dr. J. H Mellichamp, who does not even claim to be a botanist, but is imbued with arduous zeal and keen sagacity, and who lives right among the Yuccas, has wonderfully improved his opportunities, and has very greatly aided me in my investigations by specimens as well as by his observations. I may add here that also on other families of plants of his rich State, already so long and well known through the labors of a Walter and an Elliott, have his researches shed new light, as will appear in future pages of these Transactions.

Having thus been interested in the Yuccas for many years, I ever had an eye on these plants, and in my travels in Europe I neglected no opportunity to study them in the herbaria as as well as in the gardens. There I was first struck with the "fact" that "Yuccas do not bear fruit." To be sure, I had seen the fruits in the Texan and New Mexican collections, and had observed the capsules in our St. Louis gardens; but I found none in Europe, or almost none, I should say, for in the botanic garden of Venice I gathered the pulpy pods from a large *Yucca aloifolia*, about 15 feet high. This was the only Yucca fruit seen by me in Europe, though I have since learned that in other instances also, though only exceptionally, fruit and good seed have been produced there, principally by this same species, and very rarely by others.

The question why the flowers should almost invariably fail, had been frequently discussed and various reasons suggested, such as sexual incompleteness of the flowers or impossibility of self-fertilization of plants originating from the same stock.

I had observed that all the Yuccas which came under my notice, opened their more or less pendulous flowers in the evening, and half closed them during the following day, after which they withered. The anthers were observed to open a little before the flowers did, and to expel a large-grained glutinous pollen, which did not seem to readily find its way to the stigma. And how is the stigma constituted? The conspicuously papillose termination of the pistil had always been considered the stigma, but closer examination showed its papillæ to be epidermidal appendages, corresponding to similar ones on the filaments, and entirely destitute of stigmatic functions; never did they contribute to the development of a pollen-grain occasionally adhering to them. Dr. Mellichamp's notice of a minute drop of glutinous liquid in the tube formed by the coalesence of the so-called stigmas, led me on to further experiments. That tube proved to be the real stigma, exuding stigmatic liquor, and insects (in these *night-blooming* flowers, of course, *nocturnal* insects) must be the agents which introduced the pollen into the tube. Last June, several forms of Yucca which were blooming under my windows, were carefully watched, and soon different species of beetles were found in the flowers, but not as regularly and frequently as white moths, which, usually in pairs, disported themselves in the open flowers at dusk, and were found quietly ensconced in them when closed in day-time.* The suspected insects were handed over to my friend, Mr. C. V. Riley, who thereupon took up the zoölogical part of the investigation,

* These snow-white "millers" which I have found in almost every flower examined, when closed in daytime, doubtless enter their "ivory palaces" at night, and would be quite sufficient for the purpose. Dr. M.—Later, the same correspondent adds: Where I have found many moths last year, I noticed none or few this season. A few weeks later the plants were found without fruit, or with fruit bearing empty seeds.

the surprisingly interesting results of which are detailed by him in the succeeding paper.

GERMINATION.

The seeds of Yucca germinate easily, the cotyledon remaining partly in the ground * within the seed, extracting its liquified contents, and never grows into a leaf-organ; the first leaf issues from a slit in the cotyledon opposite the remnants of the seed; the succeding six or eight leaves of the first season following in $\frac{1}{2}$ order, which, in the further growth of the plant, gradually changes to the higher orders of $\frac{3}{8}$ and further. From the nodes of the very short axis, stout white rootlets break through the back of the leaves, the first one through the back of the cotyledon, opposite the first leaf, while the original radicle withers away. The Californian *Y. Whipplei* is the only one in which the axis, together with the base of the leaves, swells up into a sort of bulb.

In the second season, a stout, cylindrical secondary axis originates from the axil of one of the earliest of last year's leaves, covered with scale-like leaf-rudiments, and eventually producing from its nodes the rootlets which are to nourish the plant. This secondary axis takes a horizontal direction in all the species I could examine, especially in the different forms of *Y. filamentosa;* only in *Y. angustifolia* I have always found it to grow straight downwards, continuing this direction through, at least, the third and fourth year, and perhaps longer. Some observations seem to indicate that *Y. gloriosa* develops in a similar manner. The terminal bud of this secondary axis does not seem to form leaves as long as the primary leaf-bud continues to grow, and probably not until it has produced a flowering stem, and perhaps not even then for years. At last, however, the secondary axis branches out, if horizontal, near the surface of the soil, if perpendicular, as in *Y. angustifolia*, at a certain depth, even two or three feet, below it, forming horizontal branches, and eventually sending out leafy shoots above the surface. Some species are surrounded by such offshoots, thus forming clumps or thickets; *Y. baccata*, *Y. gloriosa*, *Y. filamentosa*, behave in this way, while *Y. angustifolia* is said to do this much more sparingly, and *Y. aloifolia* quite rarely.

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* The very similar seeds of Agave have a very different development; in their germination the cotyledon grows into a leaf, bearing the remnants of the seed on its tip.

ROOTSTOCK.

While the rootlets of Yucca annually spring from the youngest part of the rootstock, and decay again after a season, the rootstock itself increases often to a large size and irregularly branched shape. We have very few data about the form of this organ; in fact, the only definite information, accessible to me, has been imparted by Mr. Lindheimer, who, with persistent zeal, has dug up from the often hard and stony soil of West Texas the different species accessible to him. He informed me that *Y. angustifolia* usually exhibits a perpendicular rootstock of a finger's thickness, and two or three feet long, "rising from" (it is evident from what is stated above, that it is rather "descending to") a long horizontal simple or branching part, one or one and a half inches thick, exhibiting many knobs and buds of future shoots. *Y. rupicola* has a rootstock consisting of a few thick, cylindric, horizontal branches, one to two feet long. The tree-like *Y. Treculiana* has few short, thick, club-shaped, horizontal branches to its rootstock, sometimes only a single, short and very stout knob, which does not seem to readily sprout out. It will be interesting to study these conditions in other species in their native localities.

The rootstock of all the Yuccas is, under the name of "Amole," an important article in a Mexican household, being everywhere used as a substitute for soap, as it is replete with mucilaginous and saponaceous matter, probably a substance analogous to the saponine of the *Saponaria* root. It is curious to learn that the negroes of the coast of South Carolina repeatedly destroyed Dr. Mellichamp's carefully observed clumps of Yuccas, in order to obtain the saponaceous rootstock. How may the knowledge of its quality have reached them? Perhaps from the West Indies.

TRUNK.

The trunk of the Yuccas either remains entirely below the surface, or it takes different degrees of development above ground. Heretofore, specific characters were partly based on such differences, but we know now that only few species are regularly and always acaulescent (*Y. rupicola*), while others, when in a perfect, or flower-bearing state, always have trunks (*Y. aloifolia* and *Y. Treculiana*, though this species was first described as stemless); a certain number, usually counted as acaulescent, under favorable circumstances make short trunks, sometimes of only a few years' duration (*Y. filamentosa*, and still more *Y. angustifolia*), and others, again, among them most notably *Y. baccata*, are absolutely stemless near their northern limits, while the farther south we meet them, the higher and more tree-like their trunk grows.

The primary axis of the Yuccas is terminated by the inflorescence and its apex dies with it. The plant is then rejuvenated by lateral buds, either from the same axis or from the subterranean rootstock. In the first instance the buds appear about the time of the maturity of the fruit, in the trunk-bearing forms from the axils of the uppermost, in the stemless ones from those of the lowest leaves. A single subterminal bud will soon simulate the direct continuation of the main axis; several buds will produce branches in the trunk-bearing species, while in the stemless ones they will give the plant a cespitose appearance. From Dr. Mellichamp's observations, it seems that the caulescent Yuccas show certain differences in the place where the bud appears; he noticed the young bud of *Y. aloifolia*, from exactly the uppermost axil, at the base of the inflorescence, while in *Y. gloriosa* it sprung from between the uppermost and the next lower series of leaves. In a *Y. filamentosa* in my garden, I observed several buds in the axils of the highest leaves developed two years in succession, so that a short branching trunk was formed, while after the third year the vitality of this trunk seems to have died out, and the plant was rejuvenated by shoots from the subterranean rootstock. In other forms, which probably belong to the same species, I find only rarely, in very vigorous garden specimens, a bud from the uppermost axils, while almost always they branch from below the crown of leaves. But observations of this kind, relating to the biology of these plants, have been made too seldom to permit yet the deduction of general laws.

The Yucca trunk has a light fibrous wood, which exhibits distinct marks of concentric arrangement, so that in an old trunk of *Y. Treculiana*, of two and a half feet in diameter, I can count twenty layers in a space of two and a half inches, or one and a half lines to the layer; the trunks certainly grow in thickness as they get older. Another peculiarity of old Yucca trunks is their thick, corky bark; the above mentioned *Y. Treculiana*, sent by Mr. Lindheimer, has an irregular, rather scaly, dark gray bark of a quarter or a third of an inch thickness, resembling that of some elm or willow; a trunk of *Y. aloifolia*, received from Dr. Mellichamp, is covered with a bark of the same thickness, of a deep brown color, broken up into numerous small square or angular fragments, much like that of the dogwood (*Cornus florida*). The bark of a section of *Y. brevifolia*, sent by Dr. Parry, is similar, but over half an inch thick, and still more deeply cleft. The investigations of these organizations would form a worthy subject for an experienced phytotomist.

LEAVES.

The leaves of the Yuccas are evergreen, i.e. they last at least a whole year, in the low species, or several years in the arborescent ones. They are lance-linear, abruptly narrowed above a very broad, mostly membranaceous base, and usually widening again near or above the middle (some narrowed-leaved species are not contracted below the middle), and gradually, or rarely abruptly, terminate in a horny, often sharply pointed, rarely obtuse, sometimes soft and herbaceous spine, below which the tip of the leaf is more or less concave and involute. The leaves are usually more or less thick, and more or less rigid, but we find all the transitions from the stiff and sharp pointed ("Spanish bayonet") to the soft and flaccid leaf. Their size in the different species varies from half a foot to four feet in length, and from one quarter to two and three inches in width.

The upper side of the leaf is flat (the tip excepted), or almost always more or less concave, sometimes deeply channeled, and occasionally folded or plicate. The lower side is convex, and its lower part bluntly keeled. The surfaces are smoothish or more or less rough, and this roughness is the result of the peculiar structure of the cells surrounding the stomata. The lateral walls of these cells are thickened, hard and transparent, and somewhat elevated above the general surface; especially in the true *Y. filamentosa* the edges of the upper and lower marginal cells protrude over the stoma like minute, beautifully chiseled, conchoidal shields, sometimes almost completely covering it. In *Y. brevifolia* the edges of other cells are also apt to protrude, and, besides, numberless little knobs, similar to the marginal asperities, to be described below, increase the roughness of both surfaces. I notice the same appearance on the lower surface of the leaves of the *Y. Treculiana* and *Y. canaliculata*, and, less distinctly, on *Y. gloriosa*.

The color of the leaves varies from deep or fresh green through dull green to light glaucous.

Of great interest and diagnostic importance is the edge of the leaf. In some species (e.g. *Y. aloifolia*, *Y. brevifolia*, *Y. rupicola*) it is rough, or, as it is usullay termed, serrulate, and remains unaltered through life. The teeth consist of small, irregular, isolated cartilaginous knobs, each consisting of quite a large number of colorless prismatic or clavate cells, arranged in fan-shaped or straight bundles. These are the "serrulate" or rough-edged Yuccas.

Others have "smooth-edged" leaves, (*Y. gloriosa*, *Y. Treculiana*); the edge, at first green, and often roughened with very delicate and deciduous asperities, soon becomes discolored and brittle, and in old leaves is apt to crumble off, or sometimes to detach itself in a few short fibres, thus approaching the next form.

The "filamentose," or fibrous-edged Yuccas (*Y. filamentosa*, *Y. angustifolia*, *Y. baccata*) constitute the third class. In these the fibrous system of the leaves is much stronger and tougher than in the last, and, the parenchymatous tissue soon withering on the edge, the marcescent marginal fibres detach themselves as more or less numerous, delicate, or coarse, straight, or often curled threads, of a whitish, ashy or reddish color. In the young leaf they are most conspicuous, especially near the involute point of the leaf, but in old ones they sometimes become obsolete.*

Some importance has been attached to the number of leaves, which in healthy plants precede the development of the inflorescence, and there really is a relative difference in this respect in different species; but specific characters could hardly be based on a condition which depends so much on external influences of soil, climate, etc. From Dr. Mellichamp's notes it is evident that wild plants, in good health, exhibit a great many more leaves than cultivated ones, and that the number not rarely rises above one hundred on one axis.

The diagnostic characters derived from the leaves must be adopted only with great circumspection. The characters of the edges of the leaves are the most constant and reliable ones, though the abundance, thickness, and, still more, the length of the fibres,

* A fourth form of leaves is described in the books as having marginal spines, and *Y. spinosa*, H. B. K. nov. gen. I. 289, from Mexico, is quoted as the representative of this type. But the inspection of the Berlin Herbarium proves this to be a factitious species, made up of Yucca flowers (similar to those of *Y. Treculiana*) and the spiny leaves of *Dasylirion acrotriche*.

vary considerably, even in forms of the same species. The shape of the leaf is quite variable, and more so still its color, its thickness, its stiffness, (hence its direction) and the nature of its terminal spine; broader leaves, with abundant parenchyma are apt to become plicate, while in the same species leaves of stronger fibrous structure are even. The characters derived from the roughness and the peculiar structure of the stomatic surroundings, as above detailed, are also inconstant, and therefore unreliable.

INFLORESCENCE.

The inflorescence, which terminates the axis in Yucca, usually consists of a compound raceme or panicle of different dimensions, from two to three or four feet high, with differently developed lateral branches, and, therefore, of different shape, oval, lanceolate or pyramidal, and in one species at least (the northern form of *Y. angustifolia*) reduced to a simple raceme or spike. This inflorescence is nearly sessile between the uppermost leaves, especially in the arborescent species; or it is raised on a longer or shorter scape, sometimes longer than the inflorescence itself, principally in the acaulescent forms. The scape bears reduced, bract-like leaves, those of the inflorescence itself usually becoming quite small and membranaceous, or, in some southern species, increasing in size, broad, concave and spathe-like, fleshy and discolored. The inflorescence is smooth or rough or pubescent, but no important value can be assigned to these differences. The pedicels are single or (on reduced branchlets) clustered, always distinct, but shorter than the flowers, curved, patulous, declined or pendulous, never, during the flowering period, erect.

FLOWERS.

The Yucca flower consists of a PERIGON of six oval or lance-oval segments, united at base with one another, with the stamens and with the pistil, and not articulated, so that they wither after flowering without falling off. The perigon, expanding only for one evening and night, forms a shallow cup of whitish, cream-white,† or greenish-white color, sometimes externally tinged with purple, of two to five inches in diameter; on the following morning, the fading segments conniving, the flower assumes a globose or deep bell-shape, of one and one-fourth to three inches

† The flowers of *Y. canaliculata* are described and figured in the Botanical Magazine as "straw-yellow."

in depth.‡ The three outer segments are usually narrower and often a little shorter, and more frequently tinged with green or red along the midrib and tip; the three inner ones are broader (except apparently in *Y. Guatemalensis*, where they are narrower), more petaloid, of more delicate texture and color, and, in some species, tipped with a small bunch of short white wool. They possess a certain, usually not pleasant, fragrance.

The size of the flower and even the shape of the segments is extremely variable in some of the species (*Y. baccata*, *Y. Treculiana*, *Y. rupicola*), and can scarcely be used for diagnostic purposes.

The six STAMENS, in two series, but of nearly equal length, are adnate to the base of the perigon, and always shorter than this, and mostly shorter than the pistil; only in *Hesperoyucca* they are longer than the latter. Straight in the bud, they are frequently more or less recurved and even uncinate *after* maturity, in some forms more, in others less, but I am not able to discover a specific character in this change of form.

The filaments are fleshy and club-shaped, and in the true Yuccas covered, especially upwards, with transparent one-celled papillæ or papillose hair; a minute point on the obtuse, sometimes slightly trilobed apex bears the introrse anther. In *Hesperoyucca* the filament is smooth, thicker upwards, but with an acute tip.

The anthers are comparatively small, 2½ or usually 3–4 millim. long; in exceptional cases, only in cultivated plants of *Y. angustifolia*, I have seen them 5–6 mm. long; they are sagittate or cordate at the base, rounded and entire or notched at tip, adnate on the back and two-celled; they open longitudinally just before the perigon expands, and contracting to one-third or less of their size, and curling backwards, expel the large, comparatively scarce, globose, glutinous pollen grains of 0.055–0.070 mm. diameter. The size and shape of the anthers seem to me to vary in the same species.

Hesperoyucca has smaller, deeply cordate, emarginate, somewhat didymous anthers, 1½–2 mm. long, and broader than long, bearing pollen similar to that of the other Yuccas.

The PISTIL in the true Yuccas is a cylindric or rather prismatic,

‡ It is this day-time appearance which is almost always described and figured, and which gives an erroneous impression as to the form of the well developed flower.

obscurely six-sided ovary, sometimes irregularly impressed and angled by the close application of the stamens in the bud, rarely attenuated at base; terminated by three, more or less united, stigmas, which are usually sessile, or are elevated on a style formed by the gradually attenuated upper part of the ovary. Only in *Y. Guatemalensis* the ovary is more oblong than prismatic.

The ovary consists of three carpels, opposed to the exterior perigonial lobes, forming by their connection three primary dissepiments each one bearing on two central placentæ two series of numerous flat, horizontal anatropous ovules on very short (not long, as is sometimes stated) funiculi, separated from one another by a secondary dissepiment, springing from the back of the carpel; the single ovules, however, are not separated by transverse dissepiments as Gaertner has it.

The Yuccas with thick seeds and fleshy fruit bear thicker ovules (0.3–0.4 and even 0.5 millim. thick), those with thin seeds and capsular fruit thinner ones (0.2–0.25 mm. thick), so that to some extent we may, from the thickness of the ovules in well developed flowers, guess at the section to which the plant may belong. *Y. gloriosa* and *Y. Treculiana*, however, have somewhat thinner ovules than the others of their section, and in some forms, which I class with *Y. filamentosa*, I have found them occasionally as thick as these.

The three carpels are firmly united from the centre of the ovary to beyond the middle; here a thin tube, open at the base and top of the ovary, and from this to the external surface a more or less closely compressed slit, separate them. These slits open as the fertilized ovary grows, and in the fleshy-fruited species eventually form the three inner, impressed sides of the six-sided pod.

The always glabrous ovary is either obtuse and abruptly terminated by the stigma (*Y. aloifolia*), or it is gradually attenuated into a conical or prismatic, glabrous style, sometimes as long as the ovary itself (*Y. rupicola*), which towards the tip ends in the stigmas. This style is an organ of great variability in length and thickness, and may or may not be present in forms of the same species.

Stigmas we conventionally call the terminations of the three carpels, which are distinguished from the ovary and style by their coating of transparent oval or globose epidermidal cells, which, however, as already stated, have no stigmatic function, not even that of gathering the pollen. The three stigmas, emarginate or bilobed at the summit, are more or less united, and form a tube; they are generally erect, but in some species, especially in the true *Y. filamentosa*, they are at last patulous and even recurved. The inside of the stigmatic tube, somewhat triangular in the transverse section, with three pairs of tiny prominent ridges, corresponding to the commissures of the carpels, is coated with much smaller and less elevated, truly stigmatic cells, which exude the stigmatic liquor, under the influence of which alone the pollen can develope. The tube terminates near the upper ends of the three ovarian cells, and seems to communicate directly with them.

Hesperoyucca has an obovate ovary of a similar structure, crowned by a shorter or longer, sometimes filiform style, bearing a very peculiar, large, hood-shaped, trilobed stigma, beset with long filiform papillæ.

The color of the stigma is usually of a pearly white, while the ovary is dull or greenish-white; only in *Y. angustifolia*, I find the stigma bright green.

FECUNDATION.

The fecundation of the Yucca flower, as has been stated in the introduction, is very uncertain, and evidently depends on contingencies not always attainable, so that very often in its native condition, and almost always in cultivation in Europe, these plants remain sterile. The flower can only be fertilized by the introduction of the pollen into the stigmatic tube; this at least in the capsule-bearing Yuccas, which alone I have been able to examine in the growing state, is accomplished almost always by a nocturnal insect, the *Pronuba yuccasella* (thus named by Mr. Riley and described in the next paper). Even where we are unable to observe the moth itself, its traces are manifest in the presence of its offspring, the larvæ, feeding on the maturing seeds, tunneling their rows and finally emerging through a perforation of the capsule. Wherever, therefore, we find such perforated capsules, or merely the remaining annular rim of seeds, we know that *Pronuba* has been at work. The capsules and seeds of the Californian *Hesperoyucca* also show the unmistakable traces of this or a similar insect. On an average in our gardens, as well as in the fields of the coast of South Carolina, about two-thirds of the capsules and their seeds bear the marks of these larvæ.

Of the baccate Yuccas, *Y. gloriosa* and its allies seem to bear fruit very rarely, as neither my correspondents nor I myself have thus far ever been able to obtain one; *Y. Treculiana* is abundantly fertile in its native localities, but will not fructify, as Mr. Lindheimer informs me, in the gardens of the same region; *Y. aloifolia*, however, matures its pods more readily than any other species in Europe, where our moth cannot have an agency in it. We, therefore, are forced to assume that some other mode of fecundation, or even self-fertilization, can take place with them. Occasionally, no doubt, the moth performs its functions in the flowers of this species as well as in the capsular Yuccas. Dr. Mellichamp has found its larvæ tunneling the seed rows of *Y. aloifolia*, destroying 10 to 14 seeds during its growth, and eventually emerging through the characteristic perforations of the surface. He discovered also another larva in the green pods of this species, the egg of which is evidently deposited into the rind of the ovary or young fruit, and which principally feeds on the immature pulp and only rarely attacks the growing seed. This, Mr. Riley thinks, must be the larva of a hymenopterous insect, which has, perhaps, nothing to do with the fecundation of the flower. But how may these Yuccas be fertilized without the action of the Pronuba? Probably, occasionally, and, so to speak, accidentally by other insects, or possibly sometimes by the withering and conniving segments of the flower bringing adhering clumps of pollen in contact with the stigmatic juices in the open tube. Such chances, however, seem to be slim, not to say improbable, and in this case impregnation would have to take place on the day following the opening of the flower.

It has been stated above that the quantity of pollen is small, and that the grains are large and somewhat viscid; thus, when expelled from the contracting anthers, they remain in little clumps here and there within the flowers, on the papillose filaments, or, more frequently, attached to the inner surface of the perigon. When introduced into the stigmatic tube and in contact with its secretion, its tubes are developed, and, when we carefully dissect a fertilized ovary, large bundles of straight parallel tubes are found to fill the cells and to find their way, one to almost each ovule. I have followed them, through both openings of the ovule, and found them attached with their enlarged end to the outside of the nucleus, separated from the germinal vesicle by two layers of cells. It is probable that the minute, almost filiform, egg of the moth is carried with and between these bundles of pollen tubes as they elongate and push on into the ovarian cells and among the ovules.

As soon as fertilized the nascent fruit of the capsular Yuccas (and apparently also of Clistoyucca) becomes erect and its pedicel thickens and hardens, while the young fruit of Sarcoyucca remains pendulous, as the flower was, and as afterwards the mature fruit is, and its pedicel more flexible.

The Yuccas bloom from the early summer months to the end of the autumnal season. The first one in the latitude of St. Louis (all cultivated plants) is *Y. angustifolia*, which opens its flowers when the roses are in full bloom, from the middle to the end of May; the true *Y. filamentosa* makes its appearance next, about 10 or 14 days later; then come, one after another, different forms allied to the latter. Later than these, in July and August, *Y. aloifolia* unfolds its flowers, and *Y. gloriosa* very often, in our gardens, as well as on the coast of South Carolina, blooms in September and even in October.

FRUIT.

The fruit of the Yucca, is an oval or prismatic, more or less, distinctly six-angled, more or less completely six-celled pod, usually with a short beak, bearing six rows of horizontal seeds. This pod is either pulpy and never opens, or it is dry, and dehiscent, or it is intermediate between these extremes. Some of these conditions of the fruit were known to the older botanists; Linnæus (Syst. Nat. ed. X., 1759, n. 388) has a *capsula trivalvis*; Gaertner (Fruct. II. p. 34, t. 85; 1791) figures and describes the fruit of "*Y. Draconis*," as *bacca carnosa . . . . non secedens;* Nuttall, Gen. I., p. 218; 1818, says: *capsule opening at the summit;* but he mentions that of *Y. gloriosa* as *pulpy;* Endlicher (Gen. n. 1117; 1836) tries to reconcile the apparent discrepancies by describing the capsule as *subbaccata*, *demum dehiscens;* Kunth, Enum., and later botanists have followed Endlicher. In the Botanical Notes to Wislizenus' Memoir of a Tour to New Mexico, etc., 1848, p. 101, I first distinguished the Yuccas with "juiceless capsules and thin seeds" from those with "succulent fruit and thick seeds" Subsequent American botanists (Torrey in Bot. Mex. Bound. p. 221, and especially Chapman in Southern Flora,

p. 485), confirm and adopt these differences. In S. Watson's Botany of the 40th Parallel (Utah and Nevada), 1871, I have briefly characterized the four sections of Yucca, as I now understand them.

The fruit in some Yuccas is pendulous, pulpy and indehiscent, with a sort of crown or disc at base, consisting of the enlarged remnants of the perigonal segments and the stamens (*Sarcoyucca*); in another, thus far only imperfectly known, species the originally fleshy fruit eventually dries up, and constitutes a spongy pericarp, which never opens, and is apparently erect, with a disc at base like the former (*Clistoyucca*); in a third group, the erect fruit is dry and capsular, the base is contracted into a short obconical stipe; it opens with three valves corresponding with the carpels and dividing the primary dissepiments, the valves finally divide again at tip (*Chænoyucca*); in the fourth group, represented like the second, by a single species, the pod is similar to that of the last section, but opens at tip through the middle of the carpels loculicidally, the three valves remaining entire (*Hesperoyucca*).

The secondary dissepiments are usually incomplete at base and top, and, at least in one form (*Y. filamentosa*), they are often rudimentary throughout; in *Hesperoyucca* they seem to tear irregularly at the dehiscence of the capsules.

All the Yucca fruits, but more especially the capsular ones, and those of some species more than of others, are extremely variable in shape, and this seems to be caused principally by the irregular development of the seeds. When these fail near the middle, the capsule becomes constricted (very often in the true *Y. filamentosa*); when near the top, it usually is beaked (forms of *Y. rupicola*); so that definite diagnostic characters cannot be derived from these apparently so well-marked differences in the shape of the capsule. In the species just named, and in the *Y. baccata*, the beak of the fruit may also be the result of the development of an elongated style.

The substance and the surface of the capsules would also seem to afford good distinctions, for we find the capsule in some thin, membranaceous and smooth; in others, thick, ligneous, cross-wrinkled, with thick carinal and also lateral ridges, and sometimes warty; but I have observed such differences in forms of the same species, and especially in *Y. filamentosa*, which seems to be one of the most variable species, perhaps, only because we know more of it than of the others.

SEEDS.

The seeds of the Yuccas are compressed, of a triangular-obvate or obliquely ovate, or sometimes even orbicular form, the straighter, inner margin with the indistinct raphe corresponding with the secondary dissepiment, and the angle at its base containing the hilum. They vary in size from 6–12 or 13 millim. in diameter, and 0.6–3.5 millim. in thickness. The thin black more or less opaque testa exhibits, under a strong power, elevated cells or tubercles, each with or without one or several pits or impressions; in some forms these cells appear larger and irregularly rugose, but I have, thus far, not been able to discover constant specific characters even in the seed surface.

The seeds are of three different forms, corresponding with the three kinds of fruit. The baccate Yuccas have the thickest seeds (2.5–3.5 mm.), of an uneven rugose or undulating surface, with a very narrow two-edged rim, and a deeply lobed or ruminated albumen, as already indicated by Torrey, in Bot. Mex. Bound., in the instance of *Y. baccata*; I have been able to examine only the seeds of this species, *Y. aloifolia* and *Y. Treculiana*. *Clistoyucca* has a thinner seed (2 mm.), with a little more distinct rim, and with an even albumen. All the capsular Yuccas have the thinnest seeds, (0.6–1.2 mm.) with a very distinct, narrower or wider, thin and brittle margin, and with an even albumen.

The semi-transparent, hard, almost corneous, farinaceous and oily albumen, ruminated in *Sarcoyucca*, plain in all the others, contains the straight or mostly more or less curved axil embryo which extends diagonally from the hilum, to which the short caulicle points, almost to the opposite margin, thus attaining the full length of the albumen. Only very rarely and in imperfect seeds I have seen a shorter embryo, such as Gaertner figured, and Kunth described, as being less than one-half or only one-fourth as long as the diameter of the albumen. The slit in the base of the cotyledon, under which the plumule is concealed, shows the cotyledon to be about four or five times as long as the caulicle.

MONSTROSITIES.

I have seen very few abnormal developments of Yuccas, and these only in the flowers. Tetramerous flowers with an eight-parted perigon, eight stamens and a four-carpellary ovary and fruit, more or less regularly developed, are not quite rare in cultivated as well as wild plants. In overgrown garden specimens of *Y. angustifolia*, I have seen flowers irregularly doubled, the number of perigonal lobes increased, some of them yet bearing the traces of anthers, or filaments bearing perfect anthers, with petaloid excrescences or wings, also filaments adnate to the ovary, and some of them even tipped with the green stigma of the species. In a cultivated form of *Y. filamentosa*, the floral axis was elongated, the perigonal segments separated and increased in number, the exterior somewhat foliaceous, and bearing regular or irregular axillary flowers.

GEOGRAPHICAL DISTRIBUTION.

Yucca is a peculiarly American genus, the limits of which were said by the old botanists, Linnæus among them, to extend from Canada to Peru. It is certain, however, that no Yucca grows in Canada, and I find no evidence of any being indigenous in countries south of the Equator. The greatest development of the genus is found in Northern Mexico, and the Southern United States, to the Pacific, principally between the 25th and 35th deg. N. lat. On the eastern coast, one species, *Y. filamentosa*, extends as far north as 38°, while on the western, so much milder slope, they are not found farther than 35°, or perhaps 36°. On the western plains, the hardiest species, *Y. angustifolia*, reaches as high up as 44° or 45°. Southward, a form allied to *Y. aloifolia* has certainly been met with in Yucatan; and another species, *Y. Guatemalensis*, is said to be a native of Central America. I have seen no specimens from the West Indies, though many authorities credit these islands with *Y. aloifolia*, nor have I seen any from South America.

The capsular Yuccas represent the low, or herbaceous, northern type of the genus; all the known species belong to the United States, and only two of them (*Y. angustifolia* and *Y. rupicola*) extend beyond the Rio Grande into Northern Mexico. The baccate Yuccas are the more southern, caulescent, forms, and some of the species do not come up into our territory. The eastern and western species are entirely limited by the Mississippi, which none of them seem to cross. *Y. angustifolia* is a native of the great plains from north to south, and also extends southwestwardly into the mountain region; *Y. rupicola* inhabits the southern portion of the plains. *Clistoyucca* and *Hesperoyucca* are southwestern types, peculiar to Arizona and California.

SYSTEMATIC ARRANGEMENT.

In the foregoing pages it has been shown that in the fruit and seed we have excellent characters for the arrangement of the species of Yucca into several very natural groups; the nature of the edge of the leaves furnishes proper subdivisions; the specific characters are based upon the differences of trunk, leaves, flowers, and also of fruit and seed.

YUCCA, *Lin.*

Perigonium patulum demum globoso-campanulatum six-partitum subpersistens; segmenta lanceolato-ovata acutiuscula; filamenta clavata multo breviora, antheræ biloculares introrsum dehiscentes parvæ; pollen globosum; ovarium tricarpellare triloculare, loculi incomplete bilocellati; stigmata 3 emarginata plus minus connata tubum stigmaticum efformantia; ovula plurima compressa horizontalia anatropa brevissime funiculata 6-seriata; fructus baccatus seu capsularis incomplete 6-locularis; semina obovato-triangularia compressa horizontalia 6-seriata nigra, embryo diagonalis albumini corneo æquilongus.

Plantæ in America trcpica cis æquatorem et præcipue in boreali calidiore indigenæ; caudice arborescente elatiore vel humiliore, sæpe hypogæo; foliis in apice caudicis confertis lineari-lanceolatis crassis rigidis rarius flaccidis apice plerumque spinescentibus; panicula terminali multiflora subsessili vel in scapo bracteato elata; floribus majoribus albidis.

I. EUYUCCA: filamenta clavata obtusa papillosa pistillo plerumque breviora demum patula vel recurva, antheræ cordato-sagittatæ; ovarium prismaticum, stigmata papillosa.

A. SARCOYUCCA: fructus indehiscens baccatus pendulus; semina crassa undulata immarginata albumine lobato-ruminato. Plantæ plerumque arborescentes panicula sæpius sessili.

* Folia margine serrulato-asperata.

1. YUCCA ALOIFOLIA, *Lin.*: caule elatiore; foliis lineari-lanceolatis supra leviter concavis nunc rigidis pungentibus lævibus margine asperrimis; bracteis paniculæ subsessilis ovatæ vel oblongæ glaberrimæ minoribus triangularibus marcescentibus;

perigonii segmentis ovatis; staminibus ovarium prismaticum stigmatibus sessilibus brevibus crassis rectis coronatum nunc æquantibus demum patulis; bacca prismatica six-angulari acutiuscula.

Forma genuina: simplex vel parce ramosa; foliis crassis rigidissimis mucrone valido brunneo pungentibus.—*Y. aloifolia*, Lin. et auct. plur. *Y. Draconis?* Elliott, Bot. I. 401.

Var. *β. Draconis:* elatior, subsimplex; foliis laxioribus sæpius demum reflexis mucrone debiliore pungentibus.—*Y. Draconis*, Lin.

Var. *γ. conspicua:* e basi ramosa; foliis laxioribus supra lucidis in mucronem debiliorem virescentem excurrentibus.—*Y. conspicua*, Haw. Suppl. pl. succ. 32.

I have seen native flowering and fruiting specimens of the genuine plant only from South Carolina, whence Dr. Mellichamp has abundantly supplied fresh and dried material, and from Florida; it there grows always near the coast, often, and apparently most luxuriantly, under the direct influence of salt-water; it extends to North Carolina and to the eastern gulf States; it is also credited to the West Indies and to the eastern coast of Mexico; but on the shores of Louisiana and Texas it seems to be unknown. Var. *β* is said to be a native of South Carolina; var. *γ* was described from plants cultivated in English gardens; its native country is unknown; my description is taken from several magnificent specimens in the botanic garden of Naples, probably correctly named.

On the coast of South Carolina *Y. aloifolia* grows 6–8 or very rarely 10–12 feet high, mostly simple, sometimes, in favorable localities, with a few, often three, branches; trunk seldom more than 4 or 5, at most 6 inches in diameter, only the lowest part of the oldest ones covered with a rough dark brown bark; higher up the marks of the leaf-bases are seen, while the upper part is coated with the withered and dependent leaves themselves, persistent for years; the rigid foliage forms dense heads, the leaves, in $\frac{1}{3}\frac{3}{4}$ or even higher orders, are narrowest above the very broad base, and widest about the middle. I find them in the native specimens usually 18–24 inches long, and $1\frac{1}{4}$–2 inches wide; grown in the shade, they reach a length of 24–32 inches by $1\frac{1}{2}$ inches in width; under the direct influence of salt-water on the sandy beaches of the islands near Charleston they have been found shorter and broader than usually (18–21 by 1½–2½ inches), and it was here that the three-branched plants were observed. In cultivation the leaves are 12–21 inches long, and 1–1¼ wide. Dr. Mellichamp has sometimes, in plants growing close to the beach, seen the upper surface of leaves incrusted with a white deposit, which might be taken for saline efflorescence, but proves to be carbonate of lime, with a very delicate film of organic matter representing a cast of the epidermis cells; probably an exudation from these cells of oxalate of lime altered by oxydation.

The flowers open in July and August, and in the evening expand 3–4 inches, while in daytime they are 1½–1¾ inches deep. I find the stamens, in native as well as in cultivated plants, as long as the ovary, often as long as the whole pistil and occasionally even overtopping it. The unusually stout ovary with the short stigma is 9–11 lines long, the ovules I found 0.35–0.38 mm. thick. The pod is 2½–3 times as long as it is thick (3–4 by 1¼–1¾ inches), six-sided, the sides corresponding to the carpels more elevated, the alternate ones sharply depressed and turning purple before the rest of the fruit, which at last assumes a deep purple color inside and outside, has a sweet, not unpleasant, taste, and is much eaten under the name of Banana. It is always acutish but never rostrate, distinctly tipped with the 3-lobed stigma preserving its tube, whence the fruit is described as "perforated at the apex." The seeds, 6–7 mm. in diameter by 2½–3 in thickness, are very similar to those of all other Sarcoyuccas examined by me.

Var. *Draconis* I cannot distinguish from the last except by the leaves being said to be less crowded, longer, softer, less pungent, and somewhat flaccid and curved. It is said to come from the same region where my specimens, above described, were obtained, and may perhaps be the form with very long leaves, grown in the shade, described above. The plants, cultivated here and there under that name, may in part be *Y. Guatemalensis*, described below.

Var. *conspicua*, or at least the plant cultivated under that name in the botanic garden at Naples, differs from the type by its softer, though not pendulous, leaves, with a green scarcely pungent point. It there makes large bushes, over 20 feet high, branching abundantly from or near the base, the thickest trunks 6–9 inches in diameter. I notice that the panicles, sometimes three feet long, are almost sessile on the older trunks, as they usually are in this section; but in vigorous young shoots they are born on a scape of nearly their own length. When I examined the plants they had not borne fruit for many years, though flowering abundantly; I learn that they have been fertile since, but have not obtained the pods.

There are other forms of serrulate Yuccas, most probably of this section, described in the books or enumerated in the catalogues of nurserymen, which are entirely unknown to me. *Y. serrulata*, *crenulata*, *arcuata*, *tenuifolia*, all named, but scarcely described, by Haworth, (Suppl. Pl. succ.) about fifty-four years ago, from cultivated, partly very young, plants, and not known now, and *Y. aspera*, *Parmentieri* and *albospica* of the catalogues, undescribed, as I believe, will probably prove in part to be forms of *Y. aloifolia*, and the names, which cannot be identified now, the original types having perhaps disappeared from the gardens, and their native country being unknown, ought to be dropped. The two following, however, of which at least their flowering state and native country are known, are believed to have a claim to specific distinction.

2. YUCCA YUCATANA, *nov. spec.:* elata, e basi ramosissima; foliis lanceolato-linearibus versus basin vix angustatis carnosis brevioribus margine tenuissime asperatis demum patulis recurvisve; paniculæ ovatæ subsessilis dense pubescentis bracteis ultimis lanceolatis albis; florum minorum segmentis ovato-lanceolatis, staminibus demum uncinato-recurvis ovario prismatico stigmatibus parvis erectis emarginatis coronato multo brevioribus.

Ruins of Nohpat, Yucatan, collected in flower, Nov. 24, 1865, by Dr. A. Schott, who, not only by his specimens, but also by notes and sketches, aided me in drawing up this description.—Habit of the plant very similar to that of the above described var. *conspicua;* about 20 feet high, branching abundantly from and near the base; leaves in the specimens before me 14–16 inches long and about 1 inch wide, thick, fleshy, smooth, but apparently not rigid, with extremely slight marginal asperities; points of leaves in my specimens broken off. Panicle densely villous, bracts fleshy, whitish; flowers spreading about 2 inches, segments 14 lines long, less than half as wide; pistil similar to that of *Y. aloifolia*, but stamens much shorter and anthers smaller. It is quite possible that this plant is already in cultivation and may have received a name not known to me, but no accessible description agrees with it.

3. Y. GUATEMALENSIS, *Baker in Saunders' Refug. bot. V. t.* 313, *Jul.*, 1872: elata; foliis majoribus lanceolatis leviter concavis planiusculisve lævibus tenuioribus margine levissime asperatis mucrone concolore vix pungentibus demum patulis; perigonii majoris segmentis lanceolatis sursum angustatis, interioribus angustioribus longioribus; filamentis apice patentibus ovario prismatico-oblongo stylo brevissimo stigmatibusque profunde bilobis patulis coronato brevioribus.

From "Guatemala and Mexico"; flowered in the Kew Gardens in September, 1871, whence through Mr. Baker I obtained dried specimens. That plant was 8 feet high, with leaves 2½–3 feet long and 2½–3 inches wide; panicle sessile between the upper leaves, ovoid, 2–3 feet long; flowers spreading apparently 5 inches, with narrow segments (3 inches long and ¾–1 inch wide) and, an unusual case, the inner ones narrower than the outer. The most characteristic part of the flower is the ovary, which is only twice as long (¾ inch) as it is thick, and bears on a short style 3 deeply and acutely bilobed spreading stigmas; the walls of the carpels are unusually thick, the ovules themselves have the diameter of others, but are very thick (0.5 mm.) indicating very thick seeds and a pulpy fruit, which will probably be also found short and thick.

This species is said not to be rare in collections but seldom to flower; it seems that it is often taken for *Y. Draconis*, and it really resembles the typical figure of that plant by Dillenius. In the botanic garden of Rome are several fine specimens named thus, which I scarcely hesitate to refer here; they are 15–18 feet high, 1 foot in diameter at the enlarged base, not branched*; leaves 2½–2¾ feet long, 2–2¼ inches wide, much contracted above their very broad base, thin and somewhat flaccid or even pendulous, glossy on the upper surface, delicately serrulate and with a very weak point. The plants have not flowered.

* * Folia margine integra.

4. YUCCA GLORIOSA, *Lin.*: caule humiliore nunc ramoso; foliis lineari-lanceolatis versus basin latam angustatis supra plano-

* Shoots have been cut off from the base! These cultivated plants are often altered in appearance by trimming and by the removal of the dead leaves, which, left to nature, would continue to cover the trunk for several feet below the living leaves.

concavis sæpius plicatis opacis fere glaucescentibus dorso asperulis pungentibus; panicula angustiore nunc pubescente pedunculata folia excedente, bracteis e basi lata lanceolatis, summis marcescentibus; staminibus ovarium prismaticum apice attenuatum stigmatibus gracilioribus coronatum subæquantibus, effœtis uncinatis.

Forma genuina: foliis latioribus rigidis rectis; panicula angusta pubescente seu glabrata.

Var. *β. plicata:* foliis latioribus tenuioribus valde plicatis exterioribus patulis; filamentis parce papillosis ovario æquilongis demum circinato-uncinatis; stigmatibus distinctis subdivergentibus basi in stylum brevem contractis.

Var. *γ. recurvifolia:* foliis debilioribus patulis recurvis, junioribus glaucis; panicula subpuberula; filamentis parce papillosis pistillum æquantibus.—*Y. recurvifolia*, Salisb.

Var. *δ. planifolia:* caule brevissimo; panicula ovata subsessili folia angustiora plana vix excedente staminibus pistillum æquantibus demum uncinatis; stigmate brevi crasso sessili.

North Carolina to Florida on sandy sea-beaches.—All the specimens I have seen came from South Carolina, and belong to the principal form. Their stem is from a few inches to 4 or 6 feet high and 4–6 inches in diameter, simple or with a few branches and even the oldest ones entirely covered with a shaggy coat of old withered pendant leaves. Leaves 2–2½ feet long and 1½–2½ inches wide, stiff, sharply pungent, very frequently longitudinally folded, the narrower ones sometimes even. The edge of the young leaf is pale and usually delicately serrulate toward the base; later it turns brown and brittle, the asperities disappear, and it is apt to crumble off or occasionally to detach itself in a few fibres. The surface of the leaf is of a dull, often pale or glaucous, green, and on the under side, especially towards the tip, rough with small asperities. The panicles—2–4 feet long, 1–1½ feet in diameter, contracted upward and downward, where the flowers often spring directly from the main axis—are raised above the leaves on a stalk of their own length or shorter, beset with herbaceous bracts, lanceolate from a broad base; ultimate bracts of same shape, small and membranaceous; panicle, or at least the pedicels, often pubescent, or nearly or quite glabrous. Flowers, as in the genus, wide open in the evening, 3½–4 inches wide, whitish, tinged externally with green or brownish or reddish green; segments ovate, acute, or nearly lance-ovate, the inner longer and wider than the outer ones, minutely pubescent at tip (which, perhaps, is meant by Elliott's "sparingly ciliate"). Stamens often as long as the whole pistil, or at least as long as the ovary, straight at first or only patulous, but at last mostly recurved and even variously twisted; filaments in some forms scarcely papillose, in others strongly hispid; anthers deeply emarginate at tip, stigmas narrower than the prismatic ovary and much longer than wide, divided upwards and at last somewhat divergent; the ovules thinner than usually in this section, in the wild flowers examined by me 0.25–0.30 mm., in cultivated ones 0.25–0.33 mm. thick. I have not been able to obtain the fruit, which is said to be 6-angled, pulpy, and of a deep purple color, by Elliott and by Nuttall, both of whom singularly enough omit to describe the much more common fruit of *Y. aloifolia.* The seed which was sent to me is smaller and thinner than that of that species, (5.2–6.0 mm. in the longest diameter and 1.8–2.0 mm. thick) but otherwise very similar to it.—The flowering time seems to be July to October, very often, in South Carolina, in autumn.

The cultivated plants, which I have seen, scarcely differ from this form; their flowers are sometimes larger, and either whitish or cream-white, or very often externally greenish-purple; they seem to open usually in July and August, or, sometimes, later in the fall.

Y. acuminata, Sweet, and *Y. obliqua*, Haw., garden species, the native country of which is unknown, seem to belong to the typical form.

The variety which I have distinguished as var. *plicata* I have found under the name of *Y. plicata* in Mr. G. Thuret's gardens at Antibes near Nice, flowering in February and March; it has a trunk over 2 feet high, with thin but stiff, much folded leaves, $1\frac{1}{2}$–$2\frac{1}{4}$ feet long and 2–$2\frac{1}{2}$ inches wide, glaucous above, rough beneath, serrulate near the base; panicle large, flowers over 4 inches wide, externally tinged with brown-red; stamens as long as the ovary, which is contracted into a narrow neck, a sort of a style, bearing the thicker, divaricate stigmas.

Var. *recurvifolia* is the well known and commonly cultivated, elegant garden form, said to come from Georgia, where Elliott also seems to have seen it, but nobody apparently has found it since. I cannot distinguish it from the type but by the flaccid, gracefully recurved leaves. *Y. recurva*, Haw., and *Y. pendula*, Sieb. and Carrière, are synonymous, and *Y. superba*, Haw., *Y. rufocincta*, Haw., seem not to differ. *Y. ensifolia*, Baker, Ref. bot. V. t. 317, and the smooth-leaved *Y. Ellacombii*, Baker, Gard. Chron. l. c., Ref. bot. ib. t. 318, are intermediate forms connecting this variety with the typical plant.

Var. *planifolia* is also based on a single specimen, which I found in September, 1868, in flower in the botanic garden of Genoa, under the name of *Y. glauca*. Its short trunk, long and narrow (2½ feet long, 1½ inches wide), even, not at all plicate, leaves, and especially the short stigma, which is almost as thick as the ovary and resembles that of *Y. aloifolia*, distinguish this form. Flowers whitish, smaller, 2 or 2½ inches wide; filaments as long as the pistil; anthers small, entire above; ovules only 0.26 mm. thick; fruit unknown. Could it be the *Y. glauca* of gardens?

Yucca flexilis, Carr, Rev. Hort. viii. t. 89, to which Mr. Baker refers his *Y. pruinosa*, Gard. Chron. l.c., and *Y. tortulata*, Baker, ib., may be smooth-leaved forms of *Y. gloriosa*; they are thus far only known as acaulescent, and in foliage only. Leaves of both 2–2½ feet long, 1¼ inches wide, stiff and pungent; the edges serrulate towards the narrowed base.

Yucca Boerhaavii, Baker, Gard. Ch. 1870, p. 1217: caulescens, e basi latissima lanceolato-linearibus elongatis infra vix angustatis planis lævissimis, in mucronem herbaceum mollem excurrentibus.

This plant makes a short trunk; leaves 27 inches long, about 9 l. wide, with traces of marginal denticulation; flowers are unknown.—It may be an extreme form of *Y. gloriosa*.

YUCCA DESMETIANA, *Baker*, l. c.: caulescens, foliis plurimis lanceolato-linearibus brevibus, versus basin angustiorem obsolete denticulatis crassis lævissimis in mucronem vix pungentem excurrentibus.

This little plant is cultivated in many gardens, but has, I believe, never flowered. The very fleshy purplish-green leaves are only 10–15 inches long, 6–9 lines wide, and scarcely pungent. Its native country is unknown.

5. YUCCA TRECULIANA, *Carrière*, *Rev. Hort.* vii. *p.* 280, 1858, Baker, Gard. Ch. l. c. p. 828: caule elato ramoso; foliis longissimis rigidissimis profunde concavo-canaliculatis margine brunneo serrulatis tunc integris demum parce filamentosis pun-

gentibus subtus asperrimis; panicula densiflora ovata subsessili læviuscula, bracteis inferioribus amplis ovatis seu ovato-lanceolatis pungenti-cuspidatis pergamentaceis albidis, summis ovatis seu lanceolatis albis; staminibus pistillo vix brevioribus uncinatis; ovario prismatico in stylum stigmatibus gracilibus coronatum attenuato; bacca fere cylindrica elongata rostrata.—*Y. longifolia*, Engelm. in sched. 1846; Buckley in Proc. Acad. Phil. xiv. 8, 1862.

Texas from the Matagorda Bay and the Brazos and Guadaloupe, south and southwestward into Mexico, at least as far as Saltillo, Parras and Chihuahua, on the sea beach and in the interior, on the gravelly overflowed banks of streams and on the stony declivities of their slopes; flowering in April and May.—Specimens from Texas and full notes were supplied by F. Lindheimer, Mexican ones by Dr. Wislizenus and Dr. Gregg.

This is perhaps the most magnificent Yucca known; trunks 6–15 and, even in Texas, sometimes 20–25 feet high, and 1–2 feet thick, terminating in several (sometimes 5–7) branches, each one bearing a crown of long rigid leaves, and often a panicle 2–4 feet long of something like 500 flowers. The bark of very old trunks has been noticed above; younger stems are covered with the reflexed withered foliage.—Leaves longer than in any other species, 2½–3, and very often 4 or even 4½ feet long and 2–3½ inches wide when flattened out, deeply channeled and quite semi-circular in the cross-section, thick, rigid and straight, "bright sea-green," very rough on the back, less so on the upper surface, terminated by a stout brown spine. The edge of the leaf at different stages of development partakes of the character of all the three forms, as to a less extent also do the leaves of *Y. gloriosa*; the margin of the young leaf is deep brown with a pale, cartilaginous, strongly serrulate edge; then it becomes smooth and at last is often detached in brown rough fibres.

The short peduncle or scape of the inflorescence is 1–2 inches in diameter, the panicle 2–4 feet long, much branched and dense flowered, glabrous or sometimes upwards pubescent, bearing large conspicuous bracts 4 or 5 inches long, 1–3 wide concave, fleshy or leathery, greenish outside, whitish inside, with a sharp herbaceous or brown point; the ultimate small bracts are similar, mostly ovate-lanceolate; in Mexican specimens from Parras they are thinner, oblong, obtuse, and pure white.

The flowers vary from 2 to over 4 inches in expansion, and, if I may judge from the dried specimens, are remarkable for the unusually narrow, ovate-lanceolate, acuminate segments of the perigon, 1½–2 or even 2½ inches long, and about ¼ as wide, and conspicuously pubescent at tip; in the Mexican forms I find the segments more ovate and of the ordinary shape of most Yucca flowers, and only 1¼–1½ inches long. The very slightly papillose filaments, as long as the ovary and erect in the bud, soon become recurved-hooked. The prismatic ovary terminates in a slender, short or longer, style, crowned by deeply divided strongly bilobed stigmas. I find the ovules invariably thicker (0.4–0.5 mm.) than in any of the foregoing species.

The fruit is a pulpy cylindric, or rather indistinctly 6-sided, somewhat sulcate and 3-lobed, strongly rostrate berry 3–4 inches long, about 1 inch thick, of a bitter-sweetish pleasant taste, much eaten by the Indians, who roast them and peal the acrid rind off. Seeds 6–7 mm. in the longest diameter, and 3 mm. thick, very similar to those of *Y. aloifolia* but with the back less rounded.

Yucca canaliculata, Hooker, Bot. Mag. 86, t. 5201, 1860, described from a plant cultivated at Kew, with a stem 1-2 feet high, leaves 2 feet long, concave, semi-cylindric, rough on back, very probaby is not different from our plant; the flowers, in a peduncled pyramidal panicle, 4 or 5 feet high, are described as sulphur-yellow, but are stated by Baker in Gard. Chr. l. c to be cream-white.—A specimen in Mr. Henry Shaw's Missouri Botanical Garden, thus labeled, flowered in April, 1872; its trunk is 4 feet high, the leaves 2½–3 feet long, panicle 2 feet long, 1¼ feet wide, very densely flowered; flowers 3–3¼ inches wide, segments ovate acute, outer 8–9, inner ones 9–11 lines wide; filaments strongly recurved even when the flower has barely opened; anthers very slightly notched above, with a bunch of white articulated hair, corresponding with the hair at the tip of the perigon.

Yucca glauca, Sims, as understood by Baker and figured in Refug. bot. v. t. 315, and *Y. exigua*, Baker, ib. t. 314, which can scarcely be distinguished from it, are classed with the acaulescent entire-leaved Yuccas, though the former bears a few fibres; their fruit, in Europe unknown, may possibly be capsular, of which more at the proper place. Both are characterized by the conical, attenuated stigma.

Y. orchioides, Carrière, Rev. Hort. 1861, p. 369, t. 89, as quoted by Baker, is described as the smallest of all Yuccas; stemless like the last, with few short, soft-pointed leaves (9–10 inches long, 1 inch wide, almost flat); scape with a simple pubescent raceme only 1½ feet high, perianth 1 inch deep; native country unknown.—Could it be a dwarfed variety of some other form, possibly of the last mentioned *Y. glauca*?

*** Folia margine filifera.

6. Yucca baccata, *Torrey in Bot. Mex. Bound.* 221, 1858; *Ives' Rep. Bot.* 29.: acaulis seu plerumque caulescens; foliis anguste lanceolatis versus basin dilatatam angustatis crassis rigidissimis scabris mucrone brunneo robusto pungentibus concavis; margine filis crassioribus ornatis; panicula brevius seu longius pedunculata plerumque lævi, bracteis inferioribus amplis ovato-lanceolatis cuspidatis pungentibus pergamentaceis supra albidis, ultimis lanceolatis; staminibus demum patulis vix recurvis ovarium prismaticum fere æquantibus; stylo vario nunc elongato; bacca sæpius ovata rostrata.—*Y. crassifila*, Engelm. in sched. 1848.

Forma genuina, borealis, stolonifera; caule nullo seu breviore; foliis longioribus latioribus asperrimis rigidissimis, filis marginalibus crassis cinereis; segmentis florum magnorum angustis, stylo elongato.

Var. *β. australis*: caule elato ramoso, foliis tenuioribus lævioribus, filis marginalibus tenuioribus sæpe brunneis; segmentis florum minorum ovatis, stylo breviore.

A southwestern species, extending from Southern Colorado, *C. Thomas*, to New Mexico, *Dr. Wislizenus*, *A. Fendler no.* 849, *Ch. Wright*, *Dr. Bigelow*, and West Texas, *A. Schott*, and into Southern Utah, *J. E. Johnson*, Arizona, *Dr. E. Palmer*, California, (Los Angeles, *Capt. Russel*, Providence Mountain, *Dr. J. G. Cooper*, Monterey, *Dr. Parry*), and far into Mexico (Chihuahua, *Dr. Wislizenus*, Parras, *G. Thurber*, and Saltillo, *Dr. Gregg*).—Flowering season according to latitude from March to June, or in Northern Mexico, where with the rainy season a second spring opens, often again in August and September.

The very full series of specimens before me satisfies me as to the great variability of this species, the extremes of which are so very dissimilar. The typical plant towards its northern limits is stemless, more southwardly it makes trunks of 1 or 2 to 8 or 10 feet high, covered with the refracted dead leaves. Leaves 1½–3 feet long, 1–2 inches wide, narrowed downward, gradually attenuated into a very stout sharp or blunt brown point, channeled or quite concave, thicker than in most other species, very stiff and rough, especially on the back: on old branching plants Dr. Palmer found the leaves scarcely over 1 foot long and 1 inch wide, but very thick. The fibres are as thick as ordinary twine, and often regularly curved backward. The panicle of the stemless form is raised on a scape of almost its own length, in caulescent ones the peduncle is shorter. The exterior bracts are 4 or 5 inches long and 2 wide, similar to those of the last species, but narrower. The flowers are large, spreading 4–5 inches, segments 2½–3¼ inches long, ⅔–1 inch wide, stamens papillose-hispid, as long as ovary, rarely at last reflexed; pistil 1–2 inches in length, style slender, unusually long for the genus, in the largest flowers equalling the ovary, in others ½ or only ¼ its length; ovules about 0.4 mm. thick. The fruit is a dark purple berry, oval, "about the size and shape of a hen's egg," with a very distinct and often elongated beak, which is marked with six grooves, while the fruit itself is not angled or grooved. Some fruits, I have seen, were 3 inches long and 2 in thickness, with a beak of about half their length; one fruit from Arizona was 5 inches long, cylindric and curved. The base is protracted below the remnants of the perigon, which is not the case in the fruits of *Y. aloifolia* or *Y. Treculiana;* the pods of these three species are remarkably distinct, and always easily recognized, while the seeds themselves are very similar. The fruits are said to be "savory like dates," and are eaten fresh by whites and Indians, and cured by the latter for winter provisions. Dr. Palmer informs me that the Arizona Indians find the stewed flower-buds and flowers quite pleasant and nourishing. The seeds are often distinguished from those of the other Sarcoyuccas by their large size, 10–17 mm. in the longer diameter and 2–3 mm. in thickness; but other fruits from the same regions have seeds only 7–8 mm. long and 1.8–2 mm. thick.

Var. β, the southern, Mexican, form of this species, is principally distinguished by its smaller flowers, 2–3 inches wide, with ovate or lance-ovate segments 1¼–1¾ inches long and usually more than half as wide; by their short style and the somewhat thinner, less rough, leaves, with thinner, often red-brown, fibres; the panicle is sometimes pubescent. Dr. Gregg notes that it is very abundant in the plains and valleys about Saltillo; his statement is almost incredible, and is not supported otherwise, that sometimes it reaches the height of fifty feet, with leaves 1–3 feet long, "seed said to be actively purgative." Prof. Thurber brought from Parras leaves and fruit of this species, an account of which, together with a cut, is found in Bartlett's Personal Narrative II, 491: "a plain covered with Yuccas presents a beautiful appearance when in flower in pyramidal spikes several feet in length . . . . the trees 25–30 feet high and 2–3 feet in diameter, with ten or a dozen branches"; he mentions that the fibres of the leaves are used for cordage, the trunks for palings or they are split into slabs for the covering of huts; the tender top of the stem is roasted and eaten under the name of *quiote;* the edible fruits are called *latiros*. A specimen of the latter I find oval, 2 inches long, with a beak of ½ inch; seeds small for the species. We learn in the above account that the inflorescence is pyramidal; the cut represents it as sessile or peduncled, and about 3 times as long as wide.

The Californian forms are in foliage intermediate between the northern and southern extremes; a leaf collected at Monterey and distinguished by its narrowness (less than ¾ inch wide) probably indicates the northern limit of the species.

The caulescent fibrous-leaved Yuccas, recently introduced from Mexico in European establishments, of none of which either flower or fruit is known, seem distinguished by narrower and smoother leaves, some with red, others with gray marginal fibres, but they may possibly be only forms of our species; they are *Yucca periculosa*, *Y. polyphylla*, *Y. circinata* and *Y. scabrifolia*, Baker in Gard. Chron. 1870, p. 1088, and *Y. filifera* of the gardens.

7. Yucca Schottii, *nov. spec.:* caule humiliore sæpius e basi ramoso; foliis minoribus lanceolato-linearibus rectis rigidis crassis sub-pungentibus supra concavis subtus convexis lævissimis versus basin paulo angustatis, margine filis tenuissimis rectis albidis ornato; paniculæ nuncpuberulæ sparsifloræ supra folia elatæ pedunculo et ramis flexuosis, bracteis exterioribus magnis lanceolatis; florum minorum staminibus demum uncinatis, ovario in stylum brevem stigmate brevi coronatum abeunte; bacca ovata breviter rostrata, seminibus magnis crassis.—*Y. brevifolia*, Schott in Herb.; *Y. puberula*, Torrey in Bot.Mex. Bound. 221, non Haw.

Upper Santa Cruz River in Southern Arizona, *A. Schott*, in June and July, 1855.—Trunk 2–5 feet high, crooked, covered with a shaggy coat of dead leaves. Leaves "yellowish-green," 9–10 inches long, 6–8 lines wide; marginal fibres singularly fine and straight; panicle pubescent or glabrous, its axis not straight, as is usual in these plants, Mr. Schott expressly remarks, but variously twisted; lower bracts 4–5 inches long, 1 inch wide; the pendulous, ovate, short-rostrate berry not at all angled, about 2 inches long.—Some doubt may exist whether all the parts of specimens in Schott's, Torrey's and my own herbarium, all collected by Dr. Schott, belong together; from these specimens the leaves and flowers have been described above, while in the account of the stem and fruit I had to rely on Mr. Schott's notes, who possibly may have mixed the fruit of *Y. baccata* with the foliage of the new plant; but the leaves appear so peculiar that there can scarcely be a doubt about the distinctness of the species to which they belong.

B. CLISTOYUCCA: fructus indehiscens, erectus? demum siccatus, spongiosus; semina crassiuscula plana vix marginata, albumine integro.—Arbor elatior ramosa, panicula sesili.

* Folia serrulato-asperata.

8. YUCCA BREVIFOLIA, *Engelm. in S. Watson, Bot. King Expl.* 1871, *p.* 496: caule elato ramoso; foliis brevibus e basi lata sensim angustatis late linearibus supra planiusculis versus apicem concavis subtus convexis carinatis pungentibus rigidissimis utrumque asperrimis margine durissimo serrulatis; panicula sessili ramosa; fructu ovato obsolete 6-angulato acutato.—*Y. Draconis ? var. arborescens*, Torr. Bot. Whipp. Pac. R. Exp. iv. 147.

On the arid plateaus between the Colorado River and the South California Mountains, in latitude 34½°–36°, at an altitude of 2000–4000 feet, in patches from Southwestern Utah, Northwestern Arizona to Southern Nevada and to Southeastern California, where it is abundantly distributed on the "Palm-plains," also called "Tahichipi desert," between the Mohave River and Walker's Pass, often forming straggling forests. It was first noticed by Fremont 1844, ten years later by Bigelow, and since then by Brewer, Parry, Palmer and Johnson, and has lately even formed the object of photographic pictures. Leaves and fruit with seeds have been obtained, and young plants raised, but the flower remains unknown.

This remarkable Yucca makes considerable trees, 15–20–30 feet high; the stout rough-barked trunks, often 1–2 feet in diameter, 3–10 feet high, before they send off the long and numerous branches, of which, in a very characteristic photograph, I have counted 23 large and small ones. Leaves stiffer, harder and rougher, and perhaps shorter than in any other species, sometimes only 3–4, usually 6–8, and rarely, in young and vigorous specimens, even 10–12 inches long, 3–6 lines wide, not at all narrowed above the base, glaucous, very rough on both sides, with small but stout whitish or brown teeth on the edge, and a stout and sharp brown point. The flower is said to be small and white. A fruit before me is evidently erect, as the fragment of the branch to which it is attached indicates, oval, slightly 6-sided, pointed but not rostrate, and tipped with the well-preserved short, sessile stigmas. The fruit is light and perfectly dry, the brown somewhat spongy fragile pericarp 2–3 lines in thickness. Seeds large, 11–12 mm. in diameter, 2–2½ mm. thick, with a narrow margin and an even, not ruminated, albumen. In both the fruits, I have been able to examine, the traces of the moth *Pronuba* are apparent by the perforated rind and gnawed seeds or their empty ring-like rims.

C. CHÆNOYUCCA: fructus capsularis, erectus, septicide dehiscens, demum apice 6-valvis: semina tenuia plana, latius marginata, albumine integro.— Acaules vel vix caulescentes, panicula in scapo elata.

* Folia margine serrulato-asperata.

9. YUCCA RUPICOLA, *Scheele in Linnæa*, 23, *p.* 143, 1850: acaulis, foliis lineari-lanceolatis supra basin latiorem angustatis canaliculatis supra planiusculis subtus convexis rigidis erectis pungentibus; scapo elato infra bracteis majoribus foliaceis ornato, panicula pyramidali laxiflora bracteis parvis marcescentibus stipata; florum majorum segmentis ovatis acuminatis nunc aristatis apice nudis, staminibus rectis demum patulis ovario ipso æquilongis, stylo elongato; capsula acuta seu rostrata nunc medio constricta, seminibus angustius marginatis.— *Y. tortifolia*, Lindheimer in sched. 1846, *Y. lutescens*, Carrière l. c. vii. 579, ex-Baker.

Var. *a. tortifolia:* foliis saturate viridibus varie tortis undulatisve sæpius obliquis dorso lævibus et capsulis cum seminibus majoribus.

Var. β. *rigida:* foliis pallidis glaucis planis dorso carinatis asperatis et capsulis cum seminibus minoribus.

Western Texas in fertile soil mixed with broken up cretaceous limestone rocks, discovered by F. Lindheimer, 1845, on the plateaus west of New Braunfels, and described from his specimens by Scheele: found afterwards by the botanists of the Mexican Boundary Survey; the second or southwestern form was sent by Dr. Gregg from Mapimi in the Mexican State of Coahuila, and by Dr Bigelow from the mountains of the volcanic district of Bufatello near Presidio del Norte on the Rio Grande.—Flowers in Texas in May and June, "after *Y. Treculiana* and before *Y. angustifolia.*"

As far as my information goes this species is always stemless; a misapprehension of Lindheimer's notes must be the cause of Scheele's, and after him Baker's, ranging it among the caulescent Yuccas, with a "stem 4–7 feet high"; rootstock of few stout branches 1–2 feet long: leaves dark or bright green, opaque, narrowed above a not very broad base 1–2 feet long, ¾–1¾ inches wide with brown-red, strong serratures, mostly undulate, oblique, one side longer than the other, therefore twisted, stout, thick, sharp pointed, but not to be compared with *Y. aloifolia.* Scape 4–7 feet high, with long leafy narrow lanceolate bracts; panicle with few large "greenish-white" flowers which apparently spread 3–4½, perhaps 5 inches, and are well characterized by the very acute sometimes even aristate, when dried, strongly nerved, segments, 1½–3¼ inches long, 10–14 lines wide, the inner wider than the outer: also by the erect or slightly spreading, never recurved stamens, which are of the length of the prismatic ovary; and by the slender style, which, in all the specimens seen by me, is as long as the ovary; ovules 0.2 mm. thick. Capsule 2–2½ inches long, about 1 inch thick, acute or cuspidate or rostrate, prismatic or, very often, variously constricted or distorted, often showing traces of the Yucca-moth; secondary dissepiments sometimes like those of most species, incomplete at top and bottom, but not rarely, especially in very acute capsules, entire above or nearly so. Seeds 7–8 mm. long, with a distinct but narrow margin.—This form is reported to be in cultivation in France from Mr. Trecul's seeds under the name of *Y. tortilis* or *contorta.*

Var. *rigida* looks very different indeed, with its smaller, pale, yellowish or glaucous, often rough, straight leaves, only 8–12 inches long, and 3–6 lines wide, and its small wrinkled, less pointed capsule, 1½ inches in length, and seeds only 5–6 mm. in diameter; the scape is said by Dr. Gregg to be 5–10 feet high; flowers not seen; the short beak of the fruit indicates a short style. Wright's No. 1909 from Eastern New Mexico connects both forms.

** Folia margine filifera.

10. YUCCA ANGUSTIFOLIA, *Pursh. Fl.* ii. 227: subcaulescens; foliis (plurimis) e basi latiore linearibus lævibus plerumque pungentibus; stigmatibus ovario brevioribus viridibus; capsula prismatico-ovata obtusa brevi-cuspidata, seminibus magnis late marginatis.

Forma genuina: acaulis seu breviter caulescens; foliis rigidis radiatim porrectis pungentibus; racemis plerumque simplicibus inter folia fere sessilibus; florum segmentis late ovatis e cupreo virescentibus nunc albidis; capsulis majoribus vix unquam constrictis.

Var. β. *elata:* caule altiore; foliis numerosissimis rigidis pungentibus nunc glaucescentibus filamentosissimis rare denudatis, demum refractis; panicula oblonga seu lanceolata supra folia elata; florum segmentis albidis angustioribus; capsulis ut supra. — *Y. angustifolia var. radiosa*, Eng. in King Bot. 40th par. 496.

Var. γ. *mollis:* acaulis; foliis supra basin angustatis medio latioribus mollibus vix pungentibus; racemis rarius ramosis scapo ipso bracteis brevibus lanceolato-subulatis ornato brevioribus; capsula breviori nunc cum seminibus angustius marginatis minore.— *Yucca stricta*, Sims Bot. Mag. 2222 fide Baker, Gard. Chr. l. c.

All the forms of this species are characterized by the secondary axis descending horizontally, narrow leaves, bright green stigmas and large capsules and seeds, but var. γ in many respects approaches to and forms a connecting link with the next species. They are peculiar to the West and Southwest.

The typical *Y. angustifolia* is the more northern form of the plains from Northwestern Missouri and Western Iowa west and northwestward to Colorado and New Mexico; fl. May and June, earlier than the allied species. Trunk none, or, farther south, short; leaves very stiff and sharp pointed, 1–2 or in cultivation 3 feet long, 3–6 lines wide; raceme simple or with few short branches 1 or 2 to 3 or 4 feet long almost sessile, the base hidden between the inner leaves; flowers 1½–2½, in cultivation even 4 or 5 inches wide, usually greenish white or tinged with green-brown: lobes broadly ovate; stigma half the length of ovary; capsule usually 3 inches long, half as thick; seeds 10–12 mm. wide. In dwarf forms the leaves are sometimes only half a foot long and 1–2 lines wide.

Var. β is the southwestern form extending from West Texas to Utah, Arizona and Northern Mexico; trunk 3–5 feet high; leaves ¾–1½ feet long, 3–6 lines wide, rigid, often glaucous, with an abundance of long fibres or, rarely, almost destitute of them, (Wright, Gregg); naked part of scape about as long as the panicle, together 6–8 feet, whole plant therefore often over 12 feet high; flowers mostly white 2–2½ inches wide; capsules and seeds as large as in the type. It is not improbable that the narrow-leaved Mexican forms, doubtfully referred to p. 46, *Y. baccata*, may belong here; flower and fruit would decide.

Var. γ is found southeastward in Arkansas, Louisiana and throughout Texas, distinguished by its wider, softer, less pungent leaves, distinctly narrowed above the base, 1–1½, rarely 2, feet long, 5–8 lines wide in the middle, half as wide below; scape 2–3 ft. high, flowers usually in a raceme, ½–1 ft. in length, sometimes paniculate, 1½–2½ in. wide, greenish-white; green stigmas sometimes as long as ovary, often shorter; capsule shorter than in the other forms, 2–2¼ inches long, sometimes constricted; seeds 9–10 rarely 10–12 mm. wide. *Y. stricta*, which is referred here, is said to come from South Carolina, entirely outside of the limits of this form, which makes a transition to the next.

11. YUCCA FILAMENTOSA, *Lin.*: subacaulis; foliis lineari-lanceolatis supra basin latiorem contractis apice indurato seu molli; panicula pyramidata in scapo foliaceo-bracteato alte supra folia elata; stigmatibus elongatis nunc distinctis albidis; capsula cuspidata, seminibus angustius marginatis.

Forma genuina: sæpius breviter caulescens; foliis rigidioribus rectis mucrone nunc obtusato brevi apicatis dorso scabridis, filis marginalibus crebris plerumque circinatis; panicula ramis fere horizontalibus pyramidata densiflora scapo bracteis minoribus spatulatis instructo æquilonga seu longiore lævi; staminibus sæpe pistillo æquilongis; stigmatibus gracilibuis demum divergentibus seu recurvatis; capsula minore plerumque medio constricta, dissepimentis secundariis fere semper rudimentariis; seminibus minoribus.

a. angustifolia: foliis (plurimis) lineari-lanceolatis e medio sensim angustatis.—*Y. filamentosa*, Lin. ex Gronov. virg. 152.

b. latifolia: foliis (paucioribus) rigidioribus sursum latioribus nunc spatulatis versus apicem sæpius obtusatum abrupte mucronatum cochleato-concavis.— *Y. concava*, Haw. suppl. 34.

Var. *β. flaccida*: acaulis; foliis (pluribus), lineari-lanceolatis mollibus flaccidis demum irregulariter decurvatis refractisve glaucescentibus vix scabrellis subinermibus margine filis tenuissimis abunde ornatis; scapo bracteis brevibus spatulatis instructo paniculæ nunc puberulæ æquilongo; ovario versus basin irregulariter angulatam angustato, stigmatibus brevioribus conniventibus sursum attenuatis; capsula majore sæpius constricta angulata sursum profunde triloba, seminibus majoribus. — *Y. flaccida*, Haw. suppl. 34? Refug. bot. 5. t. 323?

Var.? *γ. bracteata*: subacaulis; foliis (plurimis) lineari-lanceolatis rigidiusculis scabrellis mucrone debili aristatis abunde filiferis, exterioribus demum nundatis laxis; scapo bracteis foliaceis majoribus infra medium latioribus sensim angustatis fere imbricato flexuoso quam panicula ramis ascendentibus pyramidata asperula seu puberula multo longiore; staminibus ovarium fere æquantibus; stigmatibus profunde divisis elongatis; capsula prismatica ovatave.

Var. ? *δ. lævigata*: subacaulis; foliis (paucioribus) lanceolato-linearibus elongatis fere planis lævibus rigide pungentibus margine mox denudatis laxis deflexis demum decumbentibus; scapo bracteis lanciformibus e medio sensim angustatis instructo quam panicula ramis ascendentibus laxifloris pyramidata lævissima multo longiore; ovario staminibus breviore stigmatibus ad basin divisis rectis æquilongo; capsula prismatica.

This most variable plant is a native of the coast region of the south-eastern States from Maryland, *W. M. Canby*, to Florida, Alabama, and, according to Riddell's Cat., to Louisiana.—Numerous varieties, often difficult to class, have been described in European gardens.

Linnæus' diagnosis: *foliis lanceolatis acuminatis* together with the Hab. Virginia, points to the narrow-leaved form of what I have described as the genuine plant, as the one he and Gronovius had in view. Of this and other forms numerous specimens and full notes have been obtained from Dr. Mellichamp, of South Carolina, on which the following descriptions are based.

The genuine plant has a short trunk of 2–5 inches or a foot, (Chapm. Fl. 475), stiffer, rougher, "reed-like," dull green leaves and smaller capsules than any other variety, and blooms earlier, in S. Carolina in May, in gardens of St. Louis in the first weeks of June.—The narrow-leaved form makes tufts of 60–80 or 100 leaves, 16 or 18–20 and 22 inches long, 1–1¼ rarely 1½ inches wide, widest about the middle, tapering to a hard obtusish point, with numerous, rather thin, curly fibres. The broad-leaved variety has only 30–60 leaves, 20–24 inches long, 2–3 inches wide about the upper third, and broad to the almost obtuse blunt tip; outer shorter leaves often broad-spatulate and quite obtuse; margin with fewer, coarser, more curly threads. The scape of both forms is 4–8 or 9 feet high, stout, very soft and smooth, pale green, below with oblique, spatulate bracts, 2, rarely 3 inches long; panicle with numerous nearly horizontal dense-flowered, branches as long or longer than the naked part of the scape. Flowers 2½–3 inches wide, white, tinged with green; stamens as long as the pistil, at last spreading, the elongated eventually recurved stigmas rather shorter than the ovary. Capsule 1½ inches long, more or less constricted, thin, smooth and papery in some localities, hard, wrinkled and longer beaked in others; secondary dissepiments mostly very incomplete, not reaching to the centre; but in a Maryland specimen, and in some cultivated ones, of the ordinary form, so that no specific character can be based on them; seeds 6 mm. diam.—Forms intermediate between *a* and *b* are found wild and in cultivation; leaves sometimes more flaccid, with fewer fibres, shorter stamens or stigmas, longer capsules, larger seeds.

The variety *flaccida* is described from plants in common cultivation about St. Louis, wild specimens I have not seen; it is doubtful whether it is Haworth's plant, which has *fila validissima*, or of the *Refugium*, with broad, involute leaves, but the short attenuated stigmas fully agree; the characters indicated in Gard. Chron. l. c., "an irregular, untidy appearance," "leaves conspicuously filiferous," "point not at all pungent," "panicle pubescent," point to our plant.—It is mostly stemless with 40 60 leaves, 20–26 inches long, 1–1¼ inches wide, thin, at first glaucous, flat, sometimes plaited, with a weak not pungent point, and numerous very thin threads, outer ones abruptly recurved or deflexed. Scape 4–6 feet high, bracts as in the last; panicle pubescent, about as long as the naked part of the scape. Flowers 2–3 inches wide, white with greenish; ovary attenuated and angular-impressed towards the base and attenuated upwards towards the short, somewhat unequal, together conical, stigmas. Capsule 2½ inches long, always constricted in the middle, angular and towards the short beak deeply trilobed; seeds 8–10 mm. long. —*Y. puberula* Haw. Phil. Mag. 1828, p. 186, Refug. l. c. t. 322 is scarcely distinct, as Mr. Baker l. c. already suggests for this as well as for *Y. flaccida*.—*Y. glauca*, Sims Bot. Mag. t. 2662, Refug. t. 315, with exactly the pistil of our plant, but leaves almost without fibres, also belongs here.

The two following forms, which may eventually prove distinct from *Y. filamentosa*, I have not been able to identify with any described species. All often grow together on the coast of South Carolina and there ever retain their characters unaltered.

Var.? *bracteata* has 50–100, usually about 70 leaves 20–24 in. long, 1–1¼ or even 1½ inches wide, with a sharp but slender and weak point, and numerous thin deciduous threads. Scape 4–6 feet high, stout, greenish bronze, almost covered with large foliaceous bracts, the lower 9–12, upper 4–6 inches long, tapering upwards; panicle contracted, scarcely half as long as the flowerless part of the scape, rough, uneven or somewhat pubescent. Flowers white with greenish, about 3 inches wide; pistil 16 lines, stamens half as long, elongated stigmas at last divaricate at tip. Capsule 1½–2 inches long with a short cusp, rarely constricted. Seeds 8 mm. wide. The rarest of the South Carolina forms, and not seen from anywhere else; fl. later than the others, in the second half of June.

Var.? *lævigata* is well characterized by its very long (30–40 inches, 10–15 lines wide), deep green, smooth, thickish, very sharp pointed leaves, only 25–50 in number; lower third attenuated into a narrow stalk, leaf therefore soon decumbent; epidermis cells 3 times as long as wide. Scape 8–10 feet high, smooth, purple below with lance-shaped bracts 6–9 inches long; panicle half as long as peduncular portion, contracted, with comparatively few, sometimes slightly pubescent branches. Flowers often in pairs, smaller than in last, 2½–3 inches wide, white with purple tinge, of a strong almost disagreeable odor, which was not noticed in other varieties; stigmas divided to the base, deeply bilobed. Capsules 1½–2 inches long; short pointed; seeds 8½–9 mm. wide. This is the most common species between Charleston and Hilton Head, on the sandy coast, but is also found on the clayey soil up the rivers; it probably extends down the coast to Florida, as I have seen a specimen from Tampa Bay, Fl., about 2 weeks after the first and as long before the last form. A transition form between this and the regular *Y. filamentosa* is cultivated in the Missouri Botanical Garden, with shorter, weaker-pointed leaves, lanciform bracts and constricted capsules.

II. HESPEROYUCCA: filamenta clavata, acuta. lævia, erecta, pistillo sublongiora; antheræ didymæ transversæ; stylus tenuis, stigma calystræforme papilloso-pilosum; capsula erecta loculicide trivalvis, valvis indivisis; semina ut in *Chænoyucca*.—Planta acaulescens, folia margine serrulato-asperata, panicula in scapo elata.

12. YUCCA WHIPPLEI, *Torrey, Bot. Mex. Bound.* 222; *Bot. Exp. Ives*, 29: subacaulis; foliis paucioribus e basi lata attenuatis lineari-subulatis sæpe falcatis carinatis rigidis pungentibus lævibus glaucis; scapo bracteis late vaginantibus sursum foliaceis pungentibus munito paniculam grandibracteatam lævem gerente; capsula globoso-obovata obtusa.

California, on dry rocky hills, rare north of San Francisco, abundant from Monterey to San Diego, eastward to the Cajon Pass and into northwestern Arizona; fl. in April.—Trunk none or short, sometimes prostrate between rocks, stoloniferous; leaves 10–20 inches long, 4–6 lines wide, concave only near the stout point; scape 4–12 feet high, together with the lower part of the panicle itself, beset with bracts 6–9 inches long, consisting of a broad whitish base terminating in a short rigid leaf. Flowers greenish white, spreading 2 to 4 inches; segments 1½–2½ inches long, 5–12 lines wide, outer much narrower than inner ones; anthers 1–1½ lines across; pistil 4–8 lines long; style proper slender, as long as or much shorter than the ovary; trilobed hood-like stigma 3 times as thick as style and longer than thick. Capsule less than 1 to nearly 2 inches long, frequently rough; secondary dissepiments incomplete at both ends, divided and often rent by the opening of the capsule; seeds 6½–8 or 9 mm. in diameter, with a very narrow margin.—Most of the specimens and numerous notes have been communicated by Prof. W. H. Brewer of the California State Survey.

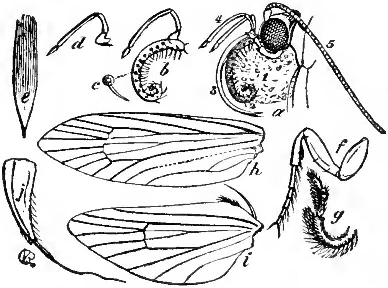
On a new Genus in the Lepidopterous Family TINEIDÆ, *with Remarks on the Fertilization of* YUCCA.

By CHARLES V. RILEY.

PRONUBA. Nov. Genus.

GENERIC CHARACTERS.—*Front wings* (Fig. 1, *h*) elliptical, the apex subacuminate; disc closed, though somewhat indistinctly between marginal veins 5–8; 12-veined exclusive of submedian (1*a*); costal vein stout, connected with subcostal near base and not extending beyond middle of wing; the subcostal vein sends, from about one-fourth its length from base, a branch which reaches costa where the latter commences to round off; it also sends, from about the middle of the wing, a branch through the discal space, forming an accessory discal cell, and sometimes considerably passing the disc and forking outside so as to form marginal veins 7 and 8, though more often forking just at the transverse discal vein; a feeble disco-longitudinal veinlet starts independently near the base, forks near the middle, and forms a second accessory discal cell; submedian vein distinct only near the margin, and indicated by an opaque line along the basal half of the fold; internal vein feeble, and bifid at basal third. *Hind wings* (Fig. 1, *i*) broad, subacuminate at tip; shoulder slightly produced and armed, in the ♂, with a long spine, and in both sexes with a tuft of long scales; 8-veined, exclusive of submedian (1*a*) which is distinct; disc entire; costal vein extending three-fourths the length of wing; an independent, feeble, disco-longitudinal veinlet, forking about the middle of the wing, the upper branch sometimes considerably passing the disc and then forking into marginal veins 5 and 6, but more often forking at transverse vein; internal vein feeble and simple. *Head* (Fig. 1, *a*, ♀) free, sparsely haired; epicranium flattened or depressed; ocelli obsolete; clypeus large; eyes round and salient; antennæ filiform and simple in both sexes, nearly one-half as long as front wing, the basal joint long, bulbous, and twice as stout as the others; maxillary palpi (Fig. 1, *b*) very long, 5-jointed, ***the basal joint in the ♀ produced into a long, stout, cylindrical, prehensile tentacle, armed with spines springing from flattened tubercles (c); this joint in the ♂ a mere***

[FIG. 1.]*



* EXPLANATION OF FIG. 1.—*a*, denuded head parts; *b*, maxillary palpus ♀; *c*, tubercle on same; *d*, maxillary palpus ♂; *e*, wing scale; *f*, front leg; *g*, labial palpus; *h*, denuded front wing; *i*, denuded hind wing; *j*, ovipositor—all enlarged.

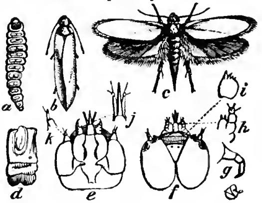
blunt-pointed tubercle (*Fig.* 1, *d*); the other joints almost smooth; 2nd, short, stout, and directed backwards; 3rd, more slender and as long again as 2nd; 4th, thrice as long as 3rd; 5th, as long as 2nd, slender and subfusiform; labial palpi (Fig. 1, *g*) moderately covered with hair-like scales, reaching nearly to base of antennæ; 3-jointed; basal joint curved and stout; 2nd, half as long and straight; 3rd, short and fusiform: tongue long and smooth. *Legs* with the usual single spur on the front, a pair on the middle, and two pair on the hind tibiæ. *Abdomen* ♀ with the terminal joint laterally compressed, long, horny, bare; the sheath of the ovipositor acute; the ovipositor when extended very long, fine, and thread-like; ♂ shorter, blunt, and slightly swollen at tip; the genital hooks large, symmetrical, the upper edge entire and thickened, the lower edge excavated about the middle, with a dark tooth in middle of excavation.

Approaches in the venation of the wings such genera as *Anaphora* Clem. and *Amydria* Clem., but is at once distinguished from all other known genera by the characters given, and especially by the maxillary palpi. The variation in the wing venation affords another illustration of the unsoundness of the principle of founding genera on the pterogstic characters alone, especially when taken from one or two individuals only.

PRONUBA YUCCASELLA, n. sp. (Fig. 2, *c*.)

Average expanse, ♀ 1 inch; ♂ 0.90 inch. *Front wings*, above, uniformly silvery-white, the scales loosely set; fringes concolorous: beneath, pale fuscous with a brassy reflection; paler internally; fringes either concolorous or paler; costa with a brush of dark hairs. *Hind wings* semi-transparent, pale fuscous both above and below; paler internally, the fringes white and the brush on shoulder dark. *Head* white; antennæ and tongue dingy yellow; maxillary palpi of same color, with the exception of tentacle, which is darker; labial palpi with scales on 2nd joint dark brown above: eyes black. *Thorax* white. *Legs* dingy yellow, more or less covered with pale scales. *Abdomen* with the terminal joint in ♀ always bare, with the exception of a few short stiff hairs near tip, and the scales on the other joints very loosely attached.

[FIG. 2.]*



Described from 9 ♂s, 15 ♀s.

I take the present occasion to describe this new genus, not because it is so characteristic and anomalous, but because, firstly, the species belonging to it has such very interesting habits; and,

* EXPLANATION OF FIG. 2.—*a*, larva; *b*, moth, wings closed; *c*, same, wings expanded—natural size; *d*, lateral view of a joint; *e*, head, under side; *f*, same, upper side; *g*, *h*, *i*, *j*, *k*, leg, maxilla, mandible, labium, and antenna of larva—all enlarged.

secondly, there is much yet to learn of these habits, and I wish to draw the attention of entomologists to the subject.

Of late years, and more especially since the publication of Mr. Chas. Darwin's interesting work on the fertilization of Orchids,* we have come to understand more and more the important part which insects play in the fertilization of plants; and the old idea, that color and perfume in flowers were intended for man's especial pleasure, is giving way to the more natural and philosophic view that they are useful to the plants by attracting the needed insects.

In Dr. Asa Gray's recent little work, "How Plants Behave," etc., instances enough are given, in an admirably plain and lucid style, to show the manner in which many flowers are curiously and elaborately constructed so as *just not to do* of themselves what must necessarily be done for them in order to prevent degeneracy or extinction of the species. Some plants, as Fritz Müller proved, are so self-impotent that they never produce a single seed by aid of their own pollen, but must be fertilized by that of a distinct species or even of a supposed distinct genus; while in some cases the pollen and stigma mutually act on each other in a deleterious manner.† The wind is an important agent in the fertilization of certain plants, and some are fertilized even by the higher animals; but by far the greater number are fertilized, or more strictly speaking pollenized, by insects; while the number of species (termed *Entomophilæ* by Delpino) which absolutely depend for pollenation on insect agency is not inconsiderable. These insect pollenizers belong to several Orders, but mostly to the Hymenoptera and Lepidoptera. A familiar example is furnished by our milk-weeds (*Asclepias*), the pollen-masses of which may often be found adhering in pairs to the legs of bees and other insects, and sometimes in such quantities as to prove a real detriment and incumbrance to the bearers. Every year I receive specimens of such pollen-burdened bees, which are generally supposed to be infested with some parasite; and Mr. Jas. D. Meador, of Independence, lately sent me a very gloomy account of the dangerous condition of his apiary from this cause. Each of the numerous flowers which constitute the well-known

* On the various Contrivances by which British and Foreign Orchids are fertilized by Insects. London, 1862.

† See Darwin's "Animals and Plants, etc.," II. p. 132.

umbels is curiously constructed so that the pollen-masses. which look like little flattened, ovoid pieces of wax. can only come in contact with the stigma by artificial means ; and we find that they hang by a bent stalk, attached to a flattened, ovoid, brown organ having a cleft which catches the claws or tarsal hairs, or the fine hairs surrounding the trophi, of insects climbing over the umbels.

With most of the plants of this kind, now known, fructification may be brought about by the aid of more than one species of insect ; and none, perhaps, offer a more striking instance of dependence, or more curious floral mechanism to allure, than do the Orchids. They display an infinitude of curious contrivances and adjustments for the purpose. In the genus *Habenaria*, for instance, the peculiarities of which are described by Dr. Gray, we find flowers that, in some cases, strongly recall butterflies ; a separate pocket for the nectar ; the pollen bound together in masses by elastic threads so as to lessen the chances of loss ; and the base of the stamens forming flattened, sticky discs, placed in the best possible position for adhering to the head parts of a moth or butterfly endeavoring to reach the nectar. In all these features, and others that might be mentioned, there is remarkable adaptation ; and the flowers of many species, as they unfold their petals, seem not only to invite, but to court and crave, the intervention of some scaly-winged marriage priest of "glorious color and glistening eye" who shall at once procure a suitor and perform the nuptials.

Yet here we have adaptation of the plant only, and except in one or two rare instances, as, for instance, in that of a Madagascar Orchis (*Angræcum sesquipedale*), where the nectary is so deep that its nectar can only be reached by a moth with a very long tongue, our Orchids are not dependent for pollenation on any one Lepidopterous species, but may be aided by many which have tongues of sufficient length. Our Yuccas, on the contrary, seem to depend for assistance, so far as we now know, on the single little Tineid which I have described, and for this reason are among the most interesting of entomophilous plants. At least such is the case with the capsule-bearing species, i. e. those which have dry, dehiscent pods ; and I will here premise that my observations have been made* upon a filamentose-leaved species, in common cultivation about

* The fructification of such *Yuccas* as bear fleshy, pulpy fruit, of which *Y. aloifolia* may be taken as the type, has not been studied; but, even with this last mentioned species, the

St. Louis, and which Dr. Engelmann takes to be *Y. puberula* or *Y. glauca*.

Dr. Engelmann has made some interesting observations on the fertilization of Yucca,† and to him I am indebted for drawing my attention to the fact that the plants of this genus must rely on some insect or other for fertilization. The sagittate anthers open a little earlier than does the perianth, and expel the pollen grains, which, being glutinous, remain attached in different sized lumps to the inside of the flower. The stigmatic tube contains nectar, and is connected with the ovarian cells, and the pollen must be introduced into the tube, but cannot be so introduced without artificial aid.

There are several insects that frequent our Yuccas about flowering-time. Some, doubtless, feast on the pollen, while others feed either by gnawing into the young fruit or pumping the juices therefrom;* but the only insect which I have found actively engaged in the pollenation is our little Tineid, which may be known, in popular language, as the Yucca Moth.

During the daytime, we may, by knowing what and where to

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facts, so far as known, strongly indicate that *Pronuba* is principally, if not solely, instrumental in bringing it about. Its seeds are infested with our *Pronuba* larva, though not to the same extent as are those of the dehiscent species. It would be premature to speculate until we have further facts; but it is not at all unlikely that the seeds of the fleshy pods are less congenial to the larvæ, and that a smaller percentage is produced from the eggs consigned to such pods by the moth. In addition to the *Pronuba* larva in the seeds, the fruit of *Y. aloifolia* nourishes a smaller white, apodous larva which is found in the pulp, sometimes in considerable numbers. It may be traced from slight depressions on the outside, and shows Hymenopterous affinities. It occasionally gnaws into the seed from the outside, but its legless character will at once distinguish it from the larva of *Pronuba*, which will be described further on.

† See Bulletin of Torrey Botanical Club, vol. iii, No. 7.

* I have taken the following insects from the flowers: COLEOPTERA—*Anthonomus signatus* Say, whose larva I have known to feed on certain Aphidan Hickory galls—*Chauliognathus Pennsylvanicus* (DeGeer), and *C. marginatus* (Fabr.). Both these insects have the maxillæ peculiarly modified into slender, pilose, extensile setæ or feelers, which doubtless resemble in function the tongue of moths, and enable them to lap honey. I once thought these might have something to do in the pollenation of the plant, and possibly they do in a small degree; but I could never find them near the stigma, and their sole object seemed to be to feed upon the pollen, for which purpose their jaws are well suited. They are found on a variety of pollen-bearing plants, such as *Spiræa*, *Rubus*, *Solidago*, etc., while as larvæ they are carnivorous, the first named being one of the principal enemies of those notorious fruit depredators *Conotrachelus nenuphar* (Herbst) and *Carpocapsa pomonella* (Linn.)—*Euryomia melancholica* Gor. & Perch, a chafer very fond of eating into the flowers and fruit of a variety of plants. HETEROPTERA—*Lygus robiniæ* Uhler—*Orthotylus discoidalis* Uhler—*Cyllocoris scutellatus* Uhler—*Theognis phyllopus* Uhler (= *albicinctus* Say). The last is notably found on Yuccas, but the others more commonly on other plants, and they all derive nourishment by puncturing and sucking, their punctures causing little rusty specks on the fruit.

seek, often find this moth, either singly or in pairs, resting with folded wings (Fig. 2, *b*) within the half-closed flowers. It is then not only hidden, but well protected by the imitative color of the front wings with that of the flower. If we visit the plants after

"* * * * the garish day
Has sped on his wheels of light away,"

and when, with full-blown perianths, the Yucca stands in all her queenly beauty and sends forth her perfume more strongly upon the night air, we shall, with a little patience, meet with this same moth flitting swiftly from flower to flower and from plant to plant —the dusky nature of the hind wings and of the under surface of the front wings almost completely offsetting and neutralizing, when in motion, the upper silvery whiteness of the latter, and thus still rendering the insect a little difficult of detection. It is principally the male which we thus see flying, and by aid of a "bull's eye" we shall find the female for the most part busily at work in the flowers. *He*, with stronger wing-power, can afford to pass, in the most pleasurable way, the few brief days allotted him; but *she* is charged with a double duty, and loses little time in its performance.

Before she can carry out the maternal task of continuing her race, she must act as foster-mother to the plant in order to insure a proper supply of food to her larvæ, which feed on its seeds. With her maxillary tentacle, so wonderfully modified for the purpose, she collects the pollen in large pellets, and holds it under the neck and against the front trochanters. In this manner, she sometimes carries a mass thrice the size of her head (Fig. 1, *a 1*). Thus laden she clings to the top of the pistil, bends her head, thrusts her tongue into the stigmatic nectary and brings the pollen-mass right over its mouth. In this position she works with a vigor that would indicate combined pleasure and purpose—moving her head and body from side to side, and apparently making every effort to force the pollen into the tube. Such is the method by which our Yuccas are fertilized.

The foregoing account of the insect's habits is founded on repeated observation; but we now come to that portion of its career to which I more especially wish to call attention, and which must be considered hypothetical till confirmed by future investigation. Yet I feel as certain of the correctness of my conclusions as though they had been demonstrated.

For want of sufficient time I have been unable to catch the moth in the act of oviposition; but from careful examination I am satisfied that the eggs are not deposited on the outside of the fruit. They are either thrust into it from the side or from the stigmatic opening, following, most probably, the course of the pollen tubes. I strongly incline to the latter view, for, though many Lepidoptera are furnished with extensile ovipositors which enable them to thrust their eggs into crevices and other orifices, I know of none which actually puncture. Nor have I been able to discover any trace of punctures leading to eggs.

Neither have I been able to discover the egg *in situ*: which is not to be wondered at, however, as when examined in the female abdomen it is found to be long, narrow, soft, and flexible, and of the exact color of the flesh of the young fruit. The ovipositor is so very fine and extensile that it may be thrust into the most minute and narrow passage.

If, a day or two after the flowers have withered (between June 15 and July 5 in the latitude of St. Louis with the species mentioned), we carefully dissect the young fruit, we shall often find it to contain from one to half a dozen, but more generally two, young larvæ. They are always found within the nascent seed, and their bodies are, at this time, so much of a color and consistence with the surrounding pabulum, that we could hardly detect them but for the comparatively large, dark jaws. The larva retains its white color till after the last molt, when it acquires the carneous tint so common, at that age, to fruit-boring moth larvæ. It is then characterized as follows:

Description of Larva.—Average length 0.55 inch. Broadest on thoracic joints, thence gradually decreasing to extremity, which is quite small. (Fig. 2, *a*.) Color carneous, with a paler greenish tint below. No piliferous spots, but a few very minute and short stiff hairs springing from the ordinary positions of such spots. A transverse dorsal wrinkle, on each of the principal joints, more or less distinctly divided in two by a medio-dorsal depression which is sometimes slightly bluish. Joints deeply incised and with a lateral, substigmatal, longitudinal wrinkle. (Fig. 2, *d*.) Thoracic legs stout, but short, with three joints and a claw. *No prolegs.* Stigmata (9 pair) forming a small rufous circle on anterior portion of joints 1 and 4–11. *Head* (Fig. 2, *e*, *f*, *h*, *i*, *j*. *k*) partially retractile, copal-colored; epistoma sharply defined; labrum slightly pilose; mandibles stout, rounded, and with four acute teeth, each diminishing in size from without; maxillæ with the inner lobe rounded and furnished with (usually 2) short fleshy hairs, the palpi 4-jointed, the terminal joint with bristles; labium prominent, with the spinneret conspicuous and the palpi 2-jointed—the first joint long with a fleshy hair at tip, the second small, spherical, and also terminating in a fleshy hair; antennæ 2-jointed, the terminal joint with a bristle: ocelli pale, around a dark crescent. Cervical shield flattened and not well-defined.

White when young. Mostly curved in the fruit like the larvæ of *Curculionidæ*.

Described from many specimens.

Two larvæ are seldom found in the same seed-row, and each one, on attaining full growth, consumes only the inside of from fifteen to twenty seeds. Each pod contains, on an average, upwards of two hundred of these seeds, disposed in six rows, and might consequently sustain a dozen larvæ; so that when, as is usually the case, there are not more than two such larvæ to a pod, an abundance of perfect seed remains to perpetuate the plant. Yet sometimes every seed will be destroyed, especially in the species with smaller capsules.

It is quite possible that the moth may, at times, introduce the pollen into the stigmatic tube without consigning any of her eggs to the fruit, and we should naturally expect to find some capsules uninfested with her larvæ. But I have this year examined hundreds of capsules around St. Louis, and some in South Illinois, and not more than four or five per cent. were uninfested. Sometimes every pod on the same plant had its worms, while at others half the pods on a given panicle would be free of them. From the very large percentage of infested pods, I conclude that oviposition naturally and immediately follows fertilization, unless the moth be disturbed.

When mature the larva bores a hole through the capsule, drops by a web to the ground, burrows a few inches below the surface, and constructs an oval cocoon of earth, lined on the inside with silk. Here it doubtless rests in the larva state through the fall. winter and spring months, and completes its transformations about the time the Yuccas begin to bloom; for it is a very general rule with Tineidæ that when they hybernate in the preparatory state, it is as larvæ, the term of the chrysalis state being brief.

The only natural enemies of the larva that I yet know of are ants. These omnivorous creatures often get into the capsule and devour the worm when it is about to leave, and its burrow may frequently be found crowded with them.

Though another year must roll around before the latter part of our Pronuba's history, as here given, can be positively substantiated, let me hope that the next blooming-season of our Yuccas will find other eyes than my own watching her ways and methods.

We have in this little moth a remarkable adaptation of means to an end. There is between it and its food-plant a mutual interdependence which at once excites our wonder, and is fraught with interesting suggestions to those who are in the habit of reasoning from effect to cause. Whether we believe, as I certainly do, that this perfect adaptation and adjustment have been brought about by slow degrees through the long course of ages, or whether we believe that they always were so from the beginning, they are equally suggestive of that same law and harmony so manifest throughout the realm of Nature.

The peculiar structure of the flower which prevents self-fertilization, though on a superficial view it strikes one as a disadvantage, is in reality a great benefit; while the maxillary tentacle of the female moth is very plainly an advantage to her species in the "struggle for life"; and it is quite easy to conceive, on Darwinian grounds, how both these characters may gradually have been produced in the course of time from archetypal forms which possessed neither. These peculiarities are, moreover, mutually and reciprocally beneficial, so that the plant and the animal are each influenced and modified by the other, and the same laws which produced the beneficial specialization of parts would maintain them by the elimination of all forms tending to depart from them.

It may be that the glutinous nature of the pollen renders consectaneous its accumulation by the spinous maxillary tentacles of the female moth; and that, when she is sipping nectar, the vigorous working of head and body from side to side is simply an effort to get rid of an incumbrance. It may be that all her actions are the result merely of "blind instinct," by which term proud man has been wont to designate the doings of inferior animals; but for my part I have not been able to watch her operations without feeling that there is in all of them as much of purpose as there is in those of the female *Pelopæus*, who so assiduously collects, paralyzes, and stores away in her mud-dabs, the spiders which are to nourish her young; or in the many other curious provisions which insects make for their progeny, which, in the majority of instances, they are destined never to behold. Nor can I see any good reason for denying these lowly creatures a degree of consciousness of what they are about, or even of what will result from their labors. They have an object in view, and whether we attribute their performances to reason or instinct depends altogether upon the meaning we give to these words. Define instinct as "congenital habit," or "inherited association," and most of the doings of the lower animals may be very justly called instinctive. But I cannot help thinking that the instinctive and reasoning faculties are both present, in most animals, in varying proportion, the last being called into play only by unusual and exceptional circumstances; and that the power which guides the ♀ *Pronuba* in her actions differs only in degree from that which directs a bird in building its nest, or which governs many of the actions of rational man.

I will conclude by referring to one practical phase of this subject. As the insect and its food-plant are inseparable under natural conditions, the former doubtless occurs wherever the latter grows wild. Pods of *Y. angustifolia* which I gathered on the Black Hills of Colorado, in 1867, all show the unmistakable holes of egress of the larvæ; while those of *Y. rupicola* from Texas, of *Y. Whipplei* from California, and of others from South Carolina and Texas, now in the herbarium of Dr. Engelmann, all show this infallible sign of having been infested. Through the courtesy of the same gentleman, I have also received the moth, taken around Yuccas, from South Carolina, and the pods of several species from the same State and from Texas, while the larvæ were yet working in them. There is every reason to believe, however, that beyond the native home of these plants the insect does not occur, except where it has naturally spread or been artificially introduced; and it is an interesting fact that, so far as I am able to learn, the dehiscent species in the northern parts of this country and in Europe never produce seed.

The cocoons containing the dormant larvæ can be very conveniently sent by mail from one part of the world to another, and by their aid our transatlantic florists may yet have the satisfaction of getting seed from their Yuccas without any personal effort.

Descriptions of North American HYMENOPTERA.

By BENJ. D. WALSH, M.A.

(WITH NOTES BY E. T. CRESSON.)

[Among the MSS. left by my deceased friend, Mr. Benjamin D. Walsh, was found that from which is prepared the present memoir, containing detailed and carefully written descriptions of many species and a few new genera of North American *Hymenoptera.*

Before the MS. (referred to me by Mr. C. V. Riley) came into my hands, I had published in the *Trans. Am. Ent. Soc.*, Sept., 1870, a paper on the Sub-family *Pimplariæ*, in which many species described by Mr. Walsh (in the MS.) as new, were published under other names. In order, therefore, to prevent an unnecessary increase in the synonymy of species, the names given them by Mr. Walsh were suppressed as of no value, and those having priority substituted. The descriptions are carefully prepared, and the comparative remarks, for which Mr. Walsh was always famous, exceedingly valuable to the student.

I owe much to the kindness of Dr. Wm. LeBaron, State Entomologist of Illinois, who made the identification of the species quite an easy task, by placing in my hands for comparison the specimens from which Mr. Walsh made his descriptions. These, together with about three-fourths of the celebrated Walsh Collection, were, most unfortunately, destroyed by the terrible conflagration that visited the city of Chicago in October, 1871.

I have only to add that all that is given below is from the original MS. of Mr. Walsh, excepting the few notes enclosed within brackets.]

Family TENTHREDINIDÆ.

GENUS HYLOTOMA.

Hylotoma scutellata, Say, ♀. — Bright sanguineous. *Head* blue-black, highly polished and glabrous. Clypeus finely but distinctly rugose, emarginate in an angle of about 135°, the apex of which is sometimes more or less rounded off so that the emargination approximates more or less to a circular arc of about 60°. Labrum transverse, squarely truncate at tip or slightly emarginate. Antennæ ⅗ as long as the body, black, very rarely (1 ♀) tipped with rufous; the long terminal joint finely rugose and opaque, but unarmed. *Thorax* highly polished and glabrous; a vertical stria, having the appearance of a suture, always dividing the side of the collare into two subequal triangles in the dried specimen. Prothorax, tegulæ, mesonotum except almost always the scutel (18 out of 21 ♀), anterior angles of the collare or very rarely (1 ♀) only its extreme anterior angles, lower surface of the mesothorax up to the suture dividing it from the sanguineous pleura, and the entire mesothorax, including the basal plates, all blue-black. Very rarely (1 ♀) there is a lateral sanguineous spot on the basal plate. Cenchri whitish. *Abdomen* polished and glabrous; basal membrane pale luteous. Last ventral joint more or less tinged with luteous. Ovipositor dull luteous, each plate with a narrow blackish vitta in its middle; sheaths black, sanguineous on their superior base. *Legs* blue-black; tarsi blackish. *Wings* clouded with fuliginous, opaque blue-black along the costal margin, the postcostal space mostly hyaline. Veins, costa and stigma black. Hind wings paler, the hyaline space extending on to the disk. The last submarginal cross-vein very rarely (2 ♀) with a stump of a vein springing from it at the curve. Length ♀ .35–.40 (.45 Say) inch. Front wing ♀ .38–.40 inch.

♂ Differs from ♀ only as follows:—1. The antennæ are ½ (not ⅜) as long as the body, and the hairs on the last joint are ⅜ its breadth. 2. The scutel is full as often black as sanguineous. 3. It is often the case that only the extreme anterior angle of the collare is black. 4. From 2 to 6 of the basal oints of the dorsum of the abdomen are often black (5 ♂ out of 9 ♂) except laterally, and the last ventral is never luteous, but often tipped more or less widely with black. 5. The wings are much paler, the costa only blue-black. Length ♂ .27–.30 inch. Front wing ♂ .28–.30 inch.

Nine ♂, twenty-one ♀. A very handsome species. Say describes the ♀ only, and from a single specimen with mutilated legs. He makes the ground-color to be "fulvous" or "reddish-yellow," instead of sanguineous as in all my ♂ ♀; but his specimen was perhaps alcoholic. He gives no habitat for the species. It is singular that this insect should vary in both sexes, so as sometimes to lack the very character from which Say's name is derived, viz. the red scutel. His ♀ was .05 inch longer than any of mine. In 1 ♂ 1 ♀ with black scutel and 1 ♀ with sanguineous scutel the 2d recurrent vein coincides with the 2d submarginal cross-vein, and all the intermediate grades occur between this and the normal structure. The same thing occurs also sometimes in *dulciaria*, Say, and *calcanea*, Say, as shown below. As it is upon this character that the genus *Scobina*, St. Farg. & Serv., appears to have been exclusively established, it must in that case be suppressed. (See Brullé *Hymen.* p. 669.)

Hylotoma coccinea, (??) Fabr. ♀.—Differs from the above ♀ only as follows:—1. The head, except the tips of the mandibles, the palpi, and sometimes the labrum, which are dusky, and the eyes and antennæ, which are black, is sanguineous. 2. The clypeus is scarcely rugose. 3. The antennæ are only ⅓ as long as the body. 4. The entire thorax is bright sanguineous, except the tegulæ and a mesonotal spot above the origin of each one of the 4 wings, which are black, and the cross-carinæ and basal plates of the metanotum, which are obfuscated. 5. The hind coxæ, except at tip, are sanguineous; the rest of the legs black. 6. The hind wings are as dark as the front ones, except on the costa; and in both wings of 1 ♀ the last submarginal cross-vein has a stump of a vein springing from it. Length ♀ .43–.45 inch. Front wing ♀ .38–.39 inch.

♂ Differs from ♂ *scutellata* only as follows: 1. As in ♀ *coccinea*, the clypeus is scarcely rugose, while in all my ♂ *scutellata* it is very obviously so. 2. The thorax is entirelv bright sanguineous, except the prothorax, tegulæ, a large mesonotal spot above the origin of each of the 4 wings, the lower surface of the mesosternum, and the metanotum, which are all black; but the basal plates are pale fuscous. 3. The abdomen is bright sanguineous, with only the tip of the last ventral joint fuscous. 4. The front wings are fuliginous up to the stigma, hyaline beyond the stigma. Length ♂ .28 inch. Front wing ♂ .28 inch.

One ♂, two ♀. Fabricius, as Mr. Norton kindly informs me, describes his *coccinea* as "Sanguineous; back of the thorax and the legs black; wings obscure cyaneous, hyaline at the apex." From such a brief notice it is impossible to decide whether my species is identical with his, and the point can only be determined from inspecting his original specimens, if still in existence. Arguing such questions as these is simply labor lost, and scientifically as unprofitable as puzzling over any other archæological enigma. My ♂ might be taken for an extreme variety of *scutellata*, but for the different sculpture of the clypeus and the conspicuous hyaline tips to the wings. The ♂ head being black and the ♀ head sanguineous is very remarkable and unusual in *Tenthredinidæ*, and possibly the ♂ may be a distinct species.

Hylotoma dulciaria, Say, ♀.—Luteo-rufous. *Head* blue-black, polished and glabrous. Clypeus emarginate in a very obtuse angle, finely but distinctly rugose. Labrum transverse, truncate at tip. Palpi varying from pale dusky to whitish. Antennæ black, ⅓ as long as the body, the last joint unarmed and with fine rugæ. *Thorax* polished and glabrous, verging on rufous above. Tegulæ and metanotum, including the basal plates, more or less stained with fuscous. Lower surface of the mesothorax blue-black up to, but never beyond, the suture dividing it from the pleura. Cenchri whitish. *Abdomen* polished and glabrous, rarely with a fuscous dorsal dot at the tip of joints 3–5; the sheaths (last ventral), except sometimes their extreme base, blue-black; ovipositor concealed. *Legs* blue-black; tarsi blackish, the 1st joint of the hind tarsi sometimes whitish on the basal ¾. *Wings* clouded with fuliginous, darker along the costal margin with some blue-black reflections. Veins, costa and stigma black. Length ♀ .27–.35 inch. Front wing ♀ .30–.34 inch.

♂ Differs from ♀ only as follows:—1. The antennæ are ⅖ as long as the body, the usual hairs on the last joint nearly as long as the joint is wide. 2. The tegulæ and the entire thorax above and below, except the cenchri which are whitish and the basal plates which are luteo-rufous, are blue-black. 3. The abdomen is immaculate. 4. The wings are several shades paler, but there is an obvious darker cloud extending from the base of the stigma to the usual dark dot in the disk of the 2d submarginal, which cloud exists in ♂ also, but is not noticed from the rest of the wing being equally clouded. Length ♂ .27 inch. Front wing ♂ .27 inch.

One ♂, six ♀. Say describes very briefly from a single ♀, the ♂ being unknown to him. The remarkable false suture on the collare, which exists in the two preceding species, is not found here. In my ♂ and one of my ♀♀, the 2d recurrent vein coincides with the 2d submarginal cross-vein.

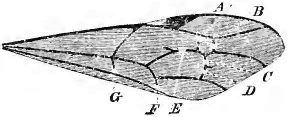
Hylotoma calcanea, Say (= *scapularis*, Klug, according to Norton), ♀. —Blue-black. *Head* polished and glabrous. Clypeus emarginate in a very obtuse angle, finely punctato-rugose. Labrum transverse and truncate at tip. Palpi pale dusky or whitish. Antennæ black, almost $\frac{2}{5}$ as long as the body, finely rugose and scarcely pubescent. *Thorax* polished and glabrous, pale rufous. Tegulæ, metanotum including the basal plates, except sometimes a small whitish band between and behind the cenchri, lower surface of the mesothorax up to the suture, and occasionally its entire pleura as well as the humeral sutures and some clouds on the collare, and also the tip of the scutel, all blue-black. *Abdomen* glabrous and polished, occasionally coal-black above. Basal membrane whitish, sometimes pale dusky. Ovipositor luteous; its sheaths black. *Legs* blue-black; tarsi blackish; the basal $\frac{3}{4}$ of the 1st joint of the hind tarsi, and sometimes the basal $\frac{1}{2}$ of joint 2 also, whitish. *Wings* clouded with fuliginous, darker along the costa with some blue-black reflections, more hyaline towards the tip in the front wings. Veins, costa and stigma black. Length ♀ .37–.40 (less than .35 Say) inch. Front wing ♀ .37–.40 inch.

♂ Differs from ♀ only as follows: — 1. The black color is but slightly tinged with blue. 2. The antennæ are fully $\frac{2}{5}$ as long as the body, the usual hairs on the last joint nearly as long as the joint is wide. 3. The thorax, including the basal plates, is entirely black, except the collare, which is rufous; 4. The legs are entirely black, except that in the front legs the knees, tibiæ and tarsi are anteriorly whitish, and sometimes in the hind legs the whole of the tibiæ and all but the extreme tip of the two basal tarsal joints, are whitish. 5. The wings are fuliginous, hyaline in the front wings beyond the stigma and in the hind wings at the extreme tip. Length ♂ .25–.27 inch. Front wing ♂ .25–.26 inch.

Two ♂, three ♀. Say's description is very brief and imperfect, and, though he evidently describes the ♀ only, he says nothing of the sex. He describes the tarsi as "white or whitish at base," whence it would be inferred that all six tarsi are so. In one wing of one ♂ the 2d recurrent vein exactly coincides with the 2d submarginal cross-vein and in the other wing almost so; and in both wings of one ♀ the 3d submarginal cross-vein bears a stump of a vein. Mr. Norton asserts that "ordinarily the ♂ and ♀ are alike," and he describes as "Variety *a* ♂" a ♂ apparently identical with mine, which is said to have been taken *in coitu* with the normal ♀. (*Proc. Ent. Soc. Phil.* iii. p. 6.)

Family ICHNEUMONIDÆ.

[The annexed figure, representing the front wing of *Ichneumon*, is here given to indicate the *locus* of the bullæ A—G, frequently referred to in the descriptions given below. For a detailed description of these bullæ, and remarks about their generic and specific value, the reader is referred to Mr. Walsh's paper "On Phytophagic Varieties and Phytophagic Species," in *Proc. Ent. Soc. Phil.* vol. v. p. 209, and vol. vi. p. 242.—CRESSON.]



JOPPIDIUM, new genus.

Head transverse; face flat; clypeus large, transversely oval, the clypeal suture distinct; mandibles large, bidentate, and, as well as the whole mouth, prominent. Antennæ moderate, setiform; the 1st joint obliquely truncate above nearly to its base, the 2d joint large, projecting beyond the tip of the 1st; first 3 joints of the flagellum long, subequal, the rest gradually shorter, the terminal ⅓ ♀ flattened except at tip and dilated to about double its width elsewhere (as in *Joppa* ♀ Brullé *Hym.*, Plate 43, fig. 1*a*). *Thorax* with the mesonotum gibbous and the parapsidal grooves usually distinct; scutel hunched and rather elevated; metathorax gradually declivous, the typical areas mostly obliterated. *Abdomen* peduncled, elongate-oval, basally depressed, slightly compressed at tip, much narrower than the thorax, and a little longer than the head and thorax together. Joint 1 very long, slightly and gradually inflated towards the tip, the spiraculiferous tubercles placed at about ⅔ of the way to the tip, where the peduncle terminates and there is a slightly curved geniculation. Joint 2 longer than wide, the rest gradually shorter and shorter, the terminal joint not retracted. Venter excavated, longitudinally bicarinate. Ovipositor moderate; the "anus slit," as it is termed. *Legs* long and slender, the femora not incrassate, the hind femora and trochanters longer than usual; spurs normal; 1st tarsal joint of the front legs basally more emarginate than usual, the 4th tarsal joint in all the legs short and entire; claws simple, longer than the pulvillus.

Wings wider than usual; radial area elongate; areolet large, pentagonal; 1st recurrent vein strongly curved in the middle; 2d recurrent vein with the salient angle pretty distinct, but very obtuse. Bullæ four, A, B, CD and E, all very distinct and normally located.

Distinct from *Joppa*, by the antennæ ♂ not being submoniliform, by the long and slender 1st abdominal joint, by the long ovipositor, and by the entire 4th tarsal joint. From *Baryceros*, by the antennæ being dilated only in ♀ and by the areolet not being obsolete. From *Helwigia*, by the antennæ being dilated only in ♀, by the abdomen not being strongly compressed, by the ovipositor not being very short, by the cubito-discoidal cell not receiving both the recurrent veins, and by the areolet not being obsolete. And from *Euceros*, by the abdomen not being sessile, by the ovipositor not being very short, and by the areolet not being obsolete.

Joppidium ruficeps, n. sp. — ♀ — Black. *Head* subopaque, finely and densely punctate, and as well as the mouth, rufo-sanguineous, except the disk of the occiput, a cloud around the ocelli, the region between and above the origin of the antennæ, and the extreme base and tip of the mandibles. Antennæ $\frac{2}{3}$ as long as the body, rufous on their basal $\frac{1}{3}$, shading into yellow on their middle $\frac{1}{3}$, their terminal $\frac{1}{3}$ brown-black. First joint of flagellum 4 times as long as wide, the 2d and 3d joints each about $\frac{1}{5}$ shorter than the preceding. *Thorax* subopaque, with long, sparse, gray pubescence, confluently and rather coarsely punctate, more finely on the mesonotum except the scutel. Carinæ of the metathorax obsolete except the transverse carinæ of the lateral areas and a trace of their hind carinæ. Tegulæ piceous. *Abdomen* polished, with rather sparse, almost microscopic punctures and appressed pubescence. Joint 1, 5 times as long as wide, $\frac{1}{3}$ wider at tip than at the extreme base, suddenly contracted behind the base to $\frac{2}{3}$ its basal width, thence with its sides, except a small spiraculiferous tubercle, nearly straight to the tip; the carinæ only indicated by a small, shallow fovea at the extreme base. Joint 2 longer by $\frac{1}{3}$ than wide, $2\frac{3}{4}$ times as wide at tip as at base; 3 slightly shorter than wide; 4–8 much shorter than wide, and all of them rufo-sanguineous. Venter blackish, the base of joint 1 and the tip of 1–3 whitish; the carinæ of 4 and 5, and the whole of 6, rufo-sanguineous. Ovipositor piceous, scarcely $\frac{1}{2}$ as long as the body; sheaths brown-black, basally not quite $\frac{1}{2}$ as wide as the last tarsal joint of the hind legs, terminally a little tapered. *Legs* yellow, with all their coxæ and the hind trochanters and femora, except the knees, black; the 4 front legs with their trochanters and femora, except the knees, rufous, the upper surface of the middle trochanters blackish. *Wings* subopaque, black; veins black; stigma black, its extreme base paler. Areolet with its inner and outer sides nearly parallel. Bullæ large and white; on the side of the areolet which adjoins the outer discoidal cell, a small, internal semi-bulla not encroaching on the vein itself. Length ♀ .52 inch. Front wing ♀ .42 inch. Ovipositor .23 inch.

The ♂ differs from the ♀ only as follows:—1. The black space above the antennæ is confluent with the black cloud around the ocelli, leaving on the front only the orbits rufo-sanguineous. 2. The antennæ are ¾ as long as the body; the yellow color on their middle extends nearer to the tip; and the 1st joint of the flagellum is only thrice as long as wide. 3. The tubercles on abdominal joint 1 are more robust than in ♀. The abdomen is black, except joint 8, which is retracted, and the penis, both of which are rufous; and the venter is blackish, except the base of joint 1, which is whitish. Length ♂ .50 inch. Front wing ♂ .45 inch.

One ♂, one ♀, taken on umbelliferous flowers in July. The ♂ may perhaps be *Banchus æquatus*, Say, but the mouth and orbits are not "yellow" but rufo-sanguineous; there is no "whitish dot" on the stigma but only a paler stain; and the tegulæ is not "honey-yellow" but piceous. The 4 anterior legs are also described by Say as "honey-yellow," whereas in my species their femora are rufous and their tibiæ and tarsi yellow, to say nothing of the black coxæ. Say may have described from an alcoholic specimen, in which, as usually happens, the sanguineous color had changed to yellowish. I have very numerous specimens of his *Hylotoma scutellata*, both ♂ and ♀, the pale color in all which is bright sanguineous, while Say describes it as "reddish yellow." I have also two specimens of his *Podabrus tricostatus* (Coleoptera), in which the lateral edges of the thorax are sanguineous both in the recent and in the dry individual, while Say describes them as "yellow" or "rufous." Dr. Velie brought from Colorado two pinned and numerous alcoholic specimens of a beautiful new species of *Œdipoda* (Orthoptera), allied to *sulphurea*, Fabr. In the former the wings are a deep, full scarlet; in all the latter they are a dingy, very pale salmon-color. Authors that are unfortunately compelled to describe from alcoholic specimens, should state the fact; otherwise their colorational specifications are generally more or less unreliable, grass-green after immersion in alcohol often changing to brown, and sanguineous to yellow or salmon-color. I cannot even guess what Say intended by saying of his *Banchus æquatus* "hypostoma with two slight lobes *situated longitudinally*," unless he refers to the cheeks, which are, of course, *situated transversely*, although in my *ruficeps* each of them is longitudinally elongated in consequence of the abnormal prominence of the whole mouth.

GENUS CRYPTUS, Fabr.

SECTION 1, *Cresson*.—"Scutel and abdomen black."

Cryptus robustus, Cress.—♀.—Mr. Cresson correctly remarks of the ♀ that "joints 2–4 of the four anterior tarsi are short [equilaterally] triangular, dilated and spinose, which seems to be an important character of the species." (*Proc.* &c. iv. p. 265.) Judging from the analogy of ♂ ♀ *Labena*, Cress., where the hind tarsi of ♂ are normal and those of ♀ abnormal, I should infer that this is a mere sexual character peculiar to ♀. I have no doubt, judging from the descriptions, that *Cr. crassicornis*, Cress. is the ♂ of *robustus*, as doubtingly suggested by Mr. Cresson (*Proc.* &c. iv. p. 265), and nothing is said as to its tarsi being abnormal. Eight ♀ from Colorado, collected by Dr. Velie.

SECTION 2, *Cresson*.—"Scutellum pale; abdomen black." Not represented.

SECTION 3, *Cresson*.—"Scutellum with pale markings; abdomen red, or red and black."

Cryptus atricollaris, n. sp.—♀.—Rufous. *Head* black, subopaque, very finely and rather closely punctate. Wide orbits, broadly but not deeply emarginate opposite the antennæ, a spot on the vertex just behind the ocelli which is often very minute but rarely absent, clypeus, and very often a large, quadrate spot above it and separated from it only by the black clypeal suture, cheeks, mandibles except their teeth, and palpi, all white. Antennæ nearly as long as the body, brown-black; the 1st joint of the scape, and sometimes 3 or 4 of the following joints, rufous beneath; flagellum with more or less of the tip of joint 5, the whole of 6–9, and sometimes the base of 10, white above and below. Joint 1 of the flagellum 6 times as long as wide, joint 2 shorter by ¼; the rest gradually shorter and shorter. *Thorax* tinged with yellow below and on the metathorax, subopaque, very finely and densely punctate; the parapsidal grooves distinct but not impressed; the disk of the collare on each side longitudinally aciculate. Metathorax with the normal areæ obsolete, except the cross-carinæ and the acute, thorn-like tips of the lateral areas. Tegulæ, a line under the front wing sometimes obscurely prolonged downwards on the front edge of the mesothoracic pleura, a broad, pointed line underlying the humeral suture to its very tip, a subquadrate spot on the disk of the mesonotum, both scutels, and the anterior edge of the collare, all white. The rest of the collare, as well as the humeral suture, more or less of the depressed areas surrounding the 2 scutels, and sometimes the parapsidal grooves and rarely the entire lateral lobes of the mesonotum and the base of its middle lobe, all black. *Abdomen* oval, not much longer than the head and thorax together, polished, with very fine, rather sparse, shallow punctures, sometimes tinged with yellow, especially at its base; the tip of joint 1 generally more or less tinged with white. Joint 1, 2¾ times as long as wide, 2½ times as wide at tip as at the extreme base, its narrowest part ⅓ of the way to the tip, gently concave from near the base ⅔ of the way to the tip, where the small spiraculiferous tubercles are located, thence with its sides slightly convex and scarcely divergent. Carinæ only represented by a shallow, narrow, dorsal excavation reaching to the middle, thereafter obsolete. Joint 2 as long as wide, and twice as wide behind as before; the rest rapidly shorter and shorter. Joint 3 almost always with a dark capillary transverse line behind the middle, and 4 almost always with one on the middle. Venter excavated, longitudinally unicarinate, tinged with yellow except at tip. Ovipositor scarcely half as long as the body, piceous, sometimes rufous; sheaths black, basally as wide as the last tarsal joint of the hind legs, and slightly tapered towards their tip. *Legs* pale rufous; front coxæ and trochanters, middle trochanters, tips of middle coxæ, and the hind tarsi except generally their extreme base, all whitish; hind tibiæ, especially towards their tips, infuscated. *Wings* subhyaline, sometimes tinged with smoky yellow; veins black; stigma rufous edged with black, but always pale yellowish at base, and rarely entirely pale except the black edging. Radial area elongate, its posterior angle about 135°. Areolet with its sides always converging towards the radial area, so that its anterior side is about equal to either one of its two posterior sides. First recurrent vein obtusely angulated, sometimes with, sometimes without a stump of a vein at the angle; second recurrent vein gently convex exteriorly or obsoletely angulated. Length ♀ .30–.38 inch. Front wing ♀ .30–.33 inch. Ovip. .14–.16 inch.

The ♂ differs from ♀ only as follows:—1. The entire face and the cheeks nearly up to the vertex are white, and the spot on the vertex is larger and never absent. 2. The antennæ are full as long as the body; in the flagellum all but the extreme base of joint 10, the whole of 11–15, and the extreme base of 16, are white (instead of joints 5–10), and its 1st joint is only 4 times as long as wide. 3. The mesothorax is black above and for a short space beneath the front wing, except in both cases the white markings, and the rest of it is white; the hind surface of the metathorax is also white, and its upper surface sometimes entirely black. 4. The abdomen is elongate-oval, ⅓ longer than the head and thorax together. Joint 1 is full thrice as long as wide, and only twice as wide at tip as at the extreme base; its tubercles are much larger, and behind them the sides of the joint are parallel; and joint 2 is only twice as wide at tip as at base. 5. The 4 front legs have their coxæ and all their trochanters white, the hind coxæ have a terminal white spot above, and the hind tarsi are entirely white. Length ♂ .30–.36 inch. Front wing ♂ .25–27 inch.

Three ♂; nine ♀. We find the ♂ pectus white and the ♀ pectus rufous in *Mesosthenus thoracicus*, Cress., also, and in many other *Ichneumonidæ*. Distinct at once from *Cr. iridescens*, Cress., ♂ and *Cr. soror*, Cress., ♂ by the white annulations of the antennæ ♂ ♀ and the white face and pectus ♂. From *Cr. semirufus*, Brullé ♀ (N. Am., length .46 inch, ovip. .30 inch), the ♀ is separated by the uninterrupted orbits, by the mesosternum not being black, by the smaller size, and by the relatively smaller length of the ovipositor, viz. less than ½ instead of ⅔ of the body.

Cryptus rhomboidalis, n. sp.—♀.—Differs from the normal *atricollaris* ♀ only as follows:—1. The size is almost ½ smaller. 2. The orbits are widely interrupted behind the eyes, and are relatively narrower except on the face, and there is no quadrate white spot above the clypeus and none on the vertex. 3. The antennæ are absolutely as stout as in *atricollaris*, and therefore relatively much stouter; the white annulus is narrowly brown-black beneath, and the first joint of the flagellum is only 3½ (not 6) times as long as wide. 4. The thorax is nowhere tinged with yellow; there is a large rhomboidal black spot in front of the middle coxæ, prolonged in a narrow line to the front coxæ; the anterior edge of the mesothoracic pleura, and all the depressed areas surrounding the 2 scutels, are black; the white line under the humeral suture stops short of its extreme tip; and there is no white spot on the disk of the mesonotum. 5. Instead of the tip of abdominal joint 1, the tips of two or three of the anal joints are narrowly white. 6. In the 4 front legs the coxæ and trochanters are all white; in the hind legs the femora and tibiæ are dark rufous, the latter infuscated at the extreme tip and whitish on their basal ⅕, and the tarsi are pale rufous. 7. The radial area is less elongate, its posterior angle being only 120°. Length ♀ .17 inch. Front wing ♀ .15 inch. Ovip. .07 inch.

One ♀; ♂ unknown. Distinct from *iridescens*, Cress. ♂ and *soror*, Cress. ♂ by the thorax not being generally black and by the abdomen not being partly black, and from the former also by the unicolorous hind tarsi. Comes very near the brief and indefinite description of *semirufus*, Brullé (N. Am.), but differs by the metathorax not being more strongly punctured than the rest of the thorax, by the much smaller size (about ⅓), and by the relatively shorter length of the ovipositor (½ the body instead of ⅔).

Cryptus cinctipes, n. sp.—♀.—Differs from the normal *atricollaris* ♀ only as follows:—1. The size is almost ½ smaller. 2. The orbits are very narrow, and are obsolete except on the face; there is no white spot above the clypeus and none on the vertex, and the cheeks are black. 3. The antennæ are only ⅔ as long as the body, absolutely nearly as stout as in *atricollaris* ♀, and therefore relatively much stouter; besides the scape, joints 1–3 of the flagellum are rufous beneath; the lower surface of the white annulus is narrowly tinged with dusky; and joint 1 of the flagellum is only 4 (not 6) times as long as wide. 4. The thorax is nowhere tinged with yellow. In the metathorax the whole posterior sides of the lateral and central areas are present, so as to show a complete posterior area; there is no discoidal white spot on the mesonotum; the anterior and upper edge of the mesothoracic pleura is black so as to enclose the white line under the front wing; all the depressed areas surrounding the two scutels are black; and there is a large rhomboidal black spot before the middle coxæ, prolonged in a narrow line to the front coxæ. 5. Instead of the tip of joint 1, the tips of abdominal joints 6–8 are narrowly white; and joint 1 is only twice as wide at tip as at its extreme base. 6. In the 4 front legs the coxæ and trochanters are all white, and there is an indistinct whitish annulus at the base of the middle tibiæ. In the hind legs the tips of the coxæ and the whole of the trochanters are whitish; the basal ⅕ of the tibiæ, the spurs, and the basal ⅗ of tarsal joints 1 and 2, are all white; and the extreme tip of the femora and the terminal ⅕ of the tibiæ all round, and their middle ⅗ exteriorly, are all black. 7. The radial area is less elongate, its posterior angle being only about 120°. Length ♀ .19 inch. Front wing ♀ .18 inch. Ovip. .07 inch.

The ♂ differs from ♀ only as follows:—1. The tips of the cheeks and the entire face, except a minute black spot below each antenna, are white. 2. The antennæ are full as long as the body; the scape is rufous except a black dot above and a large white spot below; and the 1st joint of the flagellum is rufous below. Instead of the tip of joint 5 and the whole of joints 6–9, it is the tip of joint 9, the whole of 10–14, and the base of 15, that are white in the flagellum all around. 3. The lower ½ of the pleura, and the mesothoracic sternum below, are white; the black spot before the middle coxæ very small. 4. The abdomen is elongate-oval, ⅓ longer than the head and thorax together, and rufous immaculate, save that the extreme tip is obfuscated. 5. The hind tarsi are entirely white, except joints 4 and 5, and a dot at the tip of joint 1, which are fuscous. Length ♂ .27 inch. Front wing ♂ .20 inch.

One ♂; one ♀. The ♀ comes very near *rhomboidalis* ♀, n. sp., especially in the rhomboidal black spot on the pectus, whence that species takes its name, but is sufficiently distinct by the short orbits, the black cheeks, the whitish hind trochanters, the white hind spurs, and the biannulated hind tarsi. From the other three species belonging to this group, it differs in the same way as *rhomboidalis*. The sexual distinction in the *locus* of the antennal annulus is remarkable, and occurs also in *Cr. atricollaris*, n. sp.

Cryptus rufifrons, n. sp.—♀.—Differs only as follows from the normal *atricollaris* ♀:—1. The size is rather smaller. 2. The orbits (very wide above the cheeks), face, clypeus, mandibles except their teeth, and cheeks, are all pale rufous; and the palpi are yellowish white. 3. The antennæ are only ⅘ as long as the body, absolutely full as stout as in *atricollaris* ♀ and therefore relatively stouter; the white annulus is narrowly tinged with dusky below, especially on joint 9; and the 1st joint of the flagellum is only 4 (not 6) times as long as wide. 4. The thorax is nowhere tinged with yellow. The metathorax has the lateral areas, as well as their cross-carinæ, pretty distinct; a small triangular basal area; a small and indistinct obtrigonate central area; and a large, declivous, pentagonal, posterior area. The white line under the front wing is conspicuously prolonged downwards; the white line under the humeral suture does not nearly attain its tip and is obtuse in front; there is no discoidal white spot on the mesonotum; and the metathoracic scutel is rufous, not white. The collare, except its white lines and a large black spot above, is rufous; all the depressed areas surrounding the 2 scutels are black; and there is a small black spot in the excavation before the middle coxæ. 5. Instead of the base, abdominal joints 6–8 are tinged with yellow. Joint 1 is thrice as long as wide, and thrice as wide at tip as at its extreme base, and its tubercles are pretty large and acute; the capillary line on joint 3 is distinct, that on 4 obsolete; and the ovipositor is rufous. 6. The legs are pale rufous; the 4 front legs with their coxæ and trochanters pale yellow; the hind legs with their tibiæ and tarsi obfuscated. 7. The posterior angle of the radial area is 120°, and the area consequently is less elongated. Length ♀ .27 inch. Front wing ♀ .22 inch. Ovip. .10 inch.

One ♀; ☿ unknown to me. Distinct by its rufous face, &c., from all the other species belonging to this section.

Cryptus? (*Ischnus*, Cress.) albitarsis, Cress.—♂.—In one specimen the white bilobed spot on the disk of the face is confluent with the white orbits; and in both the clypeus is white, except its extreme tip, which is black; and there are very narrow white orbits behind, but not above, the eye. The 1st joint of the flagellum is full thrice as long as wide. In the thorax the parapsidal grooves are deeply impressed, and in one specimen the white line underlying the humeral suture is reduced to a mere basal dot. In one specimen the scutel is entirely white. In the metathorax the lateral areas want their outer sides, the basal area is obsolete, and the central area is pentagonal (not "subquadrate") with its lateral sides indistinct: posterior area indistinctly hexagonal. In the wings the radial area is elongate, its posterior angle being 135°. The areolet is rhomboido-pentagonal, its inner and outer sides subequal and the longest, the two hind sides subequal and each ⅓ shorter, and the anterior side ½ shorter than the outer one. Legs black. The front legs with their coxæ inferiorly, and the whole of their trochanters, knees, tibiæ, and tarsi, white: and the front face of the femora pale rufous. Middle legs the same, except that the 2d trochanter is black and the 1st is vittate above with black, and that the entire base of the femora is black. Hind legs, with sometimes the basal ⅔ of the basal trochanters beneath, and always the tarsus, except the extreme tip and the basal ½–¾ of joint 1 which are dusky, white. Abdomen 8 times as long as wide, the 1st joint 6 times as long as wide, only ⅓–⅙ wider at the tip than at the extreme base, the tubercles placed ⅔ of the way to the tip. Joint 2, 2¼ times as long as wide, and 1¾ times as wide at tip as at base. The rest rapidly shorter and shorter. Length ♂ .43–.45 (.37–.42 Cress.) inch. Front wing ♂ .27–.29 inch.

Two ♂; ♀ unknown to me. The discrepancy in the coloration of the legs, as compared with Mr. Cresson's description, is considerable, and may be attributed partly to variation, partly to alcoholic transcoloration, and partly perhaps to the sacrifice of verity to brevity in the description. It is singular that in every one of twelve species referred to *Ischnus* by Cresson, besides *Ischnus? paratus*, Say, 1828, the ♂♂ only are known; so that it is left as yet uncertain to what genus they really appertain. Mr. Cresson's specimen or specimens of this species, like mine, came from Illinois, and one received by me from him since the above was written agrees in every respect with the above description down to the minutest details in the legs.

[*Ischnus albitarsis*, Cress., is doubtless the ♂ of *Cryptus americanus*, Cress., and varies much in coloration, especially of face and legs, and also in size.—CRESSON.]

Cryptus nigricalceatus, n. sp.—♂.—Differs from the above only as follows:—1. The bilobed spot on the face is confluent with the white orbits, and there are very narrow white orbits behind, but not above, the eye. 2. The white line underlying the humeral suture is reduced to a mere basal dot. 3. There is no "white spot above the anterior coxæ," i.e. a more or less abbreviated white line on the anterior edge of the collare. 4. In the front, as well as in the middle legs, the 2d trochanter is black; in the 4 front legs the terminal ½ of the tarsi is dusky; and in the hind legs the entire tarsus is so. Length ♂ .35 inch. Front wing ♂ .25 inch.

One ♂; ♀ unknown to me. It is only by the two last characters recited above that this insect can be separated from *albitarsis*, as the two first occur sometimes in that species. It may perhaps be a mere variety of that species, but it will require a good series of specimens to prove the fact. As a general rule, the coloration of the legs is pretty constant in this family; but in *Cr. iridescens*, Cress., the hind tarsi vary almost as much in their coloring as do those of *albitarsis* and *nigricalceatus*, with all the intermediate grades.

[This is merely a variety of *albitarsis*.—CRESSON.]

Cryptus [iridescens, Cress.]—♂.—Black. *Head* opaque, very minutely punctate, subpolished on the vertex and clypeus. Orbits very narrow and subobsolete or sometimes obsolete on the face, interrupted opposite the antennæ, broader and almost always distinct to the commencement of the vertex, and elsewhere obsolete, the terminal ½–⅔ of the clypeus almost always, the mandibles except their teeth, and the palpi, all white. Antennæ brown-black with the basal joint bright rufous beneath and the membranous base of the 1st joint of the flagellum often rufous all around, ¾–⅘ as long as the body, rather slender, joint 1 of the flagellum 4–4½ times as long as wide; joint 2 shorter by ¼; the rest slowly shorter and shorter. *Thorax* opaque, closely and very finely punctate, less so on the mesonotum which is subpolished; parapsidal grooves acute but not impressed; the usual glabrous polished spot on the hind edge of the mesothoracic pleura very obvious. Metanotum more coarsely rugoso-punctate, its carinate areas absent, except the cross-carinæ of the lateral areas and a trace of their tips, and a semicircular basal area, the disk of which last is polished and smooth. Tegulæ, a short line under the front wing, a line underlying the humeral suture nearly to its tip, which line is usually resolved into a basal and terminal dot, the latter and sometimes both of which are often obsolete, both scutels, the anterior edge of the collare generally, and an obscurely-defined, horseshoe-shaped spot on the hind part of the metathorax, sometimes reduced to a mere roundish spot on the tip of each lateral area, sometimes entirely obsolete, all white. *Abdomen* rufous, elongate, oval, subpolished, with very minute rather sparse punctures. Joint 1, $3\frac{1}{2}$ times as long as wide, $2\frac{1}{2}$ times as wide at tip as at base, its sides gently concave $\frac{2}{3}$ of the way to the tip, where the small tubercles are placed, thence subparallel and subconvex to the tip. Joint 2 longer by $\frac{1}{3}$ or $\frac{1}{2}$ than wide, and twice as wide at tip as at base; joint 3 square or rather shorter than wide; the rest slowly shorter and shorter. Base and extreme tip of joint 1 generally whitish, and a large, semicircular, dorsal, white spot always on joint 7. Basal $\frac{1}{3}$–$\frac{1}{2}$ of joint 2, sometimes the basal $\frac{1}{4}$ of joint 3, or of 3–5, and the extreme tip of joint 5, and always the whole of 6–8, except rarely the terminal $\frac{2}{3}$ of 6, and always the white spot on 7, all black. Venter pale rufous, tip blackish. *Legs* rufous. The 4 front legs with their coxæ and trochanters white, the coxæ occasionally tinged with rufous. Hind legs with the extreme base of the basal trochanters often blackish, the 2d trochanter often whitish below, and the terminal $\frac{1}{6}$ of the femora black; tibiæ fuscous, their basal $\frac{1}{6}$ whitish; spurs whitish; tarsi pale fuscous, with the extreme base of joint 1 and sometimes of 2 also, the terminal $\frac{1}{4}$–$\frac{1}{2}$ of 2, and the whole of 3 and 4, more or less obviously white or yellowish-white, sometimes entirely fuscous except the extreme base of all the joints. *Wings* subhyaline; veins black; stigma black, its basal $\frac{1}{4}$ yellowish-white. Radial area short, its posterior angle 110° or 120°. Areolet almost regularly pentagonal, its outer side usually rather shorter than the inner side, and the 2d recurrent vein often entering it rather nearer its base than its tip. Length ♂ .17–28 inch. Front wing ♂ .13–21 inch.

Fourteen ♂; ♀ unknown to me. A rather variable species. The variation in the coloring of the clypeus is especially remarkable and unusual. Distinct at once from *atricollaris*, n. sp., *rhomboidalis*, n. sp., *cinctipes*, n. sp., *rufifrons*, n. sp., and *semirufus*, Brullé, by the antennæ not being annulate; and from *Cryptus?* (*Ischnus*) *albitarsis*, Cress., and *Cr. nigricalceatus*, n. sp., by the much less slender abdomen.

To this section belong also *Cr. semirufus*, Brullé (N. Am.), and, if with Brullé we reject the genus *Hoplismenus*, Grav., *H. thoracicus*, ♂, Cress., which differs from all the preceding by having the thorax black, with the scutel and the metathorax rufous.

SECTION 4. *Cresson.—"Scutellum black; abdomen red, or red and black."*

A.—*Antennæ not annulate with white; coxæ and trochanters mostly black.*

Cryptus americanus, Cress.—.♀—The antennæ are $\frac{4}{5}$ as long as the body; the 1st joint of the flagellum (=3d joint of antennæ, *Cress.*) $5\frac{1}{2}$ times as long as wide, the 2d and 3d joints (=4th and 5th of antennæ, *Cress.*) each $\frac{1}{4}$ shorter than the preceding, so that the 3d joint is $\frac{9}{16}$ or rather more than $\frac{1}{2}$ as long as the 2d; the rest gradually shorter and shorter. In the metathorax the lateral areas, except their outer sides as well as their cross-carinæ, are distinct; there is a small subquadrate basal area; a large equilaterally obtrigonate central area separated from the posterior area by a robust cross carinæ; and not only do the tips of the lateral areas terminate in an acute thorn, but the outer tips of their cross-carinæ project in a small, robust tooth. The areolet is pentagonal, its inner and outer sides the longest, its anterior side the shortest. The radial area is elongate, having a posterior angle of 135°; and the 1st recurrent vein is angulated at 135° with a stump of a vein at the angle. Legs black; tips of the 4 front femora, especially the anterior ones, shading into rufous; all 6 tibiæ and tarsi pale fuscous, tinged, especially in the front legs, with rufous. First abdominal joint with its carinæ extending $\frac{3}{4}$ of the way to the tip. Length ♀ .37 (.25-.50 Cress.) inch. Front wing ♀ .30 inch. Ovip. .23 inch.

One ♀; ♂ unknown to me. By some clerical or typographical error the ovipositor in Mr. Cresson's diagnosis is said to be "as long as the body," instead of "as long as the abdomen," as is correctly stated in his description and also on p. 300. Precisely the same error is repeated in the diagnosis of his *Cr. persimilis*. In this species all the tibiæ have an irregular double external row of minute thorns as in several of the following species in *Cr. robustus*, Cress., and in *Phytodietus*, Grav.

Cryptus persimilis, Cress.—♀.—The antennæ are $\frac{2}{3}$ as long as the body, the 1st joint of the flagellum (=3d joint of antennæ, *Cress.*) only $4\frac{1}{2}$ times as long as wide, the following joints proportioned as in *americanus*. The metathorax differs from that of *americanus* in the basal and central areas being subobsolete except the posterior carina of the latter, and in the cross-carinæ of the lateral areas not projecting laterally in a distinct tooth. Areolet as in *americanus*, except that its anterior side is usually no shorter than either one of the two posterior sides. First recurrent vein usually with a stump of a vein at its angle. Abdomen as in *americanus*, except that the basal $\frac{2}{3}$ of joint 1 is either entirely or laterally black. Length ♀ .30-.37 (.33 Cress.) inch. Front wing ♀ .23-26 inch. Ovip. .20 inch.

Three ♀; ♂ unknown to me. Two ♀ are smaller, and yet have as long an ovipositor as the larger ♀, and in both these two the 1st abdominal joint is entirely black on its basal $\frac{2}{3}$ and the 1st recurrent vein has a stump of a vein at its angle, neither of which characters occur in the large ♀.

Cryptus frater, Cress.—♀.—The antennæ are rufous, shading into brown-black on the extreme base and tip, $\frac{4}{5}$ as long as the body; 1st joint of the flagellum 4 times as long as wide, the rest gradually shorter and shorter. The parapsidal grooves of the thorax are distinct and acute but not impressed. The carinæ of the metathorax are obsolete, except the cross-carinæ of the lateral areas, which are continuous with each other, and a trace of their terminal angles. Areolet in a regular pentagon. Radial area very short, its posterior angle about 100°. Length ♀ .20 (27 Cress.) inch. Front wing ♀ .16 inch. Ovip. .03 inch.

One ♀; ♂ unknown to me. The terminal 3 or 4 abdominal joints are in my specimen greatly retracted; otherwise it would measure more in length.

Cryptus? albisoleatus, n. sp.?—♂.—Black. *Head* opaque, closely and very finely punctate, subglabrous and polished on the clypeus and especially on the vertex. Clypeus hunched and transversely oval. Palpi very pale rufo-fuscous. Antennæ $\frac{3}{4}$ as long as the body, very robust, being as stout as the middle tibiæ, brown-black, tinged with rufous beneath at the extreme tip; joints very distinct. Joint 1 of the flagellum twice as long as wide, the rest very slowly shorter and shorter. *Thorax* with fine, close-set punctures, polished above, where the punctures are finer and more sparse, subopaque beneath; scutel flat; parapsidal grooves distinct and impressed on the anterior $\frac{1}{3}$, thereafter suddenly obsolete. Metathorax opaque and rather coarsely rugose; the hind carinæ of the lateral areas distinct and prominent at the angles in a rectangular tooth, their cross-carinæ also indistinctly present; posterior area large and pentagonal; the other areas obsolete. *Abdomen* rufous, oval, $4\frac{1}{2}$ times as long as wide, subpolished, with almost microscopic, rather sparse punctures. First joint thrice as long as wide, thrice as wide at tip as at base, its sides straight and slightly divergent $\frac{2}{3}$ of the way to the tip, where the large rectangular tubercles are placed, thence subconvex and subparallel. Joint 2 wider by $\frac{1}{3}$ than long, and twice as wide behind as before; the rest rapidly shorter and shorter. Joint 3 with a subobsolete, transverse, medial, capillary, dark line; 5–8 obfuscated, and 7 almost entirely covered by a whitish spot. Venter rufous, the tip as well as the penis dusky. *Legs* pale rufous. The basal trochanters in all 6 legs and the 4 hind coxæ black; middle tibiæ faintly, hind tibiæ strongly, obfuscated; 4 hind tarsi white, with the basal $\frac{2}{3}$ of joint 1, and the whole of 5, pale fuscous. *Wings* subhyaline; veins black, stigma dusky. Radial area short, its posterior angle 120°. Areolet in a regular pentagon. Length ♂ .25 inch. Front wing ♂ .18 inch.

One ♂ ; ♀ unknown to me. Very near *Cr. albitarsis*, ♂ Cress., but that species is said to have "rather slender" antennæ, basally "rufous beneath" (not brown-black), and "all the coxæ and trochanters except the apical half of the posterior pair [of trochanters] black"; whereas in *albisoleatus* the 2 anterior coxæ are entirely rufous, the 4 posterior ones entirely black, and all the 6 terminal trochanters are distinctly rufous. The two may possibly be identical; but if so Mr. Cresson has made some poor describing. In any case, if *Ischnus albitarsis*, ♂, Cress., be, as I suppose, a *Cryptus*, the specific name *albitarsis* will be here preoccupied. Distinct from all the preceding by the white tarsi.

[*Cryptus albitarsis*, Cress., and *albisoleatus*,, Walsh, although closely allied, are two very distinct species; the former, which I now consider to be the ♂ of *similis*, Cress., has a longer and more slender antennæ, black anterior coxæ and trochanters, a flat scutellum (which is convex in *albisoleatus*), a differently sculptured metathorax, and the apex of first abdominal segment prominently nodose.—CRESSON.]

Cryptus [limatus, Cress.]—♂.—Differs from *albisoleatus*, ♂, n. sp.? only as follows:—1. The clypeus and vertex are punctate and opaque, and the palpi are white except the last 2 joints which in certain lights are tinged with fuscous. 2. The antennæ are immaculate, a little less robust, joint 1 of the flagellum being almost 2½ times as long as wide. 3. The thorax is subopaque and uniformly sculptured above and below; the parapsidal grooves are distinct, and impressed on the anterior ⅔ (not ⅓); and the central area of the metathorax is quadrate and distinct except that it is confluent behind with the posterior area. 4 The 1st abdominal joint is 4 times as long as wide, and only twice as wide at tip as at base; its sides parallel ¾ of the way to the tip, where the tubercles are located and there is a sudden expansion, thence nearly straight and subparallel or scarcely divergent. Joint 2 as long as wide, and about 2½ times as wide behind as before. A subterminal, capillary, dark line on joint 3, and a medial one on 4. Basal ¼–½ of joint 1 blackish; elsewhere the abdomen and venter are rufous-immaculate. 5. The legs are pale rufous. All the coxæ and trochanters, basal ¼–¾ of the front femora, all but the knees in the middle femora, and the whole of the hind femora, tibiæ, and spurs, black. All 6 tarsi white, the basal ½ of joint 1 in the hind legs, and the whole of joint 5 in all 6 legs, black. 6. The stigma is dull rufous edged with black. Areolet pentagonal, with its inner and outer sides parallel and its 2 hind sides each about ¼ shorter than the other 3 which are subequal. Length ♂ .30 inch. Front wing ♂ .25 inch.

Two ♂ ; ♀ unknown to me. Distinct at once from *Cr. albitarsis*, ♂, Cress., and *albisoleatus*, ♂, n. sp., by the subopaque mesonotum with unabbreviated parapsidal grooves, and by the more or less black femora; and from all the other preceding species belonging to this group by the white tarsi.

Cryptus albicaligatus, n. sp.—♂.—Differs from *albisoleatus*, ♂, n. sp., only as follows:—1. The clypeus and vertex are punctate and opaque, and the palpi are white except the last joint which is fuscous in all lights. 2. The antennæ are 1/5 as long as the body, immaculate and much less robust, joint 3 being thrice (not twice) as long as wide. 3. The thorax is uniformly and rather coarsely punctate; the parapsidal grooves shallow but pretty distinct on the anterior 1/3, and in addition there is a shallow median groove nearly attaining the scutellar fovea. Metanotum very coarsely rugose; the hind angles of the lateral areas turned vertically upwards in a blunt tooth; their cross carinæ distinct and in range with the front carina of the central area, which is obscurely defined, twice as long as wide, constricted in the middle, and confluent with the posterior area. Basal area transverse; posterior area indistinct. 5. The abdomen is elongate-oval, 6½ times as long as wide; the 1st joint 6 times as long as wide, scarcely wider at tip than at base, the spiracle placed 2/3 of the way to the tip, but without any tubercles, so that, except a slight inflation at the extreme tip, and the usual slight dilatation at the extreme base, the joint is linear. Joint 2 longer by ½ than wide, and 2½ times wider at tip than at base; 3 square; the rest slowly shorter and shorter. Basal 1/3 of joint 1 black; the rest of the abdomen, as well as the venter, rufous. 5. The legs are black. In the 4 front legs the knees and tibiæ, except the inside of the tibiæ which is rufous, are white; and in all 6 legs the tarsi are white with joint 5 dusky, and in the hind tarsi the basal 2/5 of joint 1 is black. 6. The wings are tinged with smoky yellow. Radial area long, its posterior angle 135° with its apex not in the least rounded off and abutting on the outer side of the areolet. Areolet pentagonal; its inner and outer sides parallel or scarcely convergent in front; its inner side equal to its anterior side, and the 3 other sides ¼ shorter and subequal. Length ♂ .46 inch. Front wing ♂ about .30 inch.

One ♂; ♀ unknown to me. Distinct from all the other ♂♂ belonging to this section by the elongate, linear 1st abdominal joint, and from all the ♀♀ by its conspicuous white tarsi. Very like *Cryptus* (*Ischnus*) *albitarsis*, ♂, Cress., at first sight, but distinct by its black face, tegulæ, thorax, coxæ, and trochanters.

[Doubtless a mere variety of *albitarsis*.—CRESSON.]

Cryptus picticoxus, n. sp.—♂.—Black. *Head* subopaque, densely and very finely punctate. Orbits, very wide next the mouth, slender above and behind, and interrupted behind as they approach the cheeks, clypeus except its extreme tip and a large quadrate spot immediately above it and almost confluent with the facial orbits, mandibles except their teeth and palpi, all white. Antennæ rather robust, 2/3 as long as the body, brown-black with a white spot on the 1st joint below; 1st joint of flagellum 2¾ times as long as wide; the 2d joint ¼ shorter; the rest very slowly shorter and shorter. *Thorax* opaque, finely and confluently punctured, less so on the mesonotum which is subpolished. Parapsidal grooves acute and impressed on the anterior ⅔, with a subobsolete dorsal stria between them. Metathorax with the lips and the cross-carinæ of its lateral areas distinct: the central area large and pentagonal, with its sides indistinct, and confluent behind with the posterior area; the basal area obsolete. Tegulæ, and a short line under the front wing, white. *Abdomen* rufous with the basal ⅔ of joint 1 black, elongate-oval, about 7 times as long as wide, subpolished and almost microscopically sculptured. Joint 1 rather robust, twice as long as wide, ½ wider at tip than at the extreme base, its sides gently concave ⅔ of the way to the tip where the spiraculiferous tubercles are placed, thence subparallel. Joint 2 longer by ½ than wide, and ¾ wider at tip than at base; 3 scarcely longer than wide; the rest gradually shorter and shorter. Venter rufous; veins black. *Legs* rufous. The 4 front legs with their knees white, and their coxæ and basal trochanters white below and black above; the 2d trochanter in the front legs white below. Hind legs with their coxæ, the whole of their basal trochanters, and the base of their second ones, black; and the tip of the tibiæ and the entire tarsi fuscous. *Wings* subhyaline, tinged with smoky yellow; veins and stigma black; radial area elongate, its posterior angle 135°. Areolet with its inner and outer sides the longest, and its anterior side ⅓ shorter, the 2 posterior sides subequal and of intermediate length. First recurrent vein angulated at 135°, with a stump of a vein at the angle; second recurrent vein distinctly angulated. Length ♂ .36 inch. Front wing ♂ .26 inch.

One ♂; ♀ unknown to me. Might be taken for the ♂ of *persimilis*, Cress., but for the white (not dark) mandibles, palpi and tegulæ, the coloration of which parts is not a sexual character in this family. Moreover, the antennæ are proportionally too stout and the abdomen too slender. The same characters separate it from the other ♀♀ belonging to this group, and from the ♂♂ it is separated at once by the presence of white markings on the head and the absence of them on the tarsi. The ornamentation of the coxæ and trochanters is very like that of *Cr.* (*Ischnus*) *albitarsis*, Cress., which belongs to Section 3, but the abdomen is not near so slender.

B.—*Antennæ not annulate with white. Coxæ and trochanters not marked at all with black.*

Cryptus ultimus, Cress.—♀.—The head is subopaque and very minutely and closely punctate. The 1st joint of the flagellum is 4 times as long as wide, with its membranous base rufous; the 2d joint ¼ shorter; the rest gradually shorter and shorter. The parapsidal grooves of the thorax are acute but not impressed, and the metathoracic areas are all indistinctly present, the central area large and pentagonal, and the tips of the lateral areas acute but not thorn-like. In the areolet the inner and outer sides scarcely converge in front, and the outer side and that next the discoidal cell are shorter by ¼ than the other 3, which are equal. Radial area short, its posterior angle about 120°. First recurrent vein very obtusely angulated. First joint of the abdomen 2¼ times as long as wide, 2½ times as wide at tip as at the extreme base, gradually dilated from near the base to the extreme tip, the spiracles not tuberculiform. Joint 2 as long as wide, and twice as wide behind as before; 3 full twice as wide as long; 4 shorter and entirely black; the rest greatly retracted, but the normal white spot on 7 very plain. Length ♀ .23 (.33 Cress.) Front wing ♀ .18 inch.

One ♀; ♂ unknown to me. Mr. Cresson describes the 1st and 2d joints of the flagellum (= 3d and 4th of antennæ) as subequal; but this can scarcely be so in a *Cryptus*.* His single specimen was from Colorado. But for the retraction of the terminal joints of the abdomen, my specimen would measure more in length.

GENUS BASSUS, Grav.

In this genus the coloration and size appears to be pretty constant, the only variations of any consequence occurring in the lateral spottings of the abdomen and in the size of the facial white spot of ♀. The hooked or clavate spot overlying (not underlying) the humeral suture is very characteristic of *Bassus*, though it occurs also in a few other genera, e.g. *Lampronota* and *Tryphon*. The bullæ A and B are represented in the first Section by two faint semibullæ in the 2d cubital cell, one at its upper corner, and one at the point where the 2d recurrent vein joins it; and, as C and D are confluent, there are in the first Section two complete bullæ only, CD and E. In the second Section A is absent, B distinct, and C and D confluent as in the first Section; and here there are consequently three bullæ, B, CD, and E. In both Sections E is remarkable for being located very close to the angle of the 1st recurrent vein.

SECTION 1.—Areolet obsolete.

Bassus [**scutellaris**, Cress., Trans. Am. Ent. Soc. ii. p. 112].—♀.—Black. *Head* subopaque, finely and rather densely punctured, subglabrous and polished on the vertex and clypeus. Orbits from the vertex to the clypeus, a roundish spot of very variable size on the middle of the face, and

* The first and second joints of the flagellum (=third and fourth of antennæ) are, I find, equal or subequal in length in nearly all the species of *Cryptus* known to me; therefore Mr. Walsh could not have really meant what he has written.—CRESSON.

the clypeus, mandibles except their teeth, and palpi, all white. Clypeus subtruncate at tip, its anterior edge reflexed and emarginate in the middle so as to appear bilobate. Antennæ ⅘ as long as the body, brown-black, beneath dull rufous except the 1st joint; 1st joint of flagellum thrice as long as wide. *Thorax* finely and rather sparsely punctate and polished. The tegulæ, a short line beneath the front wing, a spot before it, and a short subclavate line adjoining the humeral suture above, all three of them almost contiguous, a large subquadrangular spot on the scutel and a transverse line behind it, all white. Metathorax finely rugose with the carinæ well defined, the basal area absent, the central area quadrate and confluent with the posterior area and the cross-carinæ of the lateral areas absent. Meso- and meta-sternum pale rufous. First joint of the *abdomen* rugose, with two very distinct longitudinal carinæ obsolete towards the tip, and a transverse white line on the middle ⅓ of its terminal edge, the outer ⅙ of that edge elevated into a glabrous, highly polished carinal Joints 2–4 rugoso-punctate, each gradually less so, 1–3 with a transverse stria behind the middle, 4 with one before the middle, all filled with short, parallel, longitudinal rugæ which are coarser on joint 1; the remaining joints more and more glabrous and polished; 2–7 each with a very narrow terminal whitish or pale rufous line. Venter blackish, irregularly blotched with white. *Legs* pale rufous, the anterior coxæ and trochanters white; the anterior surface of the 4 front legs, especially at the knees, whitish; the extreme tip of the hind femora and the whole of the hind tarsi brown-black; hind tibiæ with the basal ⅕ and termina. ⅖ black, the intervening ⅖ white. *Wings* hyaline; veins black; radius pale rufous; stigma black but basally whitish, and twice as long as wide.

♂ Differs from ♀ in the entire face and the basal joint of the antennæ below being white, and in the tips of abdominal joints 2 and 3 being sometimes marked laterally with a distinct, transverse, white spot. Length ♂ 19–.22 inch; ♀ .21–.27 inch. Front wing ♂ .22 inch; ♀ .22–.25 inch.

Two ♂, three ♀. Comes very near to the *B. maculifrons*. Cress., the ♀ only of which is described; but ♀ differs in the metathoracic carinæ being very distinct, instead of absent, in the hind tibiæ being annulate with white, and in the abdomen not being laterally spotted. From *B. orbitalis*, Cress. (♀ only described) ♀ differs in having a white spot on the face, in having no white spot on the pleura behind the anterior coxæ, in abdominal joint 2 not being crenulate basally, and in abdominal joints 2–4, instead of 1–3, being transversely striate. From both species it differs in the antennæ being longer and rufous beneath, and in the pectus being rufous, not black. The three species referred to *Bassus* by Say, evidently from the long ovipositor, do not belong here, and are probably *Braconidæ*.

Bassus tripicticrus, n. sp.—♂♀—Differ from the ♂♀ of the above only as follows:—1. The meso- and meta-sternum are black, not rufous. 2.

The abdomen is dorsally black with the extreme tip of joint 1, and the whole of joints 2 and 3 rufous, and ventrally black with joints 1-3 obscure rufous. 3. The hind femora are immaculate. 4. The hind tibiæ have their basal 1/5 black, their next 2/5 white, their next 1/5 black gradually shading into the terminal 1/5 which is bright rufous, thus presenting three distinct colors, whence the specific name. The ♀ differs also in having no facial white spot from the ♀ of [*scutellaris*, Cress.] Length ♂ .20 inch; ♀21-.27 inch. Length wing ♂ .19 inch; ♀ .19-25 inch.

One ♂, four ♀. Separated at once from Mr. Cresson's two species, and from [*scutellaris*, Cress.,] by the broad red band on the abdomen and by the remarkable coloration of the hind tibiæ.

[This is probably only a variety of *sycophanta*.—CRESSON.]

Bassus sycophanta, Walsh, [Trans. Am. Ent. Soc. ii. p. 112].—♀.—Differs from [*scutellaris*, Cress.] ♀ only as follows:— 1. The white spot is not located on the disk of the face, but on its tip so as to connect with the clypeus; and the orbits widen as they approach the clypeus so as to be more or less confluent with the white spot. 2. The antennæ are brown-black immaculate. 3. Besides the described white markings of the thorax, an abbreviated line on the front submargin of the mesothoracic pleura, a line on the front submargin of the lower surface of the mesosternum, which is prolonged backwards at right angles half way to the metasternum, and a short line in the suture under the hind wing, all white. And the posterior declivity of the metathorax is generally tinged with rufous, the rest of the thorax being black. 4. The carinæ of the 1st joint of the abdomen are less distinct, and fade out half way to the tip. Joints 1-3, and sometimes the base of 4, are rufous immaculate, the rest of the abdomen black. Venter basally dull rufous, terminally blackish. 5. The hind femora are immaculate, and the hind tibiæ have their basal 1/5 black, their next 2/5 white, their next 1/5 black, gradually shading into the last 1/5 which is bright rufous. Length ♀ .21-25 inch. Front wing ♀ .19-22 inch.

Three ♀; the ♂, which is unknown to me, will no doubt have a white face and the first joint of the antennæ white below. Remarkably like *tripicticrus* ♀, n. sp., but differs by the white spot on the face, by the white lines on the sternum, and by the 1st joint of the abdomen being rufous immaculate and having its carinæ less strongly developed. Any one of these characters might, if it stood alone, be attributed to variation; but as the three are persistent throughout, they manifestly are of specific value. The hind legs are exactly like those of *tripicticrus*, and the species is separated from others by the same characters as *tripicticrus*.

Bassus ruficrus, n. sp.—♂.—Face with a large oblong spot in the middle which extends to the clypeus, and the clypeus, mandibles, and palpi, all yellowish-white. Clypeus semicircularly emarginate at tip. Antennæ 4/5 as long as the body, brown-black, scarcely paler beneath, the 1st joint stained with yellow beneath. *Thorax* subglabrous, polished, with the tegulæ, a short line below the front wing, a short line tapered to a point in front adjoining the humeral suture below, and a large elongate spot, clavate and hooked backwards at tip, adjoining it above, all three spots contiguous, and an elongate spot in front of the middle coxa, pale yellow. Metathorax finely rugose with the carinæ subobsolete. *Abdomen* with the whole of the 1st and the basal half of the 2d joint finely rugose or almost glabrous, the normal carinæ of joint 1 only indicated by a slight but broad depression fading out before it attains the tip, which tip on each side is furnished with a polished, transverse, short carina or tubercle. The rest of the abdomen is subglabrous and polished. No transverse carinæ except on joint 3, and even there it is indistinct. The terminal $\frac{1}{3}$ of joint 2 and the whole of joint 3 rufous. Venter basally rufous, towards the tip blackish. *Legs* pale rufous, the coxæ and trochanters of all 6 yellowish-white. *Wings* hyaline, veins and stigma black, the stigma but slightly paler at base and about twice as long as wide. Length ♂ .18 inch. Wing ♂ .19 inch.

One ♂; ♀ unknown to me. Sufficiently distinct from all but the preceding two species by the red-banded abdomen, and from those by the immaculate hind tibiæ and scutel, and the nearly smooth metathorax and 1st abdominal joint.

SECTION 2.—Areolet present.

Bassus semifasciatus, n. sp.—♂.—Black. *Head* subopaque, with very minute, close-set, shallow punctures, more sparse on the vertex. Clypeus describing a circular arc, posteriorly of 90° with the foveæ, as usual, placed in the suture, $\frac{1}{4}$ of the way from the outer angle, anteriorly of 30° with the middle $\frac{1}{3}$ of the arc reflexed. Face except the terminal foveæ, broad orbits almost reaching the vertex, clypeus, mandibles except their teeth, and palpi, all yellowish-white. Antennæ $\frac{4}{5}$ as long as the body, brown-black, the flagellum tinged with rufous beneath, and its first joint with white; the scape yellowish, white beneath. First joint of flagellum 4 times as long as wide. *Thorax* polished, with very minute, but not close-set, shallow punctures. Metathorax more coarsely rugoso-punctate, subopaque, and with the lateral carinate areas distinct, but without any cross-carinæ. Tegulæ, a line under the front wing, a quadrate spot before the tegula under the humeral suture, a broad line clavate and slightly hooked backwards at tip overlying the humeral suture nearly to its tip, all three of these spots contiguous, the scutel and a short transverse line behind it, the entire prosternum, the anterior margin of the mesosternum nearly up to the wing, an unabbreviated vitta near the bottom of its pleura and another which is abbreviated behind still lower down, and the anterior margin of the metasternum up to the wing, all white. *Abdomen* narrower and less flattened than usual, subopaque on joints 1–4, with confluent fine punctures obsolete towards the tip, and the tips of the joints which are subpolished. Joint 1 longer by $\frac{1}{2}$ than wide, with a lateral, spiraculiferous tubercle placed $\frac{1}{3}$ of the way to its tip, and very large and prominent; the 2 usual carinæ reaching $\frac{2}{3}$ of the way to its tip. Joint 2 with a round fovea in its anterior angle. Joints 2 and 3, with a subobsolete transverse, medial stria widely interrupted on the dorsum. Joint 1 with a narrow, terminal white line; 2–6 with a white fascia on their terminal $\frac{1}{4}$, very narrowly interrupted above on 2, but more and more widely so in each successive joint, till in 6 it is reduced to a mere lateral white dot. Venter yellowish-white. Four front *legs* very pale rufous, hind legs pale rufous; all the coxæ and trochanters white; tips of the 4 front tarsi, and the whole of the hind tarsi fuscous. *Wings* hyaline; veins black, radius whitish; stigma black, whitish at base, twice as long as wide. Bullæ indistinct, the wings being in bad order. Length ♂ .19 inch. Front wing ♂ .16 inch.

One ♂; ♀ unknown to me. Very near *maculifrons*, Cress. (♀ only described), and may possibly be the other sex of that species. Differs by its white face and orbits, and by the legs being more marked with white, which are common sexual characters in ♂ *Ichneumonidæ;* and also in the pale markings of the sternum and abdomen, which may possibly be also sexual characters. The clypeus, however, is not "profoundly impressed on each side," unless by this phrase is meant the usual foveæ, which are located, as in all *Ichneumonidæ*, in the clypeal suture; neither is its "basal margin prominent," nor is the metathorax "without elevated lines."

Bassus bicapillaris, n. sp.—♂.—Black. *Head* with the clypeus piceo-rufous and truncate at tip, its anterior edge reflexed and in the middle slightly depressed and emarginate. Mandibles and palpi white. Antennæ $\frac{4}{5}$ as long as the body. *Thorax* very finely and regularly punctate so as to appear subglabrous and polished. Tegulæ, a short line beneath the front wing, a roundish spot before it, and a subclavate line adjoining the humeral suture above, all three of them nearly contiguous, white. Scutel rufous. A capillary white line extending in a semicircle from the front of the base of one hind wing behind the scutel to the front of the base of the other one, and a similar line parallel with the first and extending from the back of the base of one hind wing to the back of the base of the other one. *Abdomen* with joints 1–3 rugoso-punctate, each gradually less so, the remaining joints gradually almost glabrous and polished. No transverse striæ. Joint 1 with a wide, flattish, subglabrous, longitudinal carina bifurcating in front, and a narrow, acute, sublateral one terminating in a small, glabrous tubercle at each hind angle. Joint 2 with similar carinæ, fading away at the middle. Venter blackish. *Legs* pale rufous. Hind trochanters white. Terminal $\frac{1}{4}$ of hind femora, and whole of hind tarsi, black. Hind tibiæ black, with their basal $\frac{1}{3}$ white. *Wings* hyaline; veins black, paler on the postcosta; the radius whitish; stigma black, 3 times as long as wide, and with its basal $\frac{1}{3}$ whitish. Areolet peduncled, obliquely oblong and twice as long as wide. Length ♂ .21 inch. Front wing ♂ .20 inch.

One ♂ ; ♀ unknown to me. Sufficiently distinct from all described N. A. *Bassus* by the areolet, and by the capillary white lines on the metathorax, whence the specific name.

CATOCENTRUS, new genus.

Head transverse, scarcely wider than the thorax. Face with a large, transversely oval tubercle on its disk, declivous above, gradually sloped elsewhere, and projecting forwards beyond the line of the eyes about $\frac{2}{3}$ their shorter diameter. Cheeks not at all inflated. Antennæ with the 1st joint of the scapus as large as usual, truncate a little obliquely from above downwards, the 2d joint not larger than usual; the 1st joint of the flagellum rather long, the following joints all longer than wide except towards the tip. *Thorax* much prolonged beyond the wings (as in *Metopius*) so that the front wings are set on a little behind the middle; parapsidal grooves usually obsolete. Scutel rounded, with a very deep and wide transverse stria at its base. *Abdomen* sessile, curved downwards, subclavate, with joints 2–6 constricted at base (as in *Metopius*), and only joints 1–6 visible from above or behind, 7 and 8 being telescopically retracted (as in *Metopius*), and only seen from below. Joint 1 short and but slightly longer than wide, and very slightly wider behind than before. Ovipositor and its sheaths very short, generally exserted and directed perpendicularly downwards. Venter as much excavated as in *Pimpla*, so that the ventral and dorsal integuments are contiguous. *Legs* short, rather robust; hind tarsi much shorter than their tibiæ; front and middle tarsi a trifle longer than their tibiæ. Spurs normal. Tarsal claws unarmed, short and robust, shorter than the pulvillus. *Wings* pretty long, with a moderately long radial area, and usually with a small, rhomboido-triangular areolet, the 2d recurrent vein usually more or less triangulated; the 1st recurrent vein not angulated, but curved near its base. Bullæ 5, A indistinct and sometimes subobsolete, placed on the anterior angle of the areolet; B normal; C and D separated by the salient angle of the 2d recurrent vein; and E rather closer to the curve of its vein than to the areolet.

Closely allied to *Metopius* both in coloration and structure, but differs by the facial swelling not being buckler-shaped nor acutely declivous all round, by the rounded scutel, by the small areolet, by the 2d recurrent vein being more or less biangulated instead of perfectly straight, and by bullæ C and D being distinctly separated. Allied to *Exochus*, Grav., *Polyrhabdus*, n. g., and *Orthocentrus*, Grav., by the facial swelling; but differs by the cheeks not being at all inflated, by the front wings being set on behind the middle of the thorax, by the constricted abdomen, and by many other characters. Gravenhorst, in his description of the genus *Orthocentrus*, has said that the ovipositor is erect (*erectus*), by which, of course, he means that it is directed upwards, or exactly the reverse to that of *Catocentrus*. Brullé has made the ridiculous mistake of translating "erectus" by the French word "droite" (straight), thus confounding "erectus" and "rectus" (*Hym.* p. 115). The position of the ovipositor, whether erect or oblique, or pointed downwards, is, however, sufficiently indefinite and variable character by which to define a genus; for I find that in different specimens of one and the same species (e.g. *Cylloceria* [*occidentalis*, Cress.]) the ovipositor is sometimes directed straight upwards, owing to the retraction of the terminal dorsal joints, sometimes directed obliquely backwards in the usual manner.

Catocenthrus philanthoides, Walsh [Trans. Am. Ent. Soc. ii. p. 110]. —♂♀.—Black. *Head* with the vertex subglabrous and polished; front and face closely and finely punctate; the face bearing on its disk two large, roundish, subcontiguous, yellow spots, transversely arranged. Clypeus truncate and rather coarsely rugose. Mandibles and palpi piceous. Antennæ $\frac{2}{3}$ as long as the body, brown-black, the flagellum beneath dull rufous, and the 1st joint of the scapus laterally and beneath yellow. *Thorax* subpolished, finely and closely punctate, the punctures finer and more sparse beneath. Metathorax with the two carinate lateral areas distinct and divided each by cross-carinæ. The other areas obsolete. Under the tip of each humeral suture a triangular yellow spot. Scutel with a large, subquadrangular, yellow spot, rather wider in front than behind, and with its four angles, especially the front ones, considerably prolonged; a transverse yellow line behind this spot. *Abdomen* basally truncate; the angles acute and a little prolonged; joint 1 oblong and flattened, ♂ $\frac{1}{4}$ and ♀ $\frac{1}{6}$ longer than wide, ♂ $\frac{1}{6}$ and ♀ $\frac{1}{4}$ wider behind than before, laterally a little concave, the concavity greatest $\frac{1}{3}$ of the way to the tip; the usual two carinæ well developed on it but fading out towards its hind edge; the joint itself glabrous and polished between these carinæ, elsewhere slightly rugoso-punctate and polished; its terminal $\frac{1}{3}$ yellow. Joints 2–5 finely and densely punctured, slightly shining, the terminal $\frac{1}{3}$ of each yellow. The remaining joints, so far as visible, less punctured. Venter stained with yellow. *Legs* with the 6 trochanters ♂ yellow, ♀ stained with yellow; ♂♀ with the 4 front tibiæ, the 4 front tarsi except their extreme tips, the basal $\frac{2}{3}$ of the hind tibiæ and the tips of all 6 femora, all yellow. *Wings* hyaline, with a brown-black cloud along the costa fading out half way across the wing and darkest towards the tip; veins black; stigma dark rufous, subhyaline only at its extreme base, and thrice as long as wide. Areolet almost rhomboido-triangular, the 2d recurrent vein entering it $\frac{3}{4}$ of the way to its tip. Length ♂♀ .30 inch. Wing ♂♀ .27 inch.

One ♂, two ♀, taken on umbelliferous flowers in August. May be readily mistaken for a small *Philanthus* or *Cerceris*.

GENUS METOPIUS, Grav. (=*Peltastes*, Illig.)

But three bullæ exist in this genus, B, CD, & E, and they are all smaller than usual, though very distinct. Their location is normal. Most of the yellow markings seem to be here very variable in their extent, and some of them to be occasionally obsolete. In the European *M. necatorius*, for example, we are told that the yellow band at the tip of the 1st abdominal joint sometimes almost entirely covers that joint, and in Brullé's description of his *M. pinatorius* that the 7th abdominal joint has sometimes no terminal yellow border. (Brullé *Hym.* p. 120.)

Metopius (*peltastes*) **pollinctorius,** Say (=*M. pinatorius*, Brullé,=*M. cordiger*, Brullé).

From Brullé's slovenly descriptions of his *M. pinatorius* and *M. cordiger*, and of their distinctive characters, I have compiled with some labor the following Table, omitting those points which he quotes as distinctive characters, but in which, according to his own descriptions, the two insects are not distinguishable. For example, he first says that the two yellow spots on the metathorax of *pinatorius* "are *sometimes* absent," and then he adds, only five lines afterwards, that it "has no yellow spots there at all"!! And, after such a blunder as this, he quotes the presence of two large yellow spots on the metathorax as one of the characters which separate *cordiger* from *pinatorius!!!* For the sake of comparison I have also included in the same Table Say's *M. pollinctorius*, *1st.* from his description, and *2d.* from a single ♀ specimen in my Cabinet.

	M. cordiger, *Br.* ♂.	*M. pinatorius*, *Br.* ♂.	*M. pollinctorius*, *Say* ♂ ♀.	*My* ♀.
Length...........	.70 inch.	.67 inch.	♂ .43, ♀ .70 inch.	.70 inch.
Central area of metathorax.....	Obsolete?	Cordiform.	* * *	Cordiform.
Yellow spots on each metathoracic flank........	One, linear.	One? larger?	♂ One, ♀ none.	None.
2d abd. joint at tip	A narrow yellow band medially interrupted.	Two yellow dots	Hind angles obscurely yellow.	Black.
6th abd. joint.....	All black.	Tipped with yellow.	All black.	All black.
4 anterior femora.	Black behind and below.	Partly black behind.	Black behind.	All black except at extreme base.
2 anterior tibiæ...	do. do. do.	Black behind?	Yellow immaculate.	Black behind & on the terminal ½ in front also.
2 middle tibiæ..	do. do. do.	do. do. do?	do. do. do.	All black.

Hence it is, I think, sufficiently evident that the three supposed species are identical, inasmuch as intermediate grades occur in almost all the distinctive characters, and those characters are such as often vary in allied genera. We find, for instance, very similar variations in *Ichneumon Comes*, Cress., which sometimes has the metathorax all black, sometimes almost entirely yellow, and the 2d and 3d abdominal joints sometimes almost entirely black, sometimes almost entirely yellow, with all the possible gradations from one form to another. Brullé says himself, that in Bosc's original collection, from which he derived all his specimens, his two supposed species were labelled as identical. Of course, Say's name (1836) takes precedence of Brullé's (1846). As the head of Say's unique specimen of ♀ *pollinctorius* was lost, it may be well to add here that the ♀ agrees with his description of the ♂ head. *Rufipes*, Cress., and *pulchellus*, Cress., are sufficiently distinguished from *pollinctorius*, Say, by numerous characters.

A ♂ specimen of *necatorius* (England) differs from *pollinctorius* ♂, as described by Say, in having the entire facial shield yellow, not merely its "lateral and basal margins" and in the entire antenna being luteous beneath, instead of the basal joint only being "whitish." The hind tibiæ are also "yellow," as noticed by Say, instead of black. The distinction that Brullé lays down, viz. that the hind femora of *necatorius* are "black below" and those of his *pinatorius* "black at tip," does not hold good with this ♂, as the hind femora are as Say describes those of his *pollinctorius*, "yellow at base" and black at tip. As in Say's *pollinctorius* ♂♀ (but not in my ♀), the 2d abdominal joint has a lateral yellow spot at tip; but the entire metathorax is black immaculate. As compared with my ♀, the abdomen is more strongly sculptured, so as to be opaque instead of subpolished.

GENUS EXOCHUS, Gravenhorst.

Gravenhorst has placed the group to which this genus appertains between the groups *Ichneumon* and *Trogus*, which, as Brullé has well observed (p. 298), are too closely allied to be thus separated, and with which it seems to have no other analogy than the possession of a very short ovipositor. Its abdomen indeed is as sessile as that of any *Pimpla* (though there is a very considerable difference in different species in the básal breadth of its first joint), and it is scarcely correct to call it, as Gravenhorst does, subsessile. The protuberant face shows its connection with *Metopius*, and in fact most of the Pimploid genera have a more or less prominent tubercle on the face, which in some species, e.g. *Glypta tuberculifrons*, n. sp., is very prominent. My species show a considerable difference in the comparative length and breadth of the first joint of the flagellum, and consequently in that of the succeeding joints also, the first joint being in *lævis* ♀ and *albiceps* ♂ only twice as long as wide; in *albifrons* ♀, *annulicrus* ♂, and *atriceps* ♂, 2½ times as long as wide; and in *albifrons* ♂ 3½ times as long as wide. There is a similar difference in the incrassation of the hind femora, which in *lævis* ♀ are only twice as long as wide, in *atriceps* ♂ 2¼ times, and in the other three species 2½ times as long as wide. In this genus there are but three bullæ, A, CD, and E; A indistinct and sometimes obsolete on the forward end of the areolar cross-vein, CD located well forwards on its vein, and E rather nearer to the angle than to the tip of its vein. Judging from the single species of which I possess many specimens, the size and coloration are both pretty constant.

SECTION 2, *Cresson*.—Areolet obsolete.

Exochus lævis, Cress.—♀.—*Head* opaque, with confluent, rather fine punctures and pubescence on the face, the punctures finer and more sparse on the subpolished vertex. Face, when viewed in profile, projecting beyond the eyes by a distance equal to their shorter diameter. Clypeus glabrous and polished. Mandibles and the upper edge of the face rufous. Palpi yellowish-white. Antennæ ⅗ as long as the body, brown-black, with the flagellum very robust except at the tip and at the extreme base more or less tinged with rufous beneath, their tips a little convolute, the 1st joint of the flagellum twice as long as wide, all the following joints shorter than wide. *Thorax* subpolished, with fine, rather close-set punctures, more sparse on the metathoracic pleura. Metathorax with 4 equidistant longitudinal carinæ, which all attain the lunate area of the posterior declivity, the 2 outer ones medially connected with each other by a cross carina, and the two middle ones forming a central area scarcely closed at tip and twice as long as wide, which, as well as the lower part of the metathoracic pleura, is glabrous and highly polished. Tegulæ yellowish-white. *Abdomen* as long as the head and thorax together, polished, with very fine, moderately dense punctures. Joint 1 longer by ⅓ than wide, and nearly thrice as wide behind as before; its 2 carinæ extending more or less distinctly ⅓ of the way to the tip, the space between them glabrous but not excavated except sometimes slightly towards their tip. Ovipositor rufous, seldom exserted. *Legs* bright rufous, immaculate. *Wings* hyaline; veins and stigma black. Areolar cross-vein full as long as usual. Length ♀ .20–25 inch. Front wing ♀ .16–18 inch.

Six ♀, two with the ovipositor exserted; ♂ unknown. Judging from analogy, I should anticipate that the entire face of ♂ would be rufous. Differs from Mr. Cresson's description in the palpi being whitish (not "piceous") in the rufous band on the face, in the antennæ being ⅗ (not ¾) as long as the body, in the 1st abdominal joint not being "canaliculate," and in the legs being bright rufous (not "reddish-brown"). A specimen received from Mr. Cresson agrees in all these points with mine, and seems to me to be a ♀; and not a ♂, as supposed by its describer.

Exochus albifrons, [Walsh. Trans. Am. Ent. Soc. ii. p. 114].—♂♀.—Differ from the preceding only as follows:—1. The face projects beyond the eyes scarcely ⅔ of their shorter diameter, and the clypeus is punctured like the face. 2. The face, clypeus and mandibles except their teeth, and in ♂ a small triangular spot on the vertex adjoining each eye and a very narrow orbit extending just beyond the antennæ, are all yellowish-white. 3. In ♂ the 1st joint of the scapus is yellowish-white beneath; and the 1st joint of the flagellum is in ♂ 3½, in ♀ 2½ times as long as wide, the following joints about ½ longer than wide, and the tips ♂♀ are not convolute. 4. The 2 middle carinæ of the metathorax are medially connected by a cross-vein so as to form a complete basal and central area, which last is divided from the posterior area by a distinct carina. 5. The tegulæ, a long capillary line under the front wing, a broad line clavate at base and underlying the humeral suture from the tegula nearly to the tip, the whole scutel ♂ or a wide line at its tip and sometimes also a narrower one at its sides in ♀, and ♂♀ a transverse line behind the scutel, are all white. In ♂ the entire mesosternum and its pleura, as well as that of the metasternum, nearly up to the wing, in ♀ only a spot above the middle coxa, a patch above the hind coxa, and more or less of the lower face of the mesosternum, are all rufous. 6. The abdomen is in ♂ ¼, in ♀ ½ longer than the head and thorax together. Joint 1 is only ⅓ wider behind than before, and its 2 carinæ in ♂, and sometimes in ♀, only extend half way to the tip. 7. The legs are rufous, but the 4 front tibiæ are internally whitish, and the 4 front tarsi entirely so. In the hind legs the femora are lightly tipped with black, the knees whitish, the terminal ¼–⅙ of the tibiæ black, and the tarsi white with the extreme tips of the joints black. 8. The wings are slightly tinged with dusky. Length ♂ .27; ♂ .30–.31 inch. Front wing ♂ .23; ♀ .25 inch.

One ♂, two ♀. Distinct from *pleuralis* ♂, Cress., *dorsalis* ♂, Cress., and *pallipes* ♂, Cress., by their "broad white orbits" being reduced to a spot on the vertex, and by other characters.

Exochus annulicrus, n. sp.—♂.—Differs from *lævis* ♀ only as follows: 1. The face projects beyond the eyes scarcely ⅔ of their shorter diameter, and the clypeus is punctured like the face. 2. The face, clypeus, mandibles except their teeth, a small triangular spot on the vertex next the eye, and a very narrow orbit reaching just beyond the antennæ, are all yellowish-white. 3. The first joint of the scapus is yellowish beneath; joint 1 of the flagellum is 2½ times as long as wide, the following joints about ½ longer than wide, and the tips are not convolute. 4. The carinate areas of the metathorax are all complete as in *albifrons*. 5. The tegulæ, a short capillary line under the front wing, a large triangular spot adjoining the tegula in front, a transverse line at the tip of the scutel and another behind it, the entire lower face of the mesosternum, and a large spot before each anterior coxa, are all yellowish-white. No rufous markings. 6. The abdomen is ¼ longer than the head and thorax together. Joint 1 is only ½ wider behind than before, and its 2 carinæ reach ¾ of the way to its tip. 7. The legs are rufous, but in the 4 front legs the coxa, both trochanters, the knees, the inner face of the tibiæ, and the entire tarsi, are whitish. In the hind legs, the lower face of the coxa and both trochanters are whitish, the first ⅕ of the tibiæ and also their extreme tips are black and the second ⅕ whitish; and the tarsi are whitish with the extreme tips of the joints black. Length ♂ .23 inch. Front wing ♂ .18 inch.

One ♂; ♀ unknown to me. Distinct from *albifrons* ♂ by the whitish sternum, coxæ and trochanters, the whitish annulus on the hind tibiæ, and the black hind knees; and from *pleuralis*, Cress., *dorsalis*, Cress., and *pallipes*, Cress., by its having no "broad white orbits." I am not sure of the sex of the above, but infer it to be ♂ from the spot on the vertex being similar to that of ♂ (not ♀) *albifrons*.

Exochus atriceps, n. sp.—♂.—Pale rufous. *Head* black, opaque, with confluently fine, shallow punctures, obsolete on the vertex which is polished and subobsolete on the clypeus. Face extending beyond the line of the eyes by $\frac{4}{5}$ of their shorter diameter. Face, orbits reaching to the occiput where they are dilated into a triangular spot, clypeus, mandibles except their tips, palpi and cheeks half way up the eye, all yellowish white. Antennæ brown-black, with joint 1 whitish beneath, $\frac{3}{5}$ as long as the body, 1st joint of flagellum $2\frac{1}{2}$ times as long as wide, 2d and following joints about $1\frac{1}{2}$ times as long as wide. *Thorax* subpolished, with distinct, rather close, shallow, fine punctures, much less distinct and close on the pleura and sternum. Metathorax without a trace of any carinæ. Tegulæ, a broad line underlying the humeral suture nearly to its tip, and the lower face of the mesosternum, all whitish. The lateral and anterior margin of the mesonotum, and the region surrounding the two scutels, black. *Abdomen* $\frac{1}{4}$ longer than the head and thorax together, subpolished, with rather close, fine, shallow punctures, obsolete on the tips of the joints. Joint 1 squarely truncate at base with the angles acute, $\frac{1}{3}$ longer than wide, $\frac{1}{3}$ wider behind than before, its 2 carinæ only reaching $\frac{1}{3}$ of the way to the tip; its anterior angles, and the lateral carina nearly to its tip, black. Joints 7 and 8 black. Four front legs whitish, with the 4 femora (except the knees) and the outer face of the middle tibiæ, pale rufous. Hind legs pale rufous, with the tips of the coxæ, and the entire trochanters, spurs and tarsi, whitish; extreme tips of the femora, of the tibiæ and of the tarsal joints, obfuscated. *Wings* subhyaline; veins and stigma black. Length ♂ .24 inch. Front wing ♂ .18 inch.

One ♂; ♀ unknown to me. Distinct by its rufous abdomen, etc., from any of Mr. Cresson's species.

Exochus albiceps, n. sp.—♂.—Differs from the above only as follows: 1. The head is white, except a black spot just enclosing the ocelli and a large lunate black spot on the occiput, medially confluent with the other one by a short space. Face, except the orbits, tinged with rufous. 2. The 1st joint of the flagellum is only twice as long as wide, the 2d only $\frac{1}{4}$ longer than wide, and the following joints square. 3. The thorax is glabrous and polished, and the carinæ on the metathorax are all distinct as in *albifrons*. The white markings are rufescent and less distinct, and the only black markings are a short line inside the origin of the front wing, an indistinct vitta on the disk of the lateral lobe of the mesonotum, and a large spot at the tip of its middle lobe. 4. The first joint of the abdomen is immaculate, $\frac{1}{2}$ longer than wide, and twice as wide behind as before, its 2 carinæ reaching half way to the tip. An obtrigonate, dorsal spot at the tip of joint 5, and the whole of 6–8, black. 5. The legs are all dull luteous, with an abbreviated, exterior vitta on each femur, and an unabbreviated one on each tibia. Length ♂ .18 inch. Front wing ♂ .15 inch.

One ♂; ♀ unknown to me. Distinct from all Mr. Cresson's species by its rufous abdomen, etc.

EXOCHISCUS, new genus.

Head with the face and cheeks prominent (as in *Exochus*). Antennæ short and robust, subgeniculate; the 1st joint very long, scarcely incrassated, cylindrical, and truncate a little obliquely from above downwards, the rest all short; joint 2 not much shorter than the 1st joint of the flagellum. *Thorax* with the parapsidal grooves obsolete. Scutel triangular, flattish, elevated. Metathorax with the carinate areas mostly developed. *Abdomen* sessile, elongate suboblong, compressed at tip; joint 1 unusually long, its sides but slightly converging in front. Joints 1 and 2 strongly sculptured and opaque; the rest glabrous and polished. Venter excavated. Ovipositor ——? *Legs* robust and short; coxæ and femora incrassated, especially in the hind legs. Spurs normal. Tarsal claws simple, and, as well as the pulvillus, long and slender. *Wings* moderate. Radial area and stigma very short. Areolet large, pentagonal. Both recurrent veins but slightly curved. Veins at the tip of the wing subobsolete, except those of the radial area. Bullæ indistinct but apparently 4, A, B, CD, and E; A and B on the outer side of the areolet (as in *Orthocentrus*, Grav.), C and D confluent or separated only by an indistinct dot, and E rather nearer to the angle of its vein than to the areolet.

Differs from *Exochus*, Grav., by its large pentagonal areolet, by its long tarsal claws and pulvillus, and the great length and coarse sculpture of its first two abdominal joints; from *Periope*, Haliday, by its sessile abdomen, by its spurs 1, 2, 2 (not 1, 2, 1), by its simple claws, and by its large pentagonal areolet; from *Orthocentrus*, Grav., it is separated at once by its simple claws; and from *Polyrhabdus*, n. g., by its areolet not being obsolete. In the compressed tip of the abdomen it resembles *Periope*, Hal.

Exochiscus pusillus, n. sp.—♂?—Black. Head subopaque, with minute, rather sparse punctures; vertex polished. Face projecting beyond the eyes by a space equal to their shorter diameter. Face brown; lower part of the face, clypeus, cheeks, mandibles except their teeth, and palpi, all brownish-yellow. Antennæ yellowish-brown, very robust, a little convolute at tip, half as long as the body. Joint 1, 2½ times as long as wide, scarcely more robust than the flagellum; joint 2 square; 1st joint of the flagellum longer by ½ than wide; the rest slowly shorter and shorter. *Thorax* subpolished, with minute, rather sparse punctures; the entire pleura and the metanotum polished and glabrous. Metathorax with the carinate areas complete, save that the cross-carinæ of the lateral areas are absent, and the basal is confluent with the central area; the two dorsal carinæ converging on their basal ¼, thence straight and equidistant, the space between them with transverse rugæ; exterior tip of the lateral area prolonged in a minute, robust, blunt thorn. Tegulæ brownish-yellow. *Abdomen* with joints 1 and 2, except their extreme tips, opaque and coarsely and longitudinally rugose; the remainder of the abdomen, except a few minute rugæ at the base of joint 3, glabrous and polished. Joint 1 twice as long as wide, ¼ wider behind than before, its sides slightly convergent ⅓ of the way from the tip to the base, thence parallel nearly to the base, where they converge rapidly but in a regular curve without any angle or tooth; carinæ distinct, but not lofty or acute, all the way to the tip, and enclosing between them a shallow excavation. Joint 2 longer by ¼ than wide; 3 nearly as long as 2; the rest rapidly shorter and shorter. Extreme tips of 1–4 rufo-piceous. Venter luteous on the basal ⅔. *Legs* pale dull rufous; the 4 front ones honey-yellow. *Wings* hyaline; veins brown; stigma pale dusky, twice as long as wide. Radial area with a posterior angle of 90°. Areolet pentagonal, its sides converging a little as they approach the radial area, the 2d recurrent vein entering it rather nearer to its tip than to its base. Length ♂? .13 inch. Front wing ♂? .12 inch.

One ♂; ♀ unknown to me. Distinct by the shape of its areolet from all the *Exochus* described by Mr. Cresson that have any areolet at all, viz. *apicalis* and *fulvipes=pygmæus*.

POLYRHABDUS, new genus.

Antennæ rather robust, with the first joint of the scapus squarely truncate and joint 2 large; first joint of the flagellum short and the following joints almost square. Face and cheeks prominent as in *Exochus*. Scutel flattened and laterally and terminally carinate. *Abdomen* sessile; joint 1 with about 5 distinct longitudinal carinæ on its dorsal surface, joint 2 with 3, and joints 3 and 4 with 1 only. Venter much excavated. Ovipositor very short. *Legs* short and robust; femora incrassate; tarsal claws moderately long and simple; pulvillus as long as the claws. *Wings* shorter than usual. Areolet obsolete. Areolar cross-vein as long as usual. Bullæ 2, located as in *Exochus*, except that E is pretty close to the angle of its vein.

Distinct from *Exochus* by its carinate abdomen, its excavated venter and its short wings; and from *Alomya* by its sessile abdomen, obsolete areolet, the distinctness of its terminal wing-veins, its prothorax not prolonged in front, and its hind femora being more incrassate than the 4 front ones instead of *vice versa*.

Polyrhabdus cariniger, n. sp.—♀.—Black.—*Head* opaque, with very fine, dense punctures and pubescence, sparse on the subpolished vertex. Face projecting beyond the eyes ⅔ of their shorter diameter, pale yellow above and laterally, rufous on the disk and as far as the clypeus; the terminal foveæ, and a small, flat tubercle on its upper disk, fuscous. Clypeus and mandibles, except their tips, rufous. Palpi whitish. Antennæ brown-black, ½ as long as the body, the 1st joint of the flagellum twice as long as wide, the 2d joint ⅓ longer than wide, the following ones square. *Thorax* polished, with fine, rather close-set, shallow punctures; parapsidal grooves subobsolete. Scutel flat, elongate semi-oval, with a very distinct lateral and terminal carina, and a transverse, deeply impressed stria at its base. Metathorax with 4 longitudinal carinæ, and a posterior lunate area, but no cross-carinæ. Tegulæ whitish. *Abdomen* subopaque, with close-set, fine punctures. Joint 1 longer by ⅓ than wide, ½ wider behind than before, with five longitudinal, acute, lofty carinæ distinctly visible from above, viz.: the 2 usual dorsal ones and a third in the terminal ⅔ of the space enclosed between them, and the 2 usual lateral ones which are here elevated on the dorsum so as to appear detached from the lateral edge of the joint when viewed from above. Joint 2 with 3 such carinæ, the 2 outer ones a continuation of the lateral carinæ of joint 1 and the middle one a continuation of its middle carina. Joint 3 with 1 carina only, a continuation of the middle one; and joint 4 with the same but only prolonged half way to its tip. Ovipositor exserted and as well as its sheaths blackish. Venter whitish. *Legs* rufous immaculate. *Wings* subhyaline, veins and stigma black. Length ♀ .27 inch. Front wing ♀ .17 inch.

The ♂ differs from the ♀ only as follows: 1. The entire face and a short orbit extending just beyond the antennæ, the cheeks, clypeus, and mandibles except their teeth, are all pale yellow immaculate; and the tubercle on the face is obsolete. 2. The antennæ are ⅔ as long as the body, the 1st joint of the flagellum twice as long as wide, the 2d ½ longer than wide, and the following ones ⅓ longer than wide; and the 1st joint of the scape is yellow beneath. 3d. The 4 anterior coxæ are whitish at tip. Length ♂ .30 inch. Front wing ♂ .20 inch.

Two ♂, one ♀. Differs from *Tryphon carinatus*, Cress., by the 2d abdominal joint having 3 (not 1) carinæ, by the 3d and 4th being unicarinate (not simple), and by the protuberant face. Very distinct from all other allied N. A. species by the short wings and the remarkable carinæ of the abdomen. One ♂ was bred from a small Lepidopterous pupa.

[Genus ORTHOCENTRUS, Grav.]

Face and cheeks as prominent as in *Exochus*. Antennæ moderate, joints not unusually short, the 1st joint of the scapus truncate rather obliquely from above downwards, the 2d joint large. Scutel hunched, its sides declivous. Abdomen sessile, elongate-oval, almost elongate-oblong in ♂, the 2d joint in ♂ rather longer than wide. Ovipositor very short. Legs somewhat short and robust, the hind coxæ and femora much incrassated; tarsal claws, especially those of the hind legs, nearly as long as the last tarsal joint, and suddenly dilated on their basal ½ into a large tooth, the 2 teeth together simulating a 6th tarsal joint; pulvillus very narrow but as long as the claws. Wings with a large pentagonal areolet, sometimes incomplete by its terminal vein being subobsolete. When the areolet is complete the bullæ A and B cover nearly the whole of its terminal side and are separated only by a minute dot, C and D are confluent or separated from each other only by an indistinct dot, and E is as close as possible to the angle of the 1st recurrent vein. When the areolet is incomplete A and B are absent, the other bullæ remaining the same; and there are then consequently but 2 bullæ, CD and E, instead of 4, A, B, CD, and E.

Distinct from *Exochus* and *Polyrhabdus* by its hunched scutel, by its long, toothed tarsal claws, and its large pentagonal areolet: and from *Alomya* by its sessile abdomen, its wings as long as usual, and with the terminal veins distinct, its toothed claws, etc.

[Mr Walsh considered the two following species as belonging to a new genus which he called *Pachyonyx*; but they cannot be generically separated from *Orthocentrus*, Grav.—CRESSON.]

[Orthocentrus] trifasciatus, n. sp.—♂♀.—Black. *Head* subopaque with very minute, rather close-set, punctures, more sparse on the subpolished vertex. Face, cheeks, and the whole mouth, white. Antennæ 2/3 as long as the body ♂, 3/4 as long ♀, with the first joint of the flagellum about 2½ times as long as wide, and the following joints about twice as long as wide, brown-black, the scape and the extreme base of the flagellum whitish beneath, especially in ♂. *Thorax* polished, with very minute, rather dense punctures, more sparse on the mesothoracic pleura. Metathorax transversely rugose above, with 4 longitudinal subequidistant carinæ all attaining the lunate area of the posterior declivity, which is bounded by a well-defined carina throughout. Lower face of the mesosternum rufous, and in ♂ its pleura also fully half way to the wing. *Abdomen* opaque, very finely and rather densely rugose, subpolished towards its tip and at the tips of the joints. Joint 1 in ♂ full twice as long as wide, in ♀ 3/4 longer than wide, ♂♀ 3/4 wider behind than before, ♂ with its sides nearly straight, ♀ with its sides strongly convex for the 1st 1/3, thence gently concave nearly to the tip, so that the whole joint is elongate-campanulate, ♂♀ geniculate at 1/4 the way to its tip, which is bisinuate, its 2 carinæ distinct nearly to its tip and enclosing in their basal 1/4 a round excavation. Joint 2 in ♂ longer by 1/4 than wide, ♂♀ with a large, impressed, lateral, sub-basal puncture, joint 3 square in ♂, joint 2 square in ♀, the rest in ♂♀ gradually shorter. Joints 2 and 3 with their terminal 1/4 clay-yellow, and joint 1 with a similar band, which in ♀ is narrower, darker and less obvious. Venter ♂♀ yellowish except at tip. Four front legs ♂♀ yellowish-white; hind legs very pale rufous, ♂ with the coxæ brown above and the entire femora, or sometimes only their upper surface, and sometimes the tip of the tibiæ, brown. *Wings* subhyaline; veins brown; stigma nearly triangular, pale brown, twice as long as wide. Areolet large, pentagonal, the 2d recurrent vein entering it at ⅗ the way to its tip. Length ♂ .17 ♀ .12 inch. Front wing ♂♀ .13 inch.

Two ♂, one ♀.

[**Orthocentrus**] **stigmatias**, n. sp.—♀.—Differs from the above ♀ only as follows:—1. The face and the lower surface of the scape are yellowish-white (not white), and the entire flagellum is dull rufous or pale yellowish rufous below. Joints of the flagellum a little shorter. 2. The mesosternum is sometimes entirely black. 3. The 3 fasciæ on the abdomen are narrower, darker and much less distinct, that on joint 1 sometimes obsolete. 4 The 1st abdominal joint has its sides gently concave on its middle ¼, but elsewhere convex, their general direction being straight. 5. The hind legs are of a darker rufous. 6. In the wings both the veins and stigma are black, the stigma a little hunched on the costal margin, and very strongly hunched on the side adjoining the discoido-cubital cell, so as to describe a circular arc of 45°. Areolet the same, but with its outer vein so slender and pale as to be only visible in certain lights. Length ♀ .15 inch. Front wing ♀ .12 inch.

Two ♀; ♂ unknown to me. But for the different structure of the 1st joint of the abdomen and the hunched stigma, this might be taken for a variety of the preceding.

GENUS CERATOSOMA, Cresson.

The swelled face, which projects beyond the eyes by a space about equal to ¾ their shorter diameter, shows the connection of this most anomalous genus with *Exochus*, etc. Mr. Cresson has omitted to notice one of its most remarkable characters, viz.: that the mouth is rostriform as in *Osprynchotus*, Spin., and *Lapton*, Nees, and in the Braconide genera *Agathis* and *Vipio*. The clypeus and mandibles are also larger and more prominent than common, but the mandibles have the usual subequal teeth, instead of being destitute of teeth, as they are described in the two Ichneumonidous genera named above. Occasionally this rostrum is a little retracted, but ordinarily it projects beyond the clypeus by a space equal in length to the longer diameter of the eye. Mr. Cresson speaks of a "small tooth near the tip of the tarsal claws" ♂♀. This tooth exists only in ♀, and it is long, acute and slender, and placed on the middle of the claw beneath. In the ♂ the terminal ½ of the claw bears, not a tooth, but 7 or 8 fine, long pectinations. I am not aware of any other example in *Ichneumonidæ* where sexual differences exist in the armature of the tarsal claws. The genus is further remarkable by the entire body being absolutely glabrous, which does not occur elsewhere in this family so far as I am aware. The thorn-like extremity of the ♀ abdomen, whence the genus takes its name, is produced by the 6th ventral uniting with the 7th dorsal to form a perfectly smooth and very elongate cone, the whole being jointed together so closely that it requires a good lens to perceive the suture, and being basally embraced by the sides of the 6th dorsal. Occasionally from the tip of this cone there projects the tip of the sheaths of the ovipositor; but more usually they are entirely concealed within. No doubt, as in *Figitidæ*, (see *Proc.*, etc., ii. p. 467, fig. 3, and p. 468, note,) the entire tip of the abdomen is used to pierce the body of the ichneumonized insect. As will be at once perceived, this is a very different arrangement from the ploughshare-shaped 6th ventral of *Arotes* and *Acœnitus*, which, like the ventral valve of *Cynips*, (*ibid.* p. 467, fig. 1 a,) is entirely disconnected from the dorsal segments. The areolet is large and rhomboidal. The bullæ are very large and obvious on the brown wing, and are 3 in number, B, CD and E; but as both recurrent veins are nearly straight, the location of CD and E cannot be definitely fixed, further than that they are always much nearer to the areolet than to the other end of the vein. Out of 34 specimens carefully examined, the only irregularity in the bullæ that I could detect was, that in 1 ♂ *fasciata* B was obsolete, and in 3 ♂ *fasciata* C and D were not quite confluent. In coloration, but not in size, the genus varies very considerably.

Ceratosoma apicalis, Cress.—♂ ♀.—My specimens differ as follows from the description:—1. The face, clypeus and palpi are yellow immaculate, and, instead of 2 fulvous spots on the occiput, the entire occiput, except a yellow orbit narrower above and running across the entire vertex, but very wide below, is ferruginous. 2. The ferruginous color of the thorax is more or less densely stained with black; and there is always on the disk of the mesonotum a quadrate yellow spot, the anterior angles of which are connected with the clavate tip of the broad yellow line that overlies the humeral suture by a more or less obvious narrow yellow vitta, thus leaving an oblong blackish spot on the tip of the mesonotum. 3. There is a more or less broad anterior yellow margin to the mesosternum and its pleura, and a very narrow one to the pleura of the metasternum, the two yellow margins more or less entirely connected by an intermediate elongate yellow blotch of variable size and shape, which is located at the bottom of the pleura. 4. The terminal ½ of the metathorax is, as described, yellow, but on each side of its basal ½ there is a roundish yellow spot, which is occasionally confluent with the terminal yellow part. 5. The abdomen, except sometimes towards its base, is not ferruginous but black. Joint 1 is yellow, with a black, or sometimes ferruginous, round spot on each side ⅓ of the way to its tip, which two spots are generally more or less confluent with the base and with each other; and the terminal ½ of joints 2–7 (not merely of 1–4) is yellow, but more obscurely so on the last joint or two. In a single ♀, there is a large, lateral, roundish, yellow spot just forward of the tip of the black basal ½ of joint 2. Length ♂ .47–.49, ♀ .49–.57 inch. Front wing ♂ .40, ♀ .42–.45 inch.

Two ♂, four ♀; all taken in August on Golden-rod and other flowers. Perhaps as this species was described by Cresson from alcoholic specimens, taken in Colorado, its true coloration was partly misstated. To some colors alcohol is absolutely ruinous.

Ceratosoma fasciata, Cress.—♂♀.—Differs in no respect from the ♂ ♀ *apicalis* described above, except, 1st, in the large spot on the occiput being generally in ♂ (but not in ♀) rather black than ferruginous, and in its being occasionally more or less confluent with the black spot above the antennæ; 2d, in the quadrate yellow spot on the disk of the mesonotum being smaller, and generally but not always isolated; 3d, in the yellow lateral spot on the anterior ½ of the metathorax being usually smaller, occasionally obsolete, and never confluent with the yellow terminal ⅓ of the metathorax; but especially, 4th, in the apex of the front wing being, not hyaline, but pale brown like the rest of the wing. In not a single specimen ♂♀ is the face or clypeus partly ferruginous, as *apicalis* ♀ is described by Cresson; and all the variations noted above under *apicalis* occur here also, with the single exception of the last one enumerated. Length ♂ .33–.48, ♀ .45–.47 inch. Front wing ♂ .32–.40, ♀ .37–.40 inch.

Twenty-four ♂, four ♀, all taken in August in company with *apicalis* on the flowers of the Golden-rod. It appears from the above that there is not a single perfectly constant character to separate these two species, except the hyaline tip of the wing of *apicalis*, which is absolutely invariable, and towards which no approximation whatever is made in the 28 specimens of *fasciata*. And yet these two very closely allied but perfectly distinct species, each represented by numerous specimens, occurred promiscuously in the same week in the same very limited locality. To any one who disbelieved in the present existence of species, this would be a suggestive fact. To those who believe that species have been distinct for all time, the Unity of Coloration that we see in these two highly ornamented species offers an insoluble enigma.

GENUS TRYPHON, Gravenhorst.

We have but to refer to the descriptions of this genus given by authors to see that, like many others in *Ichneumonidæ*, it is a very polymorphous one, and comprises very discordant materials. No less than 99 British species are referred to it by Westwood. (*Synops.* p. 47.) The bullæ are noticed under the same species which I possess. Those of *seminiger*, Cress. ♀ are B, C, D and E, C and D not so widely separated.

Tryphon atricoxus, n. sp.—♀ ?.—Black. *Head* subpolished, with fine, confluent punctures, minute and sparse on the vertex and clypeus. Face, but not the cheeks, a little prominent on the disk. Anterior ½ of the clypeus, mandibles except their teeth, and palpi, pale rufous. Antennæ ⅔ as long as the body, brown-black, the scapus and part of the 1st joint of the flagellum covered beneath with long, whitish pubescence; 1st joint of flagellum 2½ times as long as wide. *Thorax* subpolished, with fine, dense, confluent punctures—finer, shallower and more sparse on the pleura. Scutel elevated, its sides carinate, loftily towards its base, its anterior surface flattish. Metathorax coarsely rugose, the normal carinæ all present, the central area small and ½ wider than long. Tegulæ yellowish-brown. *Abdomen* depressed, oval, with the 1st joint subpolished and finely rugoso-punctate, ½ longer than wide, ½ wider behind than before, its sides straight save a rounded tubercle at each anterior angle, and a smaller acute one bearing the spiracle at ⅖ of the way to the tip; the two dorsal carinæ acute and attaining the tip where they unite. The remaining joints subopaque except towards the tip, with minute, shallow, rather sparse punctures. Joint 2 with a basal and medial tubercle, each not far from the lateral edge. Joint 1 coal-black; joint 2, and the basal ⅔ of 3, rufous; the rest blackish. Venter dull pale rufous, obfuscated at tip. *Legs* rufous, moderately slender, the coxæ and the basal trochanters of all the legs black. *Wings* subhyaline; veins black; stigma black, basally whitish. Radial area rather short, its posterior angle about 115°. Areolet small, triangular, obliquely elongate, and with a short petiole. Bullæ 5, A on the petiole, B normal, C and D widely separated, and E longer than usual and almost touching the angle of its vein. Length ♀ ? .20 inch. Front wing ♀ ? .17 inch.

One ♂; ♀ unknown. Belongs to Mr. Cresson's 4th Section. Distinct from *americanus*, Cress. ♂, *affinis*, Cress. ♀ (which is apparently the other sex of *americanus*), *seminiger*, Cress. ♀, *semirufus*, Cress. ♀, *analis*, Cress. ♂, *festivus*, Cress. ♂, *cinctus*, Cress. ♂ (Cuba), and *claviventris*, Cress. ♂ (Cuba), by the coloration of its abdomen; from *tibialis*, Cress. ♂ by the hind legs not being annulate with black and white; and from *rufocinctus*, Cress. ♀, *minimus*, Cress. ♀, *capitatus*, Cress. ♂, *exiguus*, Cress. ♀ (Cuba), *lineolatus*, Brullé ♀ (S. A.), and *mesoxanthus*, Brullé ♀ (S. A.), by the coloration of the legs and the areolet not being obsolete.

[This is probably only a variety of *T. dimidiatus*.—CRESS.]

Genus EXENTERON, Hartig.

Section 1.—*Areolet rhomboido-triangular.*

Exenteron ornatus, n. sp.—♂.—Black. *Head* large and ½ wider than the thorax, subpolished, with very minute, sparse punctures; the face subopaque and indistinctly rugoso-punctate. Face, a short, narrow orbit just passing the antennæ, cheeks below the eye, clypeus, and mandibles except their teeth, all yellow. Palpi whitish. Antennæ as long as the body, brown-black on their basal ½ save that the scapus is yellow beneath, the other ½ gradually rufous; 1st joint of flagellum 3½ times as long as wide. *Thorax* polished, with very minute, sparse punctures. Metathorax subopaque and finely rugose, with its carinate areas all complete; the central area ½ longer than wide, rounded in front, and with its sides straight but slightly convergent behind. Tegulæ, a line under the front wing, a pointed line clavate behind adjoining the tegula and underlying the humeral suture ½ way to its tip, scutel and a transverse line behind it, and also the prosternum, all yellow. *Abdomen* short, depressed, broadly obovate, subpolished, with very fine, sparse punctures which are subobsolete towards its tip and the tips of the joints. Joint 1 squarely truncate in front, with the apex of its anterior angles prolonged a little, ½ longer than wide, ⅓ wider behind than before, its sides parallel ⅔ of the way to the tip, thence gradually diverging; the 2 usual carinæ distinct ¾ of the way to the tip. Joint 1 black, with an obtrigonate, rufous, dorsal spot on its terminal ⅓; the rest of the abdomen pale rufous. Venter pale rufous. *Legs* pale rufous; the 4 front legs with their coxæ and trochanters yellowish-white, but the middle coxæ with their anterior face rufous. *Wings* long, hyaline; veins black; stigma black, its basal ⅓ whitish. Areolet sessile, rhomboido-triangular, and obliquely elongate, the 2d recurrent vein entering it full ⅔ of the way to its tip. Bullæ 4, A, B, C, and E; A and B on the exterior cross-vein of the areolet and separated by a considerable space, C midway between the salient angle and the areolet, and E rather nearer to the angle of its vein than to the areolet. Length ♂.17 inch. Front wing ♂ .17 inch.

One ♂; ♀ unknown to me.

Section 2.—*Areolet triangular.*

Exenteron flavicoxus (*Ctenisus flavicoxæ*, Cress., ♀ only described).—♂.—Differs from the preceding ♂ only as follows:—1. The orbit is prolonged to the vertex, much contracted in width opposite the antennæ, thence widening till at the commencement of the vertex it is expanded into a short, blunt, robust bifurcation. 2. The yellow cheeks are widely prolonged behind the eye, so as to be only separated from the frontal orbits by a space equal to ½ the shorter diameter of the eye. 3. The antennæ are only ¾ as long as the body. 4. The 3 cross-carinæ of the metathorax are subobsolete; the yellow line under the humeral suture is much wider and extends twice as far forwards, and there is a square yellow spot on the disk of the mesonotum. 5. The abdomen is elongate-subolong, joints 2–5 being of uniform width. Joint 1 is ¼ narrower at tip than the base of

2, full twice as long as wide, $\frac{1}{2}$ wider behind than before, the humeral angles separated by a short space from its base, and respectively $\frac{1}{3}$ and $\frac{5}{6}$ of the way from these angles to the tip there is another tooth-like angle, the 3 lateral interspaces each gently concave, and the joint widest at the hindmost angle. Joint 1 is black, with a small, obtrigonate, dorsal, yellowish spot at tip, and there is a large, blackish cloud on each anterior angle of joint 2, the space between and behind these 2 clouds yellowish. The rest of the abdomen pale rufous. 6. The legs are pale rufous, but all the coxæ and trochanters are pale yellow. 7. The areolet is triangular and slightly peduncled, its exterior side a little convex, the 2d recurrent vein entering it exactly at its tip. Bullæ 4, B, C, D, and E; C and D very wide apart, and E rather nearer to the angle of its vein than to the areolet. Length ♂ .24 inch. Front wing ♂ .20 inch.

The ♀ (as described by Mr. Cresson) differs from the above ♂ only as follows:—1. There is a dark stain on the middle of the face, and the tips of the antennæ are "yellowish," not rufous. 2. There is no yellow spot on the disk of the mesonotum, only the tip of the scutel is yellowish, and the metascutellum is immaculate. 3. The posterior tibiæ are brownish. 4. The abdomen is "short, broad, and subdepressed"; joint 1 black immaculate, and the sides of 2–4 (not of 2 only) blackish. Length ♀ (Cresson) .21 inch.

One ♂. As the differences between my ♂ and Mr. Cresson's ♀ are mostly sexual, or such as may perhaps be ascribed to variation, I have considered the two as provisionally identical.

GENUS CTENISCUS, Haliday (=*Exenterus*, Hartig).

Head large and transverse. Clypeus moderate, transversely oval. Antennæ moderate; the 1st joint obliquely and laterally truncate; the flagellum with the joints rather long. *Thorax* with the parapsidal grooves distinct but not impressed. Scutel elevated. Carinate areas of the metathorax mostly distinct. *Abdomen* sessile, elongate; joint 1 long, flattened, subolong; joint 2 much shorter; the rest slowly shorter and shorter. Venter excavated. Ovipositor ——. *Legs* slender, moderately long; spurs 1, 1, 0; claws pectinated, the pulvillus shorter than the claws. *Wings* moderate; radial area and stigma rather short; areolet triangular, small; 1st recurrent vein angulated; the 2d recurrent vein almost straight, slightly convex externally. Bullæ 3, B, CD, and E; B normal, small, and indistinct; CD occupying the middle of its vein, and E pretty near to the angle of its vein.

Differs from *Periope*, Haliday, by its sessile (not subpetiolated) abdomen, its flat (not protuberant) face, and its spurs 1, 1, 0 (not 1, 2, 1). And from *Exyston*, Schiodte, by its sessile (not petiolated) abdomen and its pectinate claws. *Exenterus*, Hartig, as described by Brullé, appears identical with *Ctenisucs*, Hal., as described by Westwood, having, as Brullé expressly asserts, "small, simple claws"; and yet on the very next page Brullé says that *Exyston* DIFFERS from *Exenterus* in the claws being simple!! (*Hymen.* pp. 320–1.) Wesmael, writing in 1854, seems to be unacquainted with *Ctenisucs* which was published in 1840, for in his Synoptical Table he refers solely to *Exenterus*, and says that that genus usually has pectinate claws.

Ctenisucs albilineatus, n. sp.—♂?—Black. *Head* polished, the face and the base of the clypeus with some minute, sparse punctures. Face except the terminal foveæ, a short, narrow orbit scarcely passing beyond the antennæ, cheeks, clypeus except its tip which is honey-yellow, mandibles except their teeth, and palpi, all white Antennæ $\frac{2}{3}$ as long as the body, brown-black, pale yellowish-brown beneath on their middle $\frac{1}{3}$. *Thorax* polished, with very minute, rather dense punctures. Metathorax subpolished and rugose, the carinate areas all present, save that the basal is confluent with the central area, and the cross-carinæ of the lateral areæ are absent. Hind angles of the lateral areas prolonged in a short, robust thorn directed outwards and backwards. Tegulæ, a spot before them under the humeral suture, a line under the front wing, a transverse spot on the anterior edge of the mesothoracic pleura, the anterior edge of the collare, the prosternum, the hind surface of the scutel, and the whole of the metathoracic scutel, all white. *Abdomen* subopaque, densely and minutely rugoso-punctate, subpolished towards its tip and the tips of the joints. Joint 1 longer by half than wide, $\frac{1}{3}$ wider behind than before, its anterior angles laterally prolonged in a short, robust tooth, its sides parallel on the terminal $\frac{1}{3}$, thence scarcely concave and slowly converging to the basal tooth; carinæ distinct and acute nearly to the tip. Joint 2 slightly longer than wide, $\frac{1}{4}$ shorter than joint 1; 3–8 slowly shorter and shorter. Tip of 2–7 with a marginal white line, gradually stouter on 2–6, on 7 very slender. Venter whitish. Four front *legs* pale rufous, with their coxæ and trochanters white. Hind legs black, with the 2d trochanter, and the upper face of the coxæ, white. *Wings* hyaline; veins black, radius rufous; stigma black, its basal $\frac{1}{4}$ whitish. Radial area with a posterior angle of 120°. Areolet with its inner side $\frac{1}{3}$ shorter than either of the other two. Length ♂? .25 inch. Front wing ♂? .22 inch.

One ♂?; ♀ unknown. It is possible that the compression of the tip of the abdomen may be due to an accident, but it has not that appearance.

[This is very closely allied to *C. annulipes*, Cress., Trans. Am. Ent. Soc. ii. p. 112.—CRESSON.]

GENUS RHYSSA, Grav.

In this genus the bulla A is absent, B is located at the lower end of its cross-vein, C and D are wide apart, and E is nearer than usual to the angle of the first recurrent vein. Judging from the only species—*Rh. lunator*, Fabr.—of which I possess numerous specimens, the amount of colorational variation is small, but the variation in size is very great, some ♂ specimens being ½ longer than others, and the ovipositor in one of my specimens being only ⅙ longer than the body; while in others, according to Brullé, it is nearly twice as long as the body.

Rhyssa atrata, Fabr., and *Rhyssa lunator*, Fabr. — This last does not occur near Rock Island, Ill.; but I took numerous specimens in South Illinois, in the beginning of July, flying round a hickory log, and I have also seen specimens in Mr. Bolter's collection at Chicago.

Rhyssa [(*pimpla*) **humida**, Say, Bost. Jour. ii. p. 224]. — ♀. — Black. *Head* with broad, white orbits, which are widely interrupted on the vertex and narrowly at the insertion of the antennæ, where the white color is replaced by a shallow, square depression with a glassy, semipellucid, lead-colored lustre. Palpi white. Antennæ brown-black, ⅔ as long as the body. *Thorax* with the transverse rugæ coarse; the tegulæ, a large oblong spot under the front wing, and a very large triangular spot before it prolonged at the tip in a line as long as the triangle itself and the whole adjoining the humeral suture below, a line above the anterior coxæ, a pair of parallel lines arranged side by side longitudinally on the disk of the mesothorax and half as long as the mesothorax itself, the lateral and hind margin of the scutel, and two round subconfluent spots transversely arranged on the postscutel, all white. Metathorax very finely rugose, polished, with a longitudinal acute stria deeply impressed in front and fading out behind. Meso- and meta-sternum and their entire pleura glabrous and polished, pale rufous, except that on the terminal ½ of the metathoracic pleura there is an elongate white spot separating the black color from the rufous. *Abdomen* polished, with very fine transverse rugæ; joint 1 with a shallow, wide dorsal stria extending nearly to its tip, and basally wider and deeper; joints 2–7 each with a lateral, subterminal, roundish, white spot, which in 2 is a mere white dot, and becomes larger in each successive joint, till in 6 and 7 it not only covers nearly the whole length of the joint, but extends upwards so as to be respectively 2 and 3 times as wide as long; joint 8 highly polished and tapered to a conical point behind, the cone about as long as joint 7 and flattened below. Ovipositor piceo-rufous, a little longer than the body, its sheaths black both internally and externally. Venter, with the tip of the joints, whitish. *Legs* pale rufous, the anterior trochanters whitish; the knees, tibiæ, and tarsi, of all 6 legs also whitish, except that the exterior surface of the middle tibiæ and tarsi and all the tarsal tips and sutures are obfuscated, and that in the hind tibiæ the terminal $\frac{1}{3}$ is dusky and there is an infuscation externally near their base. *Wings* hyaline; veins black, paler on the postcosta; stigma black, 4 times as long as wide and whitish on its basal $\frac{1}{3}$. Areolet rhomboido-triangular, the recurrent vein entering it in the middle below, and with a peduncle half longer than the triangle itself. A faint, brown cloud in the inner angle of the radial area. Length ♀ .55 inch. Front wing ♀ .40 inch. Ovipos. .70 inch.

One ♀; ♂ unknown to me. Allied to *persuasoria*, Linn., of Europe, Canada, and the Rocky Mountains, and also to *albo-maculata*, Cress.; but is distinguished at once from both by the very different markings of the thorax and abdomen, and by the meso- and meta-sternum being rufous, not black. From *Nortoni*, Cress., it is at once structurally separated by the 2d recurrent vein entering the areolet in the middle of its posterior side, and not at the apex as in *lunator* and *atrata*, and by the white orbits being entirely interrupted opposite the antennæ, and not merely emarginate there. *Atrata*, Fabr., *lunator*, Fabr., *nitida*, Cress., *lævigata*, Br., *marginalis*, Br. (hab. unknown), and *terminalis*, Br. (Chili), have no white markings either on the thorax or abdomen, and otherwise are entirely unlike. I suspect that these 3 species with white markings on the thorax and abdomen, viz. *persuasoria*, *albo-maculata*, and *humida*, are all distinguished from the others by having a rhomboido-triangular, not triangular, areolet; and in that case they may conveniently form a separate subgenus to which the name of *Pararhyssa* may be given. *Epirhyssa*, Cress., which has no areolet at all, has a coloration very similar to that of *Rhyssa* proper.

[*Atrata*, *lunator* (=*lævigata* ♂), *Nortoni*, and *nitida*, all belong to the genus *Thalessa*, Holmgren; while *persuasoria*, *albo-maculata*, *humida*, and *canadensis*, belong to *Rhyssa* proper.—Cresson.]

GENUS EPHIALTES, Grav.

In this genus, which has a rhomboido-triangular areolet, the bulla A is small, often subobsolete, occasionally obsolete, and is placed on the same cross-vein as B, but immediately adjoining the radial area, and is separated from B, which is located near the other end of its cross-vein by a considerable space. The other bullæ are all present and normally located, except that C and D are very wide apart, and E is generally closer than usual to the angle of the 1st recurrent vein. Unlike *Rhyssa*, *Ephialtes* does not seem to vary very considerably in size, though in *irritator* some specimens appear to be ½ longer than others; and, so far as my scanty specimens show, it varies but very little in coloration. All my species have as hort, robust, basal tooth on the tarsal claws.

Ephialtes gigas, n. sp. — ♀. — *Head* with the vertex and front subglabrous and polished, the face (except the orbits) and the clypeus closely punctate, subopaque, and with sparse cinereous hairs, the clypeus truncate at tip, and slightly emarginate and depressed in the middle. Palpi yellowish-white. Antennæ full ½ as long as the body. *Thorax* above and below a little hairy, especially behind; polished, with fine but not dense punctures interspersed, especially on the anterior lobe, with some fine longitudinal rugæ. Tegulæ brownish-white. Metathorax finely rugoso-punctate, with two acute, lofty, subparallel carinæ extending full half way to the tip, where they suddenly expand so as to enclose an obsemicircular space, the excavation between the parallel carinæ glabrous in the middle throughout. *Abdomen* opaque and presenting the appearance of virgin silver, excepting of course on the small glabrous and polished tip of each joint, with regular, confluent, fine punctures entirely free from rugæ except on joint 1; these punctures gradually disappear towards the tip of the abdomen, so that the last few joints are subglabrous and polished. Joint 1 laterally rugoso-punctate, with the usual 2 dorsal carinæ lofty at base and fading out at ¾ the way to the tip, and a lateral one lofty at tip and fading out ¾ the way to the base. A subhemispherical, highly polished excavation on each side in the suture between the 1st and 2d joints, from which there proceeds an oblique, deeply impressed stria terminating in the spiracle of joint 2. A similar but much fainter excavation and stria in the following suture. The usual tubercles very distinct on joints 3–5, and elongate, not round. Joints 1 and 2 equal in length, each being 2½ times as long as wide; 3 a trifle shorter; 4 shorter by ⅐ than 2; and 5 shorter by ¼ than 4, so as to be only about ⅗ as long as either 1 or 2. Ovipositor full ⅓ longer than the body. *Legs* pale rufous, all the sutures a little darker; all the spurs, the tips of the 4 front tarsi, the tips of the hind tibiæ, and the whole of the hind tarsi, a little obfuscated. *Wings* subhyaline, tinged with smoky yellow; veins black, the radius and the extreme base of the other veins pale rufous; stigma black, 5 times as long as wide, and with its basal ⅐ pale rufous. Areolet rhomboido-triangular, the 2d recurrent vein, which describes a regular and very convex curve, entering it ⅘ of the way to its tip. Length ♀ 1.27 inch. Front wing ♀ .83 inch. Length abd. ♀ .85 inch. Width abd. ♀ .10 inch. Ovipos. 1.80 inch.

One ♀, taken on the wing in October; ♂ unknown to me. This is the largest species found in North America except *occidentalis*, Cress., from which it differs in the very different proportions of abdominal joints 1–5, in their not being transversely striate, and in the ovipositor being black, not ferruginous, which last character however is probably of but slight specific value. May possibly be identical with *manifestator*, Linn. (Europe) ; but Mr. Cresson, in enumerating the characters which separate that species from his *occidentalis*, does not mention any of those which separate *gigas* from *occidentalis*. *E. rufescens*, Cress. (Cuba), and all the 10 species described by Brullé, differ in the body being partly luteous, ferruginous, or rufous, and in other respects.

Ephialtes pygmæus, n. sp.—♀.—Differs from *gigas* ♀ as follows:—1. The size is ½ smaller. 2. The face is polished and but sparsely punctate. 3. The carinæ of the metathorax are much less prominent in front and subobsolete behind. 4. The relative proportion of abdominal joints 1–5 is somewhat different, 2 being distinctly shorter than 1, and 2–5 each about ⅙ shorter than the preceding, so that 5 is only about ½ as long as 1; and in addition, instead of 2 being 2½ times as long as wide, it is only 1½ times as long as wide. 5. The tubercles on abdominal joints 2–5 are round, not elongated. 6. The ovipositor is rather piceous than black. 7. The legs are pale rufous, but both trochanters of the front leg, the outermost one of the middle leg, and sometimes the outermost one of the hind leg, are distinctly whitish; and the 4 front knees, tibiæ and tarsi are yellowish-white, the exterior tips of the tibiæ and the tarsal tips obfuscated, especially in the middle legs. In the hind legs the terminal ⅓ of the femur is fuscous, the tarsus is entirely fuscous, and the tibia is fuscous with its basal ⅓ white and a whitish interior vitta extending ⅔ of the way to the tip. 8. The wings are subhyaline. Length ♀ .58–.63 inch. Front wing ♀ .46–.48 inch. Length abd. ♀ .38 inch. Width abd. ♀ .07 inch. Ovipos. .73–.83 inch.

Two ♀ ; ♂ unknown to me. Differs from *occidentalis*, Cress., by the first two characters which separate *gigas* from that species, and by the 1st, 2d, 3d, 4th and 7th characters which separate *pygmæus* from *gigas*. From *manifestator* (Europe), *rufescens*, Cress, and Brullé's 10 species, it differs in the same way as *gigas* does.

Ephialtes pusio, n. sp.—♀.—Differs from *gigas* ♀ as follows:—1. The size is ½ smaller. 2. The face is highly polished and scarcely punctate. 3. The metathoracic carinæ are obsolete, being represented only by a slightly impressed stria extending ⅔ of the way to the tip. 4. The carinæ of the 1st abdominal joint are entirely obsolete. 5. The relative proportions of the first 5 abdominal joints are quite different, 2–4 being equal in length and each twice as long as wide, and 1 about ¼ shorter, and 5 a trifle shorter than 2–4. 6. The usual tubercles are obvious only on 3 and 4, and are much less prominent and round, not elongated. 7. The ovipositor is rather piceous than black. 8. The legs are pale rufous, all the sutures a little darker, but both trochanters of the front leg, and the outermost one in the middle and hind leg, are whitish; and in the front leg the tarsal tip, in the middle leg the exterior face of the tibia and the whole tarsus, and in the hind leg the extreme tip of the femur and the whole tibia and tarsus, are pale fuscous. 9. The wings are subhyaline. Length ♀ .60 inch. Front wing ♀ .36 inch. Length abd. ♀ .42 inch. Width abd. ♀ .06 inch. Ovipos. .85 inch.

One ♀; ♂ unknown to me. Comes very near *pygmæus*, n. sp., but differs notably in the carinæ of the metathorax and of the 1st abdominal joint being obsolete, in the slenderer abdomen, and in the entirely different proportional length of the first 5 abdominal joints. In this last character it approximates remarkably to *occidentalis*, Cress., which is said to have the first 5 abdominal joints subequal; but it differs from that species by these joints being only twice, instead of thrice, as long as wide, and by the 1st, 2d, 3d, 4th and 8th characters which separate *pusio* from *gigas*. From the other described species it differs like the preceding.

Ephialtes irritator, Fabr.—♀.—Differ from *gigas*, n. sp., as follows:— 1. The size is nearly ½ smaller. 2. The palpi are dusky. 3. The tegulæ are pure white. 4. The pectus is subglabrous and highly polished. 5. The metathorax is more coarsely and strongly rugoso-punctate, the carinæ subobsolete, but with an acute, impressed stria between them extending ⅗ of the way to the tip. 6. The abdomen is subpolished, the punctation being less strong; joint 1 is twice as long as wide, and, as in *pygmæus*, joints 2–5 are each about ⅙ shorter than the preceding. Joint 1 black, the remainder rufous, 2–4 each with a short, transverse, black spot at the lateral tip. Venter, except the basal ½ of joint 1, dull pale rufous. 7. The usual tubercles are distinct on 2–5, but, except on 2, round instead of elongate. 8. The ovipositor is piceous. 9. The legs are pale rufous, with all 6 coxæ and the basal trochanters of the hind leg black; both trochanters of the front leg, the 2d and all but the lower surface of the basal trochanter of the middle leg, all 6 knees, and the tibiæ and tarsi of the 4 front legs, yellowish-white; hind tibiæ and tarsi pale dull rufous. 10. The wings are subhyaline, and it is only the base of the radius that is pale rufous, and the stigma is entirely black. Length ♀ .64–.70 inch (.98 inch Brullé). Front wing ♀ .53–.54 inch. Length abd. ♀ .41–47 inch. Width abd. ♀ .07 inch. Ovipos. .84–.85 inch (1.18 inch Brullé).

Two ♀; ♂ unknown to me. Readily distinguished from all the preceding, and from *occidentalis*, Cress., and *manifestator* (Europe), by the rufous abdomen. *Eph. rufescens*, Cress., differs in having the 1st abdominal joint rufous instead of black, but a single pair of black spots on the abdomen, and by its rufous head and thorax. It is remarkable that *Eph. oculatus* (South Africa) has the same 6 abdominal spots that *irritator* has, though it is otherwise quite different. None of the other species described by Brullé exhibit this character. According to Brullé, *irritator* has the tip of abdominal joints 5–8 more or less black. I find no traces of this character in my specimens. The habitat he gives is Carolina. According to Mr. Cresson, there is a specimen in the collection of the American Entomological Society "with the abdomen half black," i. e. with the normal spots on 2–4 confluent.

GENUS CYLLOCERIA, Schiodte.

The very remarkable emargination at the tip of the 3d and base of the 4th joint of the flagellum of ♂ antenna, which has much the appearance of an accidental mutilation propagated by inheritance, seems to identify this genus sufficiently when taken in connection with several other characters in which the American type agrees with the European one. Brullé, indeed, states only that "the tip of the 6th and base of 7th joints are emarginate," without specifying whether he refers to the antennæ or to the abdomen; but the etymology of the generic name proves that he must refer to the antennæ. The American type differs, however, from the European type in the 1st joint of the antennæ being laterally (not inferiorly) truncate in an angle of about 45°. Moreover, the 2d joint of the maxillary palpi is elongate-obtrigonate, and 2½ times as long as wide; the 3d joint ⅓ longer than the 2d, but a trifle narrower, straight, and basally a little constricted; the 4th and 5th slender and each respectively a trifle shorter than the preceding. Whereas Brullé says that the 2d joint is *wider than the others*, and that the 3d is *twice as wide as the 2d* and curved; so that it is impossible to tell which, according to him, is the wider, the 2d or the 3d. But in *Ichneumonidæ* the structure of the palpi appears to be rather of specific than of generic value. His description of the labial palpi agrees exactly. In my species the mandibles are toothed, the clypeus is very short and transverse as in *Xylonomus*, etc., the head scarcely twice as wide as long and much excavated behind so as to describe a circular arc of about 60°, and the parapsidal grooves are as deeply impressed as in *Xylonomus*, etc. In the ♀ the terminal joints of the abdomen are extended and the 6th ventral not prolonged, or, as it is termed, "the anus is slit." The bullæ are 4, A, C, D, and E; A indistinct and placed on the forward end of the areolar cross-vein, C well forwards on its vein, C and D quite widely separated, and E pretty close to the angle of its vein.

Cylloceria [**occidentalis**, Cress., Trans. Am. Ent. Soc. iii. p. 160.]—♀. —Black. *Head* subopaque, with very minute, rather dense, shallow punctures and rugæ; labrum more or less exserted, polished. Palpi, except the 1st joint, whitish. Antennæ 4/5 to quite as long as the body, brown-black, the flagellum sometimes rufous beneath, sometimes entirely rufous; 1st joint of the flagellum 6 times as long as wide; 2d joint 3/5 as long as the 1st; the rest rapidly shorter. *Thorax* polished, with very minute, rather sparse, shallow punctures, the pleura of the mesothorax minutely aciculate. Metathorax and its pleura opaque, finely and densely rugoso-punctate, with 6 longitudinal parallel carinæ attaining the lunate area, the 2 middle ones the nearest, and the 2 outer ones, one of which is lateral, the next nearest. No cross carinæ. Tegulæ whitish. *Abdomen* oval, opaque, with dense rugæ, fine on joint 1, minute on 2 and 3; joints 4–8 and the tips of 2 and 3 subglabrous and polished. Joint 1 almost twice as long as wide, 1/4 narrower at tip than is the base of 2, twice as wide behind as before, its sides scarcely convergent for 3/4 of the way from the tip to the base, at which point the tubercle is located, thence converging rapidly; the usual carinæ obsolete except at the extreme base. Joint 2 half as long as 1 and 1/4 wider than long; 3–5 a little shorter; the rest short. Ovipositor rufous, basally piceous, about 2/3 as long as the body; sheaths black, tapered, basally 2/3 as wide as the last tarsal joint of the hind legs. Venter excavated, longitudinally carinate, more or less whitish at the tips of the joints. *Legs* pale rufous; the tips and sometimes the whole of the hind tibiæ fuscous. *Wings* subhyaline, more or less tinged with smoky yellow. Veins black; stigma black, its basal 1/4 white. Radial area rather elongate, its posterior angle about 135°. First recurrent vein but slightly crooked, the 2d regularly convex outside. Length ♀ .36–.43 inch. Front wing ♀ .27–.32 inch. Ovipos. .19–.30 inch.

The ♂ differs from ♀ as follows: — 1. The antennæ are brown-black immaculate, more robust, the 1st joint of the flagellum scarcely 5 times as long as wide. 2. The abdomen, as usual, is narrower; joint 2 is full twice as long as wide, its carinæ are distinct for 3/4 of the way to the tip, and joint 2 is nearly square. Length ♂ .30–.35 inch. Front wing ♂ .25–.30 inch.

Three ♂; three ♀. The first N. A. species hitherto recognized as belonging to this genus. But for the great difference in size (♀ .15 inch) this might be taken for *Anomalon sexlineatum*, Say. In my smallest ♀ the ovipositor is "hardly as long as the abdomen," as described by Say; in the other 2 ♀ it is considerably longer.

GENUS LAMPRONOTA, Curtis (= *Lissonota*, Grav., preoccupied).

In this genus the venter is longitudinally carinate towards the base, and in *L. breviventris*, n. sp., *L. nigrita*, n. sp., and a single specimen of *L. pictiventris*, n. sp., the carination is continued nearly to the tip, thus giving the tip of the abdomen a compressed appearance. Both these characters denote an affinity with the *Banchus* group; but the elongate intermediate joints of the abdomen in most species, and the subobsolete abdominal tubercles in others, show its relations to be rather with *Ephialtes*.

The fundamental difference between *Lampronota* and *Ephialtes* is that the terminal abdominal joints are here retracted in both sexes, but much more so in ♀ than in ♂, and in the ♀ the 6th ventral is prolonged behind so as to form a ventral valve extending always to the tip of the abdomen and occasionally beyond it. In both genera abdominal joints 2 and 3 are longer than wide, with the exception of *L. pictiventris*, n. sp., *L. breviventris*, n. sp., and *L. nigrita*, n. sp., but they are proportionally more so in *Ephialtes*. In all my species of *Lampronota* the declivous posterior surface of the metathorax is lunate and bounded by a distinct carina, the lunate area being closed above, and not communicating, as in *Ephialtes*, with the elongate area enclosed by the two normal longitudinal carinæ. The claws are also simple; the areolet is rhomboidal and more or less petiolated, instead of being, as in all my *Ephialtes*, rhomboido-triangular and sessile; and the 2d recurrent vein is more or less biangulated, instead of forming a regular convex curve. The colors are black, or black and rufous; the abdomen often more or less rufous; with the head, the humeral suture, and the scutel, often marked with white. The bullæ are generally but three in number, B, CD, and E; B located well backwards on the cross-vein; CD well forwards on account of the salient angle of the second recurrent vein being well forwards, and generally with a black dot placed at the the apex of the angle and representing the typical stump of a vein; E further than usual from the angle of the first recurrent vein, being generally rather nearer to the areolet than to the angle, or at all events in the middle between the two. But in *L. breviventris*, which, as will have been seen, is otherwise anomalous, there are 4 distinct bullæ, B, C, D, and E; C and D being here separated distinctly by a black space nearly twice as long as the vein is wide, and the biangulation being subobsolete. In other respects the bullæ do not differ in this species. Judging from the two species of which I possess numerous specimens, and the three species of which I possess two only, the genus is pretty constant both in size and coloration. In *interpellata*, n. sp., *pictiventris*, n. sp., and *breviventris*, n. sp., traces appear of the abdominal tubercles which are well known to be characteristic of *Ephialtes.*

SECTION I.— *Thorax and legs with white or pale yellow markings.*

Lampronota [**scutellaris**, Cress. Trans. Am. Ent. Soc. iii. p. 161.]—♀.—Black. *Head* very finely punctate, less densely on the vertex, very densely on the face, which is covered with sparse, cinereous pubescence. Orbits narrowly white from the top of the vertex nearly to the mouth. Clypeus, mandibles except their teeth, and palpi, white; the clypeus sometimes pale dull rufous. Antennæ $\frac{4}{5}$ as long as the body, brown-black, dull rufous beneath towards the tip. *Thorax* subopaque with fine dense punctures, the metathorax more coarsely rugoso-punctate, the two normal longitudinal carinæ represented only by a single obtusely impressed stria. Tegulæ and a spot before them, a short line under the front wing, an elongate robust line generally widened above near the tip and overlying the humeral suture nearly to its tip, a large Y-shaped spot on each side of the meso-sternum (the prongs of the Y very rarely subobsolete), a geminate spot on the hind end of the mesosternum very rarely absent, and the sides and tip of the scutel, all white. Disk of the scutel except in a single specimen, meso- and meta-sternum below and half way up their pleura, and occasionally an indistinct vitta above the front wing, all rufous. *Abdomen* subclavate when viewed from above, owing to the length of the 1st joint and joints 6–8 being chiefly retracted. Joint 1 with only a basal trace of the normal carinæ, $2\frac{1}{2}$ times as long as wide and $\frac{1}{2}$ wider behind than in front, with the sides straight. Joints 2–4 with their sides parallel, 2 and 3 equally long and each $\frac{1}{3}$ shorter than 1, 4 shorter by $\frac{1}{3}$ than 3, and 5 about $\frac{1}{2}$ as long as 4. All the visible joints very finely, closely and evenly rugoso-punctate so as to be subopaque. Ovipositor nearly as long as the abdomen, piceous; sheaths broad, tapered to a point, and with very fine, short, dense ciliations. Venter with the sutures broadly whitish. *Legs* pale rufous, the 4 front coxæ except the lower surface of the middle ones, both trochanters of the 4 front legs, the terminal one of the hind legs, and also the hind knees, all whitish. Tips of the 4 front tarsi, extreme tips of the hind femora up to the whitish knees, an exterior vitta on the hind tibia extending from the knee to the tip and towards the tip extending all around, and the whole of the hind tarsi, all pale fuscous. Tarsal claws with very long pectinations. *Wings* subhyaline; veins black, radius rufous; stigma rufous edged with black, and 3 times as long as wide. Areolet rhomboidal, the peduncle as long as the rhomb. Length ♀ .41–.45 inch. Front wing ♀ .35–.37 inch. Ovipos. .27 inch.

Seven ♀; ♂ unknown to me.

Lampronota [**tegularis**, Cress., Trans. Am. Ent. Soc. iii. p. 163].—♂.—Differs only from the preceding ♀ as follows:—1. The entire face except the lateral foveæ at tip, the entire clypeus, a short orbit extending above the antennæ, and a spot on the lower surface of the 1st antennal joint, are all white. Except the above spot, the antennæ are brown-black immaculate. 2. The thorax is more coarsely sculptured, and, except that the tegulæ and a minute line under the front wing are white, all the white and rufous markings of [*scutellaris*, Cress.] are absent. 5. The abdomen is more coarsely punctate, elongate-oval instead of clavate, and of course more elongate. the terminal joints being more opened out and the few last sub-glabrous and polished. Joints 1-3 are proportioned as in [*scutellaris*], 4-7 each about ¼ shorter than the preceding so that 7 is only ⅓ as long as 3. 8 small. 4. The 4 front legs differ in all the coxæ and trochanters being milk-white immaculate, and in the knees and a basal exterior vitta on all 4 tibiæ and the basal ½ of all 4 tarsi being whitish. In the hind legs the coxæ are black lightly tipped with white, the basal trochanters black lightly blotched with white, the terminal ones *vice versa;* the femora, the terminal ⅗ of the tibia and the whole of the tarsi black, the basal ⅖ of the tibiæ white; claws simple. 5. The stigma is black, and the radius only basally rufous. Length ♂ .44 inch. Front wing ♂ .28 inch.

One ♂; ♀ unknown to me. Besides the tarsal claws being unarmed, the total absence of the large white spot before the front wing and the very different coloration of the sternum, which are not, so far as I am aware, sexual characters in *Ichneumonidæ*, would forbid this ♂ being correlated with the preceding ♀. On the other hand, the coloration of the face, antennæ, scutel, and legs, are common sexual characters here, of which many examples occur in *Bassus*, *Ichneumon*, *Pimpla*, etc.

Lampronota amphimilæna, n. sp.—♂.—Differs from [*scutellaris*, Cress.] ♀ only as follows: 1. The white or whitish markings of the latter, whether on the body or on the legs, become here yellow or are obsolete. 2. The face up to the front except the lateral foveæ at the tip, and the entire clypeus, is pale yellow, with a triangular black spot beneath each antenna and an acute black line descending from between the antennæ nearly to the clypeus. The antennæ are brown-black immaculate, except that there is a small pale spot on the basal joint below. 3. Except the 3 pale spots under and before the front wing, the largest one of which is hooked backwards near the tip, and except also that there is a minute pale vitta on each side of the scutel, the thorax is immaculate and more coarsely sculptured. 4. The 2 longitudinal carinæ of the metathorax are distinct but low, and diverge from the first ⅔ of their length, the enclosed space being perfectly level and without any stria. 5. The abdominal joints are proportioned as in [*tegularis*], but the anterior angle of 2 is reflexed into a tubercle. and the spiracles of 1-3 project in a lateral tubercle, each less so than the preceding. 6. Except the basal ¾ of joint 1, the terminal ½ of 5, and the whole of 6-8. the abdomen is rufous. The venter is pale dull rufous except towards the tip and at the extreme base. 7. Instead of the middle coxæ being rufous beneath, they are black on their interior base.

In the hind legs the coxæ and the basal trochanters are black lightly tipped with whitish, the other trochanters pale yellow basally marked with black, and the rest of the leg black except that the knees and the basal ¾ of the tibiæ are pale yellow; claws simple. 8. The peduncle of the areolet is only ½ as long as the rhomb. Length ♂ .52 inch. Front wing ♂ .35 inch.

One ♂ ; ♀ unknown to me. Neglecting the difference in the claws, this ♂ could scarcely be referred to [*scutellaris*] ♀ on account of the wide, rufous band on the abdomen, which, so far as I know, is not a sexual character in this family.

[This is probably only a variety of *L. varia*, Cress., Trans. Am. Ent. Soc. iii. p. 164.—Cresson.]

Lampronota [frigida, Cress., Canadian Entomologist, i. p. 36].—♂.—Differs from [*scutellaris*, Cress.] ♂ only as follows:—1. The white markings of the latter, whether on the body or the legs, become here pale yellow or are obsolete. 2. The entire face, except the lateral foveæ at the tip, and the entire clypeus, are pale yellow, and the orbits are pale yellow up to the top of the vertex, but are interrupted opposite the ocelli by a space rather longer than they are wide, so as to leave a pale yellow dot on the vertex. 3. The antennæ are full as long as the body, brown-black above and below, with the 1st and 2d joints pale yellow beneath. 4. The pale spot before the front wing is prolonged in a slender, pointed line along the lower edge of the humeral suture nearly to its tip, and above the humeral suture there is only a small elongate spot opposite the tip of the preceding. The tegulæ and a short line under the wing, the anterior border of the collare, and the entire mesosternum half way up its pleura, with the exception of its declivous surface in front and a large geminate black spot behind, are also pale yellow. The rest of the thorax is black. 5. The metathorax is entirely opaque, and the longitudinal carinæ are entirely unrepresented. 6. The abdomen is regularly elongate-oval, and the joints are proportioned and sculptured nearly as in [*tegularis*, Cress.], but the terminal ¼ of 1 and the whole of 2–8, except an obfuscation on 8, are rufous. Except the basal ¼ of 1, the whole venter is dull pale rufous. 7 The 4 front legs are pale rufous, with all their coxæ and trochanters pale yellow. The hind legs are pale rufous, with the terminal ½ of their coxæ and the terminal trochanters pale yellow; claws simple. 8. The stigma is black, basally tinged with rufous; and the peduncle of the areolet is scarcely ½ as long as the rhomb. Length ♂ .35 inch. Front wing ♂ .25 inch.

One ♂ ; ♀ unknown to me. Sufficiently distinct from all described N. A. species, except the following, by the interrupted orbits.

Lampronota interpellata. n. sp.—♂.—Differs from [*scutellaris*, Cress.] ♀ only as follows:—1. The white markings of the latter, whether on the body or the legs, become here pale yellow or are obsolete. 2. The entire face, except the two foveæ at the tip, and the entire clypeus, are yellow, and the orbits are pale yellow up to the top of the vertex, but are interrupted just below the ocelli by a space twice as long as they are wide. Beneath each antenna is a minute black triangle, and from between the antennæ there descends half way to the clypeus a capillary black line. 3. The antennæ are brown-black immaculate, and have on the 1st joint below a small, pale dull yellow spot. 4. The pale spot before the front wing is prolonged in a slender, pointed line along the lower edge of the humeral suture nearly to its tip, and above the humeral suture there is only a very minute, elongate spot opposite the tip of the preceding. The tegulæ, a short line under the wing, and a narrow line on the anterior border of the collare, are also pale yellow; but the rest of the thorax is black. 5. The metathorax is entirely opaque. 6. The abdomen has the sides of joints 2–6 exactly parallel, and the terminal joints being more opened out are seen to be subpolished. Joint 1 is only twice as long as wide, and twice as wide behind as before, with its sides straight. Joints 2 and 3, but especially 2, have each a pair of subobsolete tubercles similar to those of *Ephialtes*, and are each $\frac{1}{3}$ shorter than 1, and $\frac{1}{3}$ longer than wide, 4 shorter by $\frac{1}{4}$ than 3, 5–7 each $\frac{1}{2}$ as long as 3, and 8 concealed. The terminal $\frac{1}{5}$ of 1 and the terminal $\frac{1}{3}$ of 2–4 are rufous, the rest of the abdomen black. Venter mostly dull pale rufous. 7. The 4 front legs are rufous, with all their coxæ and trochanters pale yellow. The hind legs are rufous, their coxæ and basal trochanters all black, with the extreme tips whitish, and their terminal trochanters rufous above and pale yellow below; claws simple. 8. The stigma is black with its disk dull rufous, and the peduncle of the areolet is scarcely $\frac{1}{3}$ as long as the rhomb. Length ♂ .34 inch. Front wing ♂ .24 inch.

One ♂; ♀ unknown to me. Very near the preceding, but distinguished at once by the nearly black abdomen and by numerous other characters. The interrupted orbits separate it at once from all other described N.A. species.

Lampronota pictiventris, n. sp.—♂.—Differs from [*scutellaris*, Cress.] ♀ only as follows:—1. The white markings of the latter, whether on the thorax or the legs, become here yellowish-white or are obsolete. 2. The entire head is black, except that the clypeus all but the tip which is more or less of it rufous, the palpi, and the mandibles all but their black teeth, are whitish. 3. The antennæ are brown-black immaculate. 4. The tegulæ and a minute spot before the front wing are whitish, but the rest of the thorax is black. 5. The metathorax is entirely opaque. 6. The abdomen is regularly elongate-oval and the terminal joints are subpolished. Joint 1 is only twice as long as wide, $\frac{1}{2}$ wider behind than before, with its sides straight. Joints 2 and 3 each $\frac{1}{3}$ shorter than 1, but are no longer than wide, 4–7 are each about $\frac{1}{6}$ shorter than the preceding joint, and 8 is scarcely visible. On 2 there is a pair of pretty distinct tubercles, and a subobsolete pair on 3. The extreme tip of joint 3 and the whole of 4 and 5, except a medial black band which on 5 is sometimes interrupted, rufous. The terminal ½ of 6 obscurely rufous. Venter yellow, with an abbreviated, lateral, fuscous vitta on each joint, the entire base of 1 black and the two or three last joints mostly fuscous. 7. The legs are rufous, the front coxæ and trochanters yellowish; in the middle and hind legs the coxæ and the basal trochanters are black tipped with yellowish and the terminal trochanters *vice versa*. Claws simple. 8. The stigma is black, and the petiole of the areolet is only ⅓ as long as the rhomb. Length ♂ .35–.39 inch. Front wing ♂ .26–.27 inch.

Two ♂; ♀ unknown. Very like the preceding, but sufficiently distinct by the black face, the black middle coxæ, and the different fasciation of the abdomen.

Lampronota breviventris, n. sp., ♀.—Differs from [*scutellaris*, Cress.] ♀ only as follows:—1. The white markings of the latter become here yellowish-white or are obsolete. 2. The entire head is black, save that the clypeus is rufous, and the palpi and mandibles, except their black tips, whitish. 3. The antennæ are brown-black immaculate and only ⅔ as long as the body. 4. The tegulæ and a minute spot before them are whitish, but the rest of the thorax is black. 5. The metathorax is perfectly opaque, and its two carinæ are pretty distinct except towards the tip. 6. The abdomen is regularly oval, and the terminal joints are subpolished. Joint 1 is only ¾ longer than wide, 2½ times as wide behind as before, with its sides straight ⅔ of the way from the tip to the base, whence they converge more rapidly. Joint 2 is ⅓ shorter than 1, but is scarcely as long as wide; 3 is a trifle shorter than 2 and ⅙ shorter than wide, and 4–7 regularly and rapidly diminish in length. On joints 2 and 3 there is a pretty distinct pair of the typical tubercles. Basal ⅔ of joint 1 black; the rest of the abdomen rufous. Ovipositor ¼ longer than the body, bright rufous, piceous at the extreme tip; sheaths black, very slender, and of uniform width throughout. Venter yellowish, with an abbreviated, lateral, fuscous vitta on joints 2–4; joint 6 slightly projecting beyond the tip of the dorsum. 7. The legs are rufous immaculate. Claws simple 8. The stigma is black and the petiole of the areolet is very short. Bullæ C and D widely separated, and the 2d recurrent vein scarcely biangulated. Length ♀ .37 inch. Front wing ♀ .26 inch. Ovipos. .45 inch.

One ♀; ♂ unknown to me. But for the differently colored abdomen, and especially the difference in the bullæ, this might be taken for ♀ of *pictiventris*. Differs from all the species but *pictiventris* and *nigrita* by the shortness of abdominal joints 2 and 3, and from all without exception by the bullæ C and D not being confluent. A similar anomaly in these bullæ occurs in *Pimpla annulipes*, Brullé.

SECTION 2.—*Thorax and legs without white or pale yellow markings.*

Lampronota [**americana**, Cress., Trans. Am. Ent. Soc. iii. p. 164].—♀. —Black. *Head* subopaque, densely and rather coarsely punctate. Clypeus and palpi dull rufous, the clypeus polished. Mandibles piceous. Antennæ brown-black, 4/5 as long as the body. *Thorax* subopaque, confluently and rather coarsely punctate; metathorax opaque, coarsely rugoso-punctate, the longitudinal carinæ obsolete. *Abdomen* elongate-ovate, almost microscopically punctate, subpolished; joint 1 slightly rugose, about 2½ times as long as wide, ½ wider behind than before, its sides straight, the usual carinæ fading out at ¼ the way to the tip; 2 and 3 each ¼ shorter than 1, and ½ longer than wide; 4 shorter than 3 by 2/5; the remaining joints rapidly shortened. Basal ¾ of 1 black, the rest of abdomen rufous. Venter pale dull rufous except the basal ¼ of 1; 6 triangularly prolonged beyond the tip by a space nearly equal to ½ the breadth of the abdomen. Ovipositor as long as the body, piceous; sheaths black and of uniform width throughout. *Legs* black, with the front tarsi, the tip of the front tibiæ and sometimes the whole of them and the knees as well, all dull rufous. Claws simple. *Wings* tinged with yellowish smoky; veins black; stigma black tinged with rufous at base, and 3 times as long as wide. Areolet with the peduncle ⅔ as long as the rhomb. Length ♀ .47-.50 inch. Front wing ♀ .35-.39 inch. Ovipos. .50-.53 inch.

Two ♀; ♂ unknown to me. Distinct from all the preceding, and from *rufithorax*, Cress. (Cuba), by the total absence of any white or yellow markings. Comes very near *montana*, Cress., but differs by the 4 hind legs being entirely black, by the wings not being fuliginous, and probably by the unusual prolongation of the 6th ventral, which is not referred to in the description of that species.

Lampronota imitatrix, n. sp. — ♀ —Differs only as follows from the preceding:—1. The size is ¼ smaller. 2. The tegulæ are brownish-white. 3. The longitudinal carinæ of the metathorax are represented by two parallel striæ confluent in front and evanescent ⅔ of the way to the semilunar carina. 4. The abdomen is distinctly but very finely punctate; joint 1 is twice as wide behind as before, and the spiracle projects laterally in a distinct tooth, the sides being otherwise straight; 2 and 3 are each only ¼ longer than wide, and 4 is ⅔ as long as 3. 5. Abdominal joints 5-8 are black both dorsally and ventrally, joint 1 being colored as in [*americana*, Cress.] 6. The 6th ventral is not unusually prolonged. 7. The ovipositor is pale rufous, and is a little shorter than the body. 8. The legs are entirely pale rufous. 9. The wings are subhyaline, the radius pale rufous, and the stigma black, brownish-white at the extreme base and rufous at the extreme tip. The peduncle of the areolet is scarcely ½ as long as the rhomb. Length ♀ .35 inch. Front wing ♀ .23 inch. Ovipos. .29 inch.

One ♀; ♂ unknown to me. Distinct from *rufithorax*, Cress., and from all the preceding but [*americana*, Cress.], by the absence of pale markings, and well separated from [*americana*, Cress.] by the 3d, 5th and 7th characters given above. From *montana*, Cress., it differs in the coxæ and trochanters being all rufous not black, by the wings being subhyaline not fuliginous, and by the black tip of the abdomen.

Lampronota [**rubrica**, Cress., Trans. Amer. Ent. Soc. iii. p. 165].—♀.—Differs only as follows from [*americana*, Cress.]:—1. The size is ½ smaller. 2. The mandibles are dull rufous, except the tips of their teeth which are black. 3. The orbits are white from the insertion of the antennæ to the hind end of the vertex. 4. The scutel, the hind ½ of the mesothoracic pleura, and the entire metathorax except its anterior edge above, are all rufous; and the tegulæ are brownish-white. 5. The longitudinal carinæ of the metathorax are represented by 2 parallel striæ confluent in front and behind attaining the semilunar carina. 6. The abdomen is subclavate, and a spiraculiferous tubercle projects very slightly on each side of joint 1. 7. The abdominal joint 1 is entirely rufous, but joints 6–8 are black. Venter yellowish-white. 8. The ovipositor is rufous, and proportionally ⅕ longer. 9. The legs are pale rufous, with the middle tarsi and the hind tibiæ and tarsi obfuscated. 10. The wings are subhyaline, with the radius rufous; the stigma is black, brownish-white on its basal ⅓, and only 2½ times as long as wide. Areolet scarcely peduncled. Length ♀ .23–.25 inch. Front wing ♀ .18 inch. Ovipos. .30 inch.

Two ♀; ♂ unknown to me. Sufficiently distinct from all described N. A. species by the black mesothorax and rufous scutellum.

Lampronota nigrita, [Walsh, Trans. Am. Ent. Soc. iii. p. 159].—♂♀.—Differ from [*americana*, Cress.] ♀ only as follows:—1. The whole body is black, much more robust, and, except the abdomen, obviously pubescent. 2. The head is opaque and, including the mouth, immaculate; the face with long pubescence, and the clypeus opaque and punctate. 3. The metathorax is punctured like the mesothorax, and in ♂ the tegulæ are sometimes pale dull rufous. 4. The abdomen is immaculate, oval, about 4 times as long as wide ♀, 5 times ♂, subpolished, with very minute, dense punctures, more sparse towards the tip and tips of the joints. Joint 1 with some rather coarse longitudinal rugæ near the tip, its sides straight save that they are slightly incurved at the extreme base and tip, especially ♀; ♀ ½ ♂ ¾ longer than wide, ♂ ♀ ¾ wider behind than before. Joint 2 shorter by ⅕ than wide ♀, square ♂; joint 3 ♂ ♀ a little shorter than 2; the rest rapidly, especially in ♀, shorter and shorter. Ovipositor ⅓ as long as the body, piceous, basally curved upwards; sheaths black, not tapered, as wide as the last tarsal joint of the hind legs. Venter blackish, in ♀ a little excavated and strongly carinate longitudinally to the tip, with joint 6 no longer than the dorsum, in ♂ excavated. 5. The legs ♀ are black immaculate, in a bred ♀ rufous except all the coxæ and trochanters and the 4 front femora, the tibiæ and tarsi with a whitish reflection from dense, short pubescence. Legs ♂ black, the extreme tips of all the femora, and sometimes in the 4 front legs their upper surface also, and always all the tibiæ and tarsi, dull pale rufous. ♂ ♀ Claws simple. 6. The wings ♂ ♀ are subhyaline, tinged more or less with smoky yellow; veins and stigma black. Areolet rhomboidal, the 2d recurrent vein entering it rather nearer the base than the tip of the wing, the peduncle about ½ as long as the rhomb, and the bulla CD without any black dot. Length ♂ .37–.50, ♀ .35–.45 inch. Front wing ♂ .29–.37, ♀ .28–36 inch. Ovipos. .11–.16 inch.

Two ♂, four ♀. One ♂ was captured Mar. 4, and one ♀ captured Ap. 19, and another ♀ was bred from a small lepidopterous pupa, inside the split integument of which it had spun its white cocoon. Distinct from all the preceding by its immaculate black body, and from all but *pictiventris* and *breviventris* by the short intermediate joints of its abdomen.

[This belongs to the genus *Arenetra*, Holmgren.—CRESSON.]

GENUS GLYPTA, Gravenhorst.

In this well-marked genus the bullæ are but three in number, C, D, and E; and sometimes but two, CD and E, C and D being usually separated only by a minute black dot, which often terminates in the usual stump of a vein, while occasionally, but only in those species where the salient angle of the biangulated 2d recurrent vein is obsolete, the black dot is obsolete and C and D become completely confluent. C and D are located well forwards on their vein, and E pretty close to the angle of its vein. In both those two species of which I possess numerous specimens, the coloration, especially that of the legs, is very constant. In one of the two the size is also remarkably constant, while in the other it varies considerably. On the whole, *Glypta* may be considered as a pretty constant genus The colors are black and rufous with more or less white markings.

SECTION 1.—*Hind legs not annulate with white. Abdomen black. Clypeus white.*

Glypta simplicipes, [Walsh, Trans. Am. Ent. Soc. iii. p. 156.]—♀.—Black. *Head* rather coarsely punctate, sparsely on the vertex which is subpolished, and more closely on the face which is subpubescent and opaque. Face with a wide, flat, discoidal tubercle, more obvious in some specimens than in others, but always opaque and sculptured like the face. Clypeus and mandibles, except their teeth, white. Labrum piceous, occasionally rufous. Palpi very pale rufous. Antennæ ¾ as long as the body, brown-black, dull rufous beneath except the scape. *Thorax* subopaque, rather coarsely punctate; metathorax more coarsely rugoso-punctate and with the carinæ distinct. Tegulæ, an acutely pointed line under the humeral suture, usually extending nearly to its tip and robustly clavate at base, occasionally extending only half way to its tip, and a terminal quadrangular spot on the scutel, all white. *Abdomen* subopaque, rather coarsely punctate, polished and subglabrous towards the tip. Joint 1 longer by ½ than broad and ⅓ wider behind than before, with the two usual carinæ lofty on the basal ¼, thence subobsolete. Ovipositor scarcely ⅔ as long as the body, rufous, darker at base; sheaths black, gradually and slowly tapered, about as wide at base as the last tarsal joint of the hind leg. Venter whitish, sometimes blackish towards the tip. *Legs* pale bright rufous, the anterior coxæ very rarely blotched with white in front. Hind legs with the terminal ½ or sometimes ¾ or occasionally ¼ of the tibiæ gradually black; tarsi black; extreme tip of the femora very rarely fuscous. *Wings* subhyaline tinged with smoky yellow; veins black; stigma dark rufous edged with black, sometimes all black; 2d recurrent vein distinctly biangulated. Length ♀ .37–.40 inch. Front wing ♀ .31–.34 inch. Ovipos. .26–.28 inch.

Fourteen ♀; ♂ unknown to me. Distinguishable from *varipes*, Cress., and from all other species here described but *albiscutellaris* by its white scutel, and from that by its hind legs not being annulate with black and white.

SECTION 2.—*Hind legs multiannualate with black and white. Abdomen and clypeus black.*

Glypta tuberculifrons, [Walsh, Trans. Am. Ent. Soc. iii. p. 152.]—♂ ♀. —Differ from *simplicipes* only as follows:—1. The tubercle on the face is large and obvious, varying in prominence but generally semicircular on a profile view, its tip always polished and sparsely punctate. 2. The clypeus and mandibles are entirely black, the clypeus with a small, subpolished, flattish tubercle on the middle of its anterior edge. 3. The thorax is subpolished and less strongly sculptured. The white line under the humeral suture never extends further than half way to the tip, and sometimes less, the scutel is immaculate, and the metathoracic pleura where it adjoins the coxa is always rufous for a small space. 4. The venter is more generally blackish. 5. The ovipositor is proportionally a little shorter, and the sheaths are basally 1½–2 times as wide as the last tarsal joint of the hind leg, and much more suddenly tapered. 6. The legs are pale bright rufous, but in the front legs the coxæ and both trochanters are white, the coxæ and basal trochanters sometimes lightly spotted, or very rarely, and in ♀ only blotched strongly, with rufous. In the middle leg the 2d trochanter is white, the tibia has its basal ⅓ whitish and its extreme tip black, the intervening space rufous internally and externally whitish, with a pale dusky semi-fascia at the basal end; tarsi white, tips of all the joints dusky. In the hind leg the terminal ¼ of the femur is black, the tibiæ are white with their 2d and terminal ⅓ black, and the tarsi are black with the basal ½–⅓ of joints 1–3 white. Spurs of 4 hind legs white tipped with black. 7. The stigma is black, the base and occasionally the tip dull rufous, the radius is dull rufous, and the salient angle in the biangulated 2d recurrent vein is subobsolete or obsolete. Length ♂ .51-.55 inch; ♀ .33-.56 inch. Front wing ♂ .36-.37 inch; ♀ .27-.40 inch. Ovipos. .22.-.30 inch.

Three ♂; eight ♀. In this species there are absolutely no sexual variations, except that the white markings of the legs are, as usual, brighter in ♂. Comes near *varipes*, Cress., but that species is expressly stated to have all the coxæ ferruginous, and nothing is said of any of its trochanters being other than ferruginous. Moreover its ovipositor is "about as long as the body," instead of being little more than half as long, and the description of the hind tibiæ does not agree at all.

Glypta diversipes, n. sp.—♀.—Differs from *simplicipes* ♀ only as follows:—1. The tubercle on the face is large and obvious, but not near as prominent as in *tuberculifrons*, and its tip is polished and sparsely punctate. 2. The clypeus is black, the mandibles rufous including their teeth, and the palpi are whitish. Labrum not seen. Antennæ brown-black immaculate. 3. The thorax is subpolished and less strongly sculptured, the white line under the humeral suture is less robust and only extends half way to tip of the suture, and the scutel is immaculate. 4. The carinæ on abdominal joint 1 extend distinctly $\frac{2}{3}$ of the way to the tip, whence they become subsolete. 5. The ovipositor is full $\frac{2}{3}$ as long as the body, and is black except the rufous tip. 6. The legs are pale rufous. In the 4 front legs the coxæ, both trochanters, the knees, the exterior face of the tibiæ, and the entire tarsi except their fuscous tips, are all white; but the middle coxæ are anteriorly rufous except at tip. In the hind legs the terminal $\frac{1}{2}$ of the basal trochanter, and the whole of the second one, are white; the extreme tips of the femora are fuscous; the tibiæ are white with their terminal $\frac{4}{5}$ interiorly dusky, the dusky vitta prolonged a little laterally at its base so as to foreshadow a black annulus, and on the terminal $\frac{1}{5}$ forming a complete black annulus; and the tarsi are black with the basal $\frac{1}{2}$-$\frac{1}{3}$ of joints 1-3 white. Spurs of all the legs white. 7. The wings are hyaline, veins black, radius rufous, stigma pale rufous edged with black, the salient angle in the biangulated 2d recurrent vein obsolete, and the bullæ C and D confluent, with an exterior dusky dot at the point of confluence. Length ♀ .30 inch. Front wing ♀ .25 inch. Ovipos. .21 inch.

One ♀; ♂ unknown to me. Very near *varipes*, Cress, but differs in the 4 front coxæ and trochanters being all more or less white. The unusual coloration of the hind tibia agrees very well with that species.

Glypta rufiplaralis, n. sp.—♂.—Differs from *simplicipes* ♀ only as follows:—1. The tubercle on the face is large and obvious, but not near as prominent as in *tuberculifrons*, and its tip is polished and sparsely punctate. 2. The clypeus and mandibles are black and the palpi whitish.

Labrum not seen. The antennæ are full $\frac{4}{5}$ as long as the body. 3. The thorax is subpolished and less strongly sculptured; the white line before the front wing becomes a mere white spot; the scutel is immaculate; and the pleura is rufous half way up from the middle and hind coxæ. 4. The carinæ on abdominal joint 1 extend distinctly $\frac{2}{3}$ of the way to the tip, whence they become subobsolete; and the terminal $\frac{1}{3}$ of 1 and the whole of 2, except an obfuscation on each of the 3 tubercles, are rufous. 5. . . . 6. The legs are pale rufous. In the front legs the coxæ and both trochanters are white. In the middle legs the 2d trochanter is white and the tarsi dusky, with the basal $\frac{1}{2}$–$\frac{1}{3}$ of joints 1–3 white. And in the hind legs the extreme tip of the femora is black, the tibiæ are white with their 2d and terminal $\frac{1}{5}$ black, and the tarsi are black with the extreme base of joints 1–3 white. Spurs of all 4 hind legs white, lightly tipped with fuscous. 7. The wings are subhyaline, veins black, radius rufous, stigma pale rufous edged with black. the salient angle of the 2d recurrent vein obsolete, and the bullæ C and D confluent, with a minute, exterior, dusky dot at the imaginary point of confluence. Length ♂ .25 inch. Front wing ♂ .19 inch.

One ♂; ♀ unknown to me. Might be taken for the ♂ of *diversipes*, n. sp., but that it differs in its black mandibles, its partly rufous thorax and abdomen, and in the coloration of the legs. From *varipes*, Cress., it differs still more widely than does *diversipes*. I observe that in *tuberculifrons*, ♂ ♀ the rufescence of the pleura is perfectly constant throughout my eleven specimens.

Glypta rufiscutellaris, [Walsh, Trans. Am. Ent. Soc. iii. p. 153.]—♂♀.—Differ from *simplicipes* ♀ only as follows:—1. The tubercle on the face is large and obvious, but not near as prominent as in *tuberculifrons*, and its tip is polished and sparsely punctate. The clypeus and mandibles are black and the palpi whitish. Labrum not seen. Antennæ generally brown-black immaculate, rarely dull rufous beneath in the middle. 3. The thorax is subpolished and less coarsely punctate; the white line under the humeral suture almost always extends nearly to its tip, but is occasionally abbreviated terminally by full one-half; and the whole scutellum or occasionally only the terminal $\frac{1}{2}$. the lateral lobes of the mesonotum generally, the lower face of the sternum generally, and always about half way up its pleura from the middle and hind coxæ, are all rufous. 4. The carinæ on abdominal joint 1 extend full $\frac{3}{4}$ of the way to its tip, whence they become subobsolete. 5. The ovipositor is black except its rufous tip, and the sheaths are a little wider at base than the last tarsal joint of the hind leg. 6. The legs are pale rufous. In the front legs the coxæ, both trochanters, the knees, the entire face of the tibiæ, and the entire tarsi except their fuscous tips, are all white. In the middle legs the extreme tip of the coxæ, and sometimes, in addition, the whole interior face, both trochanters, and the knees, are all white; the tibiæ are whitish with their 2d and terminal $\frac{1}{5}$ very pale dusky; and the tarsi are dusky with the basal $\frac{2}{3}$-$\frac{1}{3}$ of joints 1-5 white. In the hind legs the 2d trochanter and the knees are white; the extreme tip of the femora as far as the white knees is black; the tibiæ are white with their 2d and terminal $\frac{1}{5}$ black, the two black annuli more or less elongated towards each other on the interior face; and the tarsi are black with the basal $\frac{1}{2}$-$\frac{1}{3}$ of joints 1-5 white. Spurs of all 4 hind legs white. 7. The wings are subhyaline; veins black, radius rufous; stigma pale or dark rufous edged with black, sometimes entirely black; salient angle of the 2d recurrent vein obsolete, and the bullæ C and D confluent, with a minute, exterior, dusky dot at the point of confluence. Length ♂ .17 inch; ♀ .23-38 inch. Front wing ♂ .15 inch; ♀ .18-.33 inch. Ovipos. .13-.20 inch.

One ♂, bred Aug. 15 from some of the Microlepidoptera that burrow in the gall *Sallicis brassicoides*, Walsh; five ♀, one bred Apr. 5 from the gall on the Solidago inhabited by *Euryptychia saligneana*, Clemens, another Sept. 20 from Microlepidopterous larva that mines the gall *Quercus prunus*, Walsh, and a third found dead in the Cecidomyidous gall *Salicis strobiloides*, O. S., where it had doubtless preyed on some of the Microlepid optera that are inquilinous in that gall. In the first and last of the above galls I have repeatedly found a robust, bright orange-color larva enclosed in a tough, opaque, brown cocoon, which I have little doubt appertains to this species, though I failed to breed the imago from isolated specimens. This *Glypta* is very near both the preceding, but may be distinguished at once by the rufous scutellum, and by several minute but apparently constant characters. The variation in the coloration may perhaps be partly due to some of my bred specimens having been prematurely killed.

Glypta albiscutellaris, n.sp.—♂.—Differs from *simplicipes* ♀ only as follows:—1. The tubercle on the face is large and obvious, but not near as prominent as in *tuberculifrons*, and its tip is polished and sparsely punctate. 2. The clypeus and mandibles are black and the palpi whitish. Labrum not seen. Antennæ brown-black, dark reddish-brown except the scapus beneath. 3. The thorax is subpolished and less coarsely punctate; the white line under the humeral suture is wide and of nearly uniform width throughout and extends to the tip of the suture: and the scutel and a narrow transverse line behind it are white. A broad vitta inside the origin of the front wing, the lower surface of the sternum and its pleura full half way up from the middle and hind coxæ, are all pale rufous, verging beneath upon white. Mesothoracic spiracle black. 4. The carinæ on abdominal joint 1 extend $\frac{1}{2}$ way up to its tip, and are thence subobsolete. 5. . . . . . 6. The 4 front legs are white with the tips of the tarsal joints lightly obfuscated. The hind legs are white with the femur pale bright rufous, except the knee which is white and the extreme tip before the knee which is black; tibiæ with their second $\frac{1}{5}$ externally black, and their terminal $\frac{1}{5}$ black all around; tarsi black with the basal $\frac{1}{2}$–$\frac{1}{3}$ of joints 1–5 white. Spurs of all 6 legs white. 7. The wings are hyaline; veins black; stigma black, rufous at base; the 2d recurrent vein scarcely biangulated and with bullæ C and D confluent. Length ♂ .25 inch. Front wing ♂ .20 inch.

One ♂; ♀ unknown to me. Distinct from all N. A. *Glypta* but *simplicipes* by its white scutel, and from that species by its black clypeus, pale sternum and legs, etc.

SECTION 3.—*Hind legs multiannulate with white and black. Abdomen black. Clypeus white.*

Glypta longiventris, [Walsh, Trans. Am. Ent. Soc. iii. p. 154.]—♀.—Differs from *simplicipes* ♀ only as follows:—1. The tubercle on the face is large and obvious, but not near as prominent as in *tuberculifrons*, and its tip is polished and sparsely punctate. 2. The palpi are whitish, and the antennæ are dull rufous beneath only on their terminal $\frac{1}{2}$, and on the terminal $\frac{1}{2}$ of joint 1 and the whole of joint 2. 3. The thorax is subpolished and less coarsely punctate; and the metathoracic carinæ, except the lunate area on the posterior declivity and the 2 longitudinal carinæ for $\frac{2}{5}$ of the way to the lunate area, are obsolete. The scutel is immaculate, but the meso- and meta-sternum, and also the pleura for a small space above the middle and hind coxæ, are rufous. 4. The abdomen is longer and slenderer than usual, and the carinæ of joint 1 extend about $\frac{1}{2}$ way to its tip, whence they gradually fade out. 5. The ovipositor is piceous, rufous at tip, full $\frac{2}{3}$ as long as the body; and the sheaths are basally $\frac{1}{2}$ wider than the last joint of the hind tarsus, and taper much towards the tip. 6. The legs are pale rufous. In the front legs the coxæ except some rufous blotches, both trochanters, the knees, the anterior face of the tibiæ, and the tarsi, are all white. In the middle legs both trochanters, the knees, the anterior face of the tibiæ except an external obfuscation on its 2d and terminal $\frac{1}{5}$ and the spurs, are all white; and the tarsi are dusky, with the basal $\frac{1}{2}$–$\frac{1}{3}$ of joints 1–5 white. In the hind legs both the trochanters are white, the basal one with a median fuscous annulus; the extreme tip and a basal cloud on the femora are black; the tibiæ are white, with their 2d and terminal $\frac{1}{5}$ black; and the tarsi are black, with the basal $\frac{1}{2}$–$\frac{1}{3}$ of joints 1–5 white; spurs blackish, white at base. 7. The wings are subhyaline; veins dusky, radius pale rufous; stigma pale rufous, whitish at base, the bounding vein in front dusky; 2d recurrent vein with its salient angle obsolete, and the bullæ C and D confluent.

The ♂ differs from ♀ as follows—1. The space between the origin of the mandibles and the eye, and sometimes the entire face $\frac{2}{3}$ of the way to the antennæ, is white, as well as the clypeus. 2. The antennæ are beneath dull rufous throughout, except the scape which is either entirely white beneath, or has the basal $\frac{1}{2}$ of joint 1 black. 3. The metathoracic carinæ are sometimes partially obsolete, precisely as in ♀, sometimes pretty distinct. 4. The entire prosternum and a line on the upper $\frac{2}{3}$ of the anterior edge of the collare are white; and the rufous color on the meso- and metathoracic pleura extends half way up to the wings. 5. The front coxæ have no rufous blotches; the middle coxæ are white with rufous blotches, instead of being rufous; the two obfuscations on the middle tibiæ are much more distinct; and in the hind legs the extreme tip of the coxa is white, the space intervening between the 2d and terminal $\frac{1}{5}$ on the tibia is sometimes pale rufous instead of white, and the spurs are sometimes entirely white. Length ☿ .34–.37 inch; ♀ .33 inch. Front wing ☿ .23–.27 inch. Ovipos. .23 inch.

Two ☿; one ♀. Distinguishable from *varipes*, Cress., and from all the preceding but *simplicipes*, by its white clypeus, and from that species by its rufous sternum and multiannulate hind legs.

Glypta ruficornis, n. sp.—☿.—Differs from *simplicipes* ♀ only as follows:—1. The facial tubercle is very slightly polished and a trifle more prominent. 2. The mandibles are pale rufous with their teeth black, and the palpi are whitish. The antennæ are opaque rufous above and below, except joint 1 which is black and polished. 3. The thorax is subpolished and less strongly sculptured, the metathoracic carinæ distinct. The white line before the front wing is very short, and the scutel is immaculate. 4. The carinæ on abdominal joint 1 extend $\frac{2}{3}$ of the way to the tip, whence they become subobsolete. 5. . . . . 6. The legs are pale rufous; the 4 front legs with the coxæ, both trochanters, and the knees, white, and the spurs and tarsi whitish; the hind legs with the 2d trochanter white, the extreme tip of the femora black, the tibiæ white with their 2d and terminal $\frac{1}{5}$ black, and the tarsi black with the basal $\frac{1}{2}$–$\frac{1}{4}$ of joints 1–5 white; spurs blackish. 7. The wings are subhyaline; veins black; stigma rufous edged with black, and the 2d recurrent vein with the salient angle obsolete, and bullæ C and D confluent. Length ♂ .27 inch. Front wing ♂ .22 inch.

One ♂; ♀ unknown to me. Distinct from *longiventris* by its rufous mandibles and antennæ, its black sternum, and the different ornamentation of its legs; from *varipes*, Cress., and all the preceding but *simplicipes* and *longiventris*, by its white clypeus; and from *simplicipes* by its rufous mandibles and antennæ, and its entirely different legs.

SECTION 4.—*Hind legs multiannulate with black and white. Abdomen black with white bands. Clypeus white.*

Glypta [**scitula**, Cress., Trans. Am. Ent. Soc. iii. p. 155.]—♀.—*Head* subglabrous, polished, scarcely pubescent; facial tubercle very small and imbedded in a carina which descends from between the antennæ nearly to the clypeus; general color black, with an orbit entirely surrounding the eye, the face except a minute elongate spot under each antennæ, the clypeus, the mandibles except their teeth, and the palpi, all white Antennæ brown-black above, dull rufous below except the 1st joint which is black tipped below with white. Thorax sparsely and very finely punctate, polished, the carinæ of the metathorax obsolete. General color a pale bright rufous. Tegulæ white; lateral lobe of the mesonotum with a black vitta which occupies its disk and is edged internally by a white line, the terminal $\frac{1}{3}$ of the lobe white and confluent with a broad white vitta which extends broadly below, and very narrowly above the humeral suture to its tip; middle lobe of the mesonotum with its terminal $\frac{2}{5}$ black. Scutel white at its tip, with a round, discoidal, black spot on its highest part. Lower surface of the sternum with its medial suture black in front, and a small blackish spot behind the anterior acetabulum. Metathorax black above, laterally white with a black line on the anterior submargin; a curved, white, capillary line, confluent in front with a transversely oblong white spot behind the scutel, extends from the origin of one hind wing round the tip of the scutel to the origin of the other; and there is a transverse white line on the upper edge of the posterior declivity of the metathorax. *Abdomen* black, subpolished, with fine but not dense punctures; joint 1 longer by $\frac{1}{4}$ than wide and twice as wide behind as before, with the usual carinæ obsolete, but with the same oblique, lateral striæ as joints 2–5; hind and lateral edge of 1–7 conspicuously white. Ovipositor $\frac{1}{2}$ as long as the body, rufous; the sheaths black, basally $\frac{1}{2}$ wider than the last tarsal joint of the hind leg, and tapered to the tip, which is obtuse, so as to be there of the same width as that joint. Venter whitish. *Legs* white. The 4 front legs with their femora very pale rufous. The hind legs, with the basal $\frac{2}{3}$ of their coxæ and a lateral spot on the basal trochanter, black; femora bright pale rufous, with a basal cloud and their extreme tip, except the white knees, black; tibiæ with their second $\frac{1}{5}$ laterally and their terminal $\frac{1}{5}$ all round, black; tarsi dusky, except the basal $\frac{1}{2}$ of joint 1. *Wings* subhyaline; veins black; stigma black, basally pale rufous: the 2d recurrent vein with its salient angle obsolete, and the bullæ C and D confluent and smaller than usual. Length ♀ .21 inch. Front wing ♀ .18 inch. Ovipos. .10 inch.

One ♀; ♂ unknown. This is one of the loveliest ichneumon-flies known to me, the black, red and white colors being most artistically arranged, so as to produce very striking contrasts. Entirely distinct from all other N. A. *Glypta* known to me by the banded abdomen.

GENUS PIMPLA, Fabr.

This very extensive genus will probably be eventually subdivided into two or more genera. At all events *melanocephala*, Brullé, with its pale rufous body, its subpentagonal areolet, its well-developed metathoracic carinæ, its long 1st abdominal joint, and its robust legs, is very unlike any of the species that here follow it. Remarkable sexual variations in the structure of the

1st abdominal joint occur in *conquisitor*, Say, *inquisitor*, Say, and *scriptifrons*, n. sp.; and the coloration of the coxæ and trochanters varies sexually in several other species according to the usual law, viz. that ♂ legs are lighter-colored than ♀ legs. The size varies enormously in *annulipes* and *conquisitor*, Say, and would probably be found to do so in other species also if we could generalize on an equally large number of specimens. The coloration, on the contrary, is very constant, especially in the legs. The bullæ are 5 in number, A placed above B on the terminal side of the areolet, the two being generally separated only by a very minute space, and in *annulipes* being confluent; C and D generally separated by a considerable space, but in the above-named species sometimes only by a minute space and sometimes not at all; and E rather further from the areolet than from the angle of the 1st recurrent vein.

SECTION 1.—*Areolet subpentagonal.*

Pimpla melanocephala, Brullé.—♀.—Yellowish-rufous. *Head* black, subopaque, with rather sparse, very fine punctures, polished on the vertex; a geminate, roundish, rufous spot transversely arranged under the antennæ. Mandibles except their teeth rufous. Palpi pale yellowish-rufous. Antennæ nearly as long as the body, brown-black, the scape and the extreme base of the flagellum yellowish-rufous beneath; 1st joint of flagellum 2½ times as long as wide. *Thorax* polished, with sparse, almost microscopic punctures, more close-set above; the mesonotum reddish-brown, except the scutel and a line on each parapsidal groove. Metathorax (as in *Ichneumon* generally) with an elongate central area and lateral triangular area, which last however is not bisected by any transverse carina; the area on each side these last punctate and subopaque; the area of the posterior declivity hexagonal. *Abdomen* polished, with sparse, almost microscopic punctures; the normal tubercles subobsolete. Joint 1 narrower by ⅓ at the tip than the base of 2, full ½ longer than wide, its sides nearly parallel except on the basal ⅓ where they gradually converge; the usual 2 carina distinct and nearly attaining the tip. Joints 2–8 tinged with reddish-brown towards their base. Ovipositor rufous, about ½ as long as the body; sheaths black, very finely and sparsely pubescent, scarcely tapered, ½ as wide as the last tarsal joint of the hind legs. *Legs* short and robust. Tarsal claws robust, and, as well as the whole of the last joint of the hind tarsi, brown. *Wings* subhyaline, tinged with smoky yellow and at their extreme tip with fuscous; veins black, radius rufous; stigma rufous, its disk paler; areolet pentagonal, its anterior side only ½ as long as either of the adjacent sides, and the 2d recurrent vein entering it ⅔ of the way to its tip. Bullæ normal; C and D pretty wide apart. Length ♀ .37 (Brullé .56) inch. Front wing ♀.33 inch. Ovipos. .17 (Brullé .20) inch.

The ♂, which was unknown to Brullé, only differs in the entire flagellum except the extreme tip being rufous beneath, in its 1st joint being only twice as long as wide, and in the stigma being entirely yellowish-rufous, the bounding veins black. Length ♂ .29-.39 inch. Front wing ♂ .25-.33 inch.

Two ♂; one ♀. Closely allied to, and perhaps identical with, *fuscicornis*, Brullé (Guadeloupe). Has a different habit, owing to its robust legs and elongate 1st abdominal joint, from any of my other species; but is probably, judging from the colorational pattern, allied to *cubensis*, Cress., which is expressly stated to have rather stout legs, and to five other Cuban species described by Mr. Cresson, none of which however have a black head like *melanocephala*. From *nigriceps*, Brullé (Chili), which has a black head, it is separated at once by having no transverse carina on abdominal joints 2-5. I have no other species of *Pimpla* that has the carinæ of the metathorax all well-developed.

[This belongs to the genus *Theronia*, Holmgren.—CRESSON.]

SECTION 2.—*Areolet rhomboidal or rhomboido-triangular.*
† *Hind tibiæ with no white bands.*

Pimpla pedalis, Cresson.—♂ ♀.—It may be added to Mr. Cresson's somewhat brief description, based on a single ♂ specimen, that the palpi are often rufous towards their tips rather than fuscous, and generally have a rufous tinge throughout; and that the 1st joint of the flagellum is about 3½ times as long as wide in ♂, and 5 times as long as wide in ♀. The metathoracic carinæ are usually obsolete, with the exception of a small basal portion of the two middle ones. These last, however, are sometimes prolonged and crossed at tip by another one, so as to form a tolerably distinct central area, about ½ longer than wide. The wings in all my specimens are subhyaline, generally with a smoky-yellow tinge; the stigma is basally whitish; and the areolet is rhomboido-triangular, the 2d recurrent vein entering it ⅔ of the way from its basal to its terminal angle. Bullæ normal; C and D pretty wide apart. The legs are very bright (not "dull") rufous; it is only the basal ⅔-¾ of the front coxæ that is black in ♂, though in ♀ all but the very extreme tip, and sometimes the whole coxæ, is so; and the extreme tip of the hind femur is always black ♂ ♀. The abdomen, except towards its tip and on the terminal margin of the joints, is confluently punctate so as to have an opaque appearance, and the usual tubercles are subobsolete, and sometimes, especially in ♀, almost undistinguishable. Joint 1 is ½ longer than wide, ¾ wider behind than before, with the usual two carinæ reaching ¾ of the way to the tip, and enclosing between them on the basal ½ of the joint a polished, nearly circular excavation. The ovipositor is scarcely half as long as the body, piceous, and the sheaths are black with very short and very fine pubescence, and half wider than the last tarsal joint of the hind leg. Length ♂ .37–.54 inch; ♀ .58–.64 inch. Front wing ♂ .31–.40 inch; ♀ .49–.53 inch Ovipos. .28–.30 inch.

Seven ♂; three ♀. Mr. Cresson's specimen was probably alcoholic, which may account for the discrepancies in the color of the legs and wings. There are no other sexual distinctions than the usual stoutness of the ♂ antennæ, and the slight difference in the coloring of the front coxæ. The tegulæ in all my specimens are black, which is unusual in this genus. It is possible the ♂ of *pedalis* that Brullé has erroneously correlated with his ♀ *rufipes* from S. Am. At all events his brief description agrees with *pedalis*. The ♀ is very like *instigator* ♀ (Europe), but that species has rufous legs, with all the coxæ and trochanters and the hind tarsi black ♀.

Pimpla [pterelas, Say.]—♀.—Black. *Head* perfectly glabrous and highly polished. Palpi dull dark rufous. Antennæ $\frac{2}{3}$ as long as the body, with the 1st joint of the flagellum $3\frac{1}{2}$ times as long as wide, brown-black, tinged with rufous beneath towards their tips. *Thorax* polished, sparsely and finely punctate, glabrous on the mesosternum and its pleura; the two carinæ of tne metathorax extending to the posterior declivity, the others obsolete. Tegulæ yellowish-white. *Abdomen* polished, rather coarsely and closely punctate except behind and on the tips of the joints, the usual tubercles pretty distinct. Joint 1 longer by $\frac{1}{4}$ than wide and $\frac{1}{2}$ wider behind than before, the usual carinæ extending $\frac{3}{4}$ of the way to the tip and enclosing between them on the basal $\frac{1}{2}$ of the joint a polished oval excavation. Ovipositor piceous, full $\frac{1}{2}$ as long as the body; sheaths black, scarcely tapered, rather hairy than pubescent, the hairs dense and long, and the sheath including its hairs scarcely wider at base than the last tarsal joint of the hind legs. Venter dull whitish. *Legs* bright pale rufous, immaculate save the usual obfuscation of the tarsal tips. *Wings* subhyaline, tinged with smoky yellow; veins black, radius rufous except towards the stigma; stigma black, its basal $\frac{1}{4}$ whitish. Areolet rhomboido-triangular, the 2d recurrent vein entering it scarcely $\frac{2}{3}$ of the way to its tip. Bullæ all distinct and normal, C and D very wide apart. Length ♀ .37 inch. Front wing ♀ .29 inch. Ovipos. .22 inch.

One ♀; ♂ unknown to me. Differs from the preceding by the glabrous and highly polished face, the pale tegulæ, the hairy sheaths, and the immaculate legs.

†† *Hind tibiæ black with a medial white band.*

Pimpla annulipes, Brullé.—♂ ♀.—Differ from [*pterelas*, Say,] ♀ only as follows:—1. The head is sparsely and finely punctate, especially on the face, which is sometimes so pubescent as to appear opaque, sometimes has the pubescence mostly removed so as to be subpolished. A minute, glabrous tubercle on the disk of the face. 2. The palpi are generally dull dark rufous in ♀, sometimes pale rufous, sometimes almost whitish, but in ♂ they are always whitish. The antennæ are about $\frac{4}{5}$ as long as the body, the 1st joint of the flagellum in ♂ 3–3½ times, in ♀ 4–5 times, as long as wide, the entire flagellum ♂♀ tinged with rufous beneath. 3 The thorax is finely and sparsely punctate both above and below, and the metathorax is confluently and rather coarsely punctate, and usually more or less covered with fine whitish pubescence so as to be opaque, the posterior declivity and a small area behind the scutel glabrous and polished, the two glabrous areas never quite confluent. Carinæ all obsolete, except a small basal portion of the two central ones. 4. The abdomen is confluently punctate and opaque; the usual tubercles are subobsolete; and the sides and extreme tips of the intermediate joints are often more or less tinged with sanguineous in ♀, sometimes conspicuously so, but never in ♂. In joint 1 the usual carinæ scarcely extend half way to the tip, and enclose between them a glabrous, circular, subbasal excavation. 5. The ovipositor is ½ as long as the body; the sheaths pubescent, scarcely tapered, and basally rather narrower than the last tarsal joint of the hind legs. Venter dull rufous, blackish at tip, sometimes all blackish except the extreme base. 6. The legs are pale bright rufous, but in the front legs of more than ¼ of the ♂♂ the trochanters are whitish, in the middle legs ♂♀ the second ¼ of the tibia is whitish, and very rarely the first ¼ and the terminal ½ blackish exteriorly; and in the hind legs the ♂♀ extreme tips of the femora and the whole tibia except the second ¼ are black, and the tarsi are pale dusky, often with the base of each joint gradually a little paler. 7. The areolet is mostly rhomboidal, very rarely subtruncate anteriorly, but never peduncled. The bullæ A and B are confluent, and C and D sometimes separated by a small space and sometimes quite confluent. Length ♂ .14–.44 inch; ♀ .20–.47 inch. Front wing ♂.11–.33 inch; ♀ .20–38 inch. Ovipos. .10–.19 inch.

Twenty-six ♂; twenty-seven ♀. I bred a single ♀ from a small Lepidopterous pupa. The variation in size is enormous, but all the intermediate grades occur, and the variations enumerated in the description are not correlated with size. In *P. conquisitor*, Say, the size is almost as variable. Very near *tenuicornis*, Cress., described from a single ♀, but differs in the metathorax not being "indistinctly sculptured," in the tegulæ being always white not "piceous," in the anterior coxæ being never black, and in the middle tibiæ being always annulate with whitish and the tips of the hind femora black. Brullé describes only the ♀, and says that "it is only *behind* that the middle tibiæ are black"; whereas it is only on their *exterior* (or superior), not on their *posterior*, surface that they are ever black, and even then but rarely so. Sanguineous tips to the intermediate abdominal joints occur also in *rufipes*, Brullé (S. Am.), and in *pictipes* ♀, n. sp., *scriptifrons* ♂ ♀, and *annulicornis* ♂ ♀, n. sp.

Pimpla pictipes, n. sp.—♀.—Differs from *ruficrus* ♀ only as follows:—1. The head is sparsely and very finely punctate, more densely on the face, which is sparsely pubescent and subopaque. 2. The palpi are whitish and the antennæ are brown-black immaculate, with the 1st joint of the flagellum about 4 times as long as wide. 3. The whole thorax is polished and very finely and sparsely punctate except the metathorax which is pubescent, opaque, and closely and more coarsely punctate, except a broad, highly polished, glabrous stripe extending from base to tip and showing at its base the usual two carinæ. Tegulæ white, and before them a white spot pointed in front. 4. The abdomen is subopaque, confluently punctured, rather more coarsely so than the metathorax, and the extreme tip of joints 1–6 is pale sanguineous except laterally. The usual tubercles subobsolete. A very deep, transversely oval, lateral fovea occupying $\frac{2}{5}$ of the suture between joints 1 and 2. 5. The ovipositor is rufous; the sheaths black, sparsely pubescent, rather wider at base than the last tarsal joint of the hind leg, and but little tapered. Venter blackish, broadly whitish on the sutures except towards the tip. 6. The legs are pale rufous. Front legs with the basal $\frac{3}{4}$ of the coxæ, and an abbreviated, exterior vitta on the tibiæ, black; tarsi whitish. Middle legs with the second $\frac{1}{4}$ of their tibiæ white; and an exterior black vitta, interrupted near the tip, on the remaining part; tarsi black, with the basal $\frac{1}{2}$ of joints 1–3 and 5 white. Hind legs with the tips of the femora black; tibiæ black, with their second $\frac{1}{4}$ white; tarsi as in middle legs; spurs white. 7. The wings are hyaline; veins black, radius rufous; stigma black, its basal $\frac{1}{4}$ pale rufous. Areolet rhomboidal. Bullæ all distinct, C and D separated by a pretty wide space. Length ♀ .32 inch. Front wing ♀ .30 inch. Ovipos. .15 inch.

One ♀; ♂ unknown to me. Distinct from *annulipes* by the white spot before the tegula, by the uninterrupted glabrous metathoracic vitta, by the black front coxæ, and by the tarsi of the 4 hind legs distinctly annulate with white. In *Pimpla* the 4th tarsal joint is small as compared with that of *Glypta*, which accounts for its being often not annulate with white like the other 4 joints. The front coxæ ♀ alone being black is abnormal, but occurs also in *tenuicornis* ♀, Cress., *annulicornis* ♀, n. sp., *conquisitor*, ♀ Say, *bicolor* ♀, Brullé (N. Afr.), and *bilineata* ♀, Brullé (S. Afr.) Distinct from *tenuicornis*, Cress., by the white tegula and the white spot before it, and by the beautifully annulate 4 hind tarsi.

Pimpla annulicornis, [Walsh, Trans. Am. Ent. Soc. iii. p. 147.]—♂.—Black. *Head* polished, very finely and sparsely punctured, less sparsely on the face. A narrow white orbit extending from the mouth to the vertex. Palpi whitish, basally pale rufous. Antennæ $\frac{3}{4}$ as long as the body, 1st joint of flagellum $4\frac{1}{2}$ times as long as wide, the scapus shining black, the flagellum, except the sutures which are black, pale brown-black above, brownish-white below. *Thorax* polished, very finely and sparsely punctate, much more closely on the subopaque mesonotum; parapsidal lines distinct. Metathorax with the usual two carinæ divergent and pretty distinct as far as the posterior declivity, and the enclosed area as well as the declivity highly polished; its pleura with long, white pubescence. Tegulæ a largish oval spot under the front wing, and another touching the tegula under the humeral suture, a large quadrangular spot on the scutel with a capillary line extending from its tip to the anterior origin of the hind wing, and a transverse spot behind the scutel, all white. *Abdomen* subopaque, finely and confluently punctate, subpolished behind and on the tips of the joints, the usual tubercles subobsolete, and the extreme tip of joints 2–7 or 3–7 pale sanguineous. Joint 1 terminally $\frac{1}{5}$ narrower than the base of 2, $\frac{1}{2}$ longer than wide, $\frac{1}{2}$ wider behind than before; the two carinæ distinct to the tip, where they converge, but obtuse and not lofty behind, and on their basal $\frac{1}{2}$ enclosing a polished, oval excavation. A deep, subtriangular, lateral fovea in the suture between 1 and 2, occupying full $\frac{2}{5}$ of the suture. Ovipositor black, not quite $\frac{1}{2}$ as long as the body, with its tip hooked downwards; sheaths black, very finely pubescent, a little tapered, their basal part about as wide as the last tarsal joint of the hind leg of a ♂ of similar size. Venter blackish, the sutures widely whitish. *Legs* pale rufous. Front legs with the basal $\frac{3}{4}$ of their coxæ black, and the knees, the inside of the tibiæ, and the whole of the tarsi, whitish. Middle legs with the knees, the tibiæ except an exterior rufous vitta interrupted on the second $\frac{1}{4}$, the spurs and the tarsi whitish. Hind legs with the extreme tips of the femora and the basal and terminal $\frac{1}{4}$ of the tibiæ black, the middle $\frac{2}{4}$ of the tibiæ and the spurs white; tarsi black, the basal $\frac{4}{5}$–$\frac{1}{2}$ of joints 1–3 white; joint 5 missing. *Wings* subhyaline, slightly obfuscated at tip; veins black, radius pale rufous; stigma black, its basal $\frac{1}{4}$ white. Areolet rhomboidal. Bullæ normal and distinct, C and D pretty widely separated. Length ♀ .47 inch. Front wing ♀ .38 inch. Ovipos. .18 inch.

The ♂ differs from ♀ only as follows:—1. The entire face except the terminal foveæ, the clypeus, the mandibles except their teeth, and the palpi, are white. The white orbits are continued to the occiput, but interrupted opposite the ocelli by a space as long as they are themselves wide. 2. The 1st joint of the flagellum is only $3\frac{1}{2}$ times as long as wide, and the scapus is brownish-white below. 3. There is sometimes a short, whitish line in each parapsidal groove of the thorax opposite the tegula. 4. The front legs are entirely white, including the coxæ and trochanters, except that the femora are more or less rufous. Middle legs entirely white, except more or less of the outer surface of the coxæ, and the outer surface and sometimes the whole of the femora. Hind legs the same as in ♀, except that the basal $\frac{1}{2}$ of tarsal joint 4 sometimes, and always of the missing 5th joint, is white. Length ♂ .37–.41 inch. Front wing ♂ .30–.33 inch.

Two ♂; one ♀. Distinct from all the preceding by the multi-annulate antennæ and the white scutel. Similar antennæ occur in *P. ephippium*, Brullé (N. Afr.)

Pimpla (*Cryptus*) **conquisitor**, Say (= *Cryptus plurivinctus*, Say).—♀.—Black. *Head* subopaque, finely and closely punctate, more sparsely on the vertex. Palpi white. Antennæ full $\frac{2}{3}$ as long as the body, brown-black, the flagellum tinged more or less with rufous below, its 1st joint 4–4½ times as long as wide. *Thorax* subpolished, closely and finely punctate; metathorax more coarsely rugoso-punctate, its sides pubescent, the two normal carinæ pretty distinct and extending to the posterior declivity, which, as well as the space enclosed by the carinæ, is highly polished. Tegulæ and a quadrangular spot acutely prolonged in front, and underlying the humeral suture and nearly reaching its tip, both white. *Abdomen* subopaque, confluently and rather coarsely punctate, more sparsely behind and on the tips of the joints. The usual tubercles indistinct or obsolete. Joint 1 longer by ½ than wide, ½ wider behind than before, the usual carinæ only reaching half way to the tip, and enclosing an oval, polished excavation. In the suture between 1 and 2, a deep, lateral, transversely oval fovea occupying about $\frac{1}{3}$ of it. Tips of 1–7, except the part of 1 adjoining the above fovea, and except a small lateral space on the others, terminated by a conspicuous, well-defined white line, of uniform width, which is sometimes tinged with sanguineous. Ovipositor scarcely ½ as long as the body, piceous; sheaths black, pubescent, a little tapered, basally full as wide as the last tarsal joint of the hind leg. Venter blackish, broadly whitish on the sutures except sometimes behind. *Legs* pale rufous. Front legs with the coxæ often basally more or less black; trochanters sometimes whitish; tibiæ with a subbasal, exterior, fuscous line, the space around which is more or less extensively whitish. Middle legs with the first ¼ of the tibiæ black and the second ¼ white, the remaining ¾ often with a short exterior black line next the white annulus; spurs whitish, sometimes tipped with black; tarsi dusky, with the basal $\frac{2}{3}$–½ of joints 1–3 and 5 whitish. Hind legs with the terminal $\frac{1}{6}$ of their femora black; tibiæ white, with their basal $\frac{1}{5}$ and terminal $\frac{2}{5}$ black; spurs white; tarsi black, with the basal $\frac{2}{3}$–½ of joints 1–3 and 5 white. *Wings* subhyaline, tinged with smoky yellow; veins black, radius rufous; stigma black, its basal ¼ reddish-white. Areolet rhomboidal. Bullæ normal, C and D wide apart. Length ♀ .27–.55 inch. Front wing ♀ .23–.49 inch. Ovipos. .12–,27 inch.

The ♂ differs from ♀ only as follows:—1. The 1st joint of the flagellum is only 3 times as long as wide; the terminal $\frac{2}{3}$–$\frac{1}{5}$ of the scape, and generally the 1st joint of the flagellum are whitish below, and the rest of the flagellum is rufous below. 2. The 1st joint of the abdomen is about $\frac{1}{6}$ narrower at tip than the base of the 2d, and except at the extreme base its sides are subparallel. Its carinæ almost always extend nearly to the tip. 3d. In the front legs the coxæ, both trochanters, and the tarsi, are white; and in the middle legs the coxæ are whitish interiorly. Length ♂ .22–.33 inch. Front wing ♂ .17–.25 inch.

Five ♂, ten ♀; one ♂ bred June 7 from a small Lepidopterous pupa beaten off forest-trees. The variation in the size of ♀ is considerable, and evidently deceived Say into treating the sizes as distinct species; but all the intermediate grades occur, and a still wider range is met with in the size of *P. annulipes*, Brullé. (See above.) Say describes his ♀ *plurivinctus* as having been bred from the cocoon of a *Bombyx*, which is probably *Clisiocampa americana*. According to Mr. Cresson (*Practical Entomologist*, i. p. 19), *conquisitor* was bred from this same cocoon.

To this group also appertains apparently *P. tenuicornis*, Cress.

††† *Hind tibiæ black with a basal and a medial white band.*

Pimpla (*Ichneumon*) **inquisitor**, Say.—♀.—Black. *Head* highly polished, very sparsely and almost microscopically punctate. Clypeus occasionally piceous. Palpi white. Antennæ $\frac{1}{2}$–$\frac{2}{3}$ as long as the body, with joint 1 of the flagellum 3–4 times as long as wide, brown-black, the flagellum more or less tinged with rufous beneath. *Thorax* highly polished, sparsely and almost microscopically punctate, the metathorax rather closely and finely aciculate on the upper part of its pleura, and with its two carinæ distinct as far as the posterior declivity. Tegulæ, and a contiguous quadrangular spot in front of them, white; the latter sometimes rufescent, and the upper anterior angle of the quadrangle sometimes slightly prolonged. *Abdomen* subpolished, finely and confluently punctate except towards its tip and the tips of the joints, the normal tubercles pretty distinct. Joint 1 scarcely narrower at tip than the base of 2, $\frac{1}{4}$ longer than wide and $\frac{1}{2}$ wider behind than before, the two carinæ distinct nearly to the tip and enclosing on their basal $\frac{1}{2}$ a highly polished excavation, the polished surface continued between them $\frac{3}{4}$ of the way to the tip. A shallow, transverse, lateral fovea on the suture between 1 and 2 occupying $\frac{2}{5}$ of its width. The very extreme tip of joints 5-7, and rarely that of 3 also, pale sanguineous. Ovipositor piceous or black, $\frac{1}{2}$–$\frac{3}{4}$ as long as the body; sheaths black, rather densely hairy than pubescent, a little tapered, and basally full as wide as the last tarsal joint of the hind leg. Venter whitish, rarely pale fuscous. *Legs* pale rufous. Front legs with both trochanters generally whitish, and the tibiæ and tarsi whitish more or less tinged with rufous. Middle legs with the 2d trochanter generally whitish, and the tibiæ and tarsi whitish more or less tinged with rufous, the tibiæ always with their middle $\frac{1}{3}$ faintly paler. Hind legs with the extreme tip of the femora, except sometimes a very narrow white knee, obfuscated; the tibiæ white, with their second $\frac{1}{6}$ and terminal $\frac{1}{6}$–$\frac{2}{6}$ black, and the tarsi dusky, with the basal $\frac{2}{3}$–$\frac{1}{3}$ of joints 1–3 and occasionally of 1–5 white. *Wings* subhyaline, tinged with smoky yellow; veins black, radius rufous; stigma black, basally pale rufous, sometimes with its disk also pale or dark rufous. Areolet rhomboido-triangular, the 2d recurrent vein entering it $\frac{2}{3}$ of the way to the tip. Bullæ normal, distinct; C and D very wide apart, C sometimes almost touching the areolet. Length ♀ .34–.40 inch. Front wing ♀ .29–.36 inch. Ovipos. .20–29 inch.

The ♂ differs only as follows from the normal ♀ :—1. The 1st abdominal joint is proportionally longer, being full ½ longer than wide, and its carinæ are loftier and more acute behind. 2. In the front legs the coxæ, as well as both trochanters, are white; in the middle legs both trochanters are white; and in the hind legs both trochanters are white, the tibiæ have their terminal $\frac{2}{6}$ (not $\frac{1}{6}$) black, and the tarsi have the basal $\frac{2}{3}$–½ of joints 1–5 white. Length ♂ .30 inch. Front wing ♂ .24 inch.

One ♂ ; six ♀. Sufficiently distinct from all the preceding by the two white bands on the hind tibiæ. The variation in the comparative length of ♀ antennæ and ovipositor is remarkable, some of the longest ♀♀ having the shortest ovipositor and *vice versa*, and a ♀ with a very long ovipositor having very short antennæ. A similar variation in the comparative length of the ovipositor was noticed in *Rhyssa lunator*, Fabr. Say refers his *inquisitor* to *Ichneumon*, but so he does also three other species which he describes as having long ovipositors—*pterclas*, *concinnus*, and *hilaris*—the first of which he himself states to belong to *Pimpla.* His description of the areolet agrees precisely; but the length which he assigns to the body—♀ .25 inch—would be rather too small, if we did not consider that in *annulipes* my largest ♀ is 135 per cent. longer than my smallest one. The sexual distinction in the length of the 1st abdominal joint and the development of its carinæ is noteworthy, and occurs elsewhere also; though it does not appear to have been hitherto observed by authors.

Pimpla scriptifrons, [Walsh, Trans. Am. Ent. Soc. iii. p. 148.]—♀.—Differs from the normal *inquisitor* ♀ only as follows: — 1. The clypeus is white, blackish at tip; the mandibles are basally white; a white orbit, sometimes obsolete from a little beneath the antennæ to the mouth, extends from the mouth to the occiput; and beneath the antennæ there is a transverse white line, sometimes not attaining the orbits and sometimes medially interrupted for a short space. 2. The terminal ½ of the scape, as well as the entire flagellum, is rufous beneath. 3. The metathorax is rather closely aciculate up to the two carinæ, leaving the space between them, the posterior declivity, and the lower part of the pleura, all highly polished. Tegulæ, a line under the front wing, a narrow line which is basally clavate underlying the humeral suture nearly to its tip, a transverse line at the tip of the scutel and another behind it, all white. A large, bright rufous patch above the origin of the middle coxæ, and a duller one which is sometimes obsolete on the hind end of the lower face of the mesosternum, the two sometimes confluent and covering the whole lower surface. 4. On abdominal joint 1 the highly polished surface is confined to the anterior excavation, the carinæ only extending half way to the tip; joints 2–7 mostly with a very narrow sanguineous line behind. 5. The ovipositor is less than $\frac{1}{2}$ as long as the body, and the sheaths are pubescent rather than hairy. Venter whitish. 6. The front coxæ are white, except sometimes externally; both trochanters of all the legs are white, but the basal one of the 4 hind legs is superiorly rufous; and in the hind tibiæ the terminal $\frac{2}{5}$ (not $\frac{1}{6}$) is black, and the tarsi are black with the basal $\frac{2}{3}$–$\frac{1}{3}$ of joints 1–5 white. Length ♀ .26–.32 inch. Front wing ♀ .22–.27 inch. Ovipos. .10-12 inch.

The ♂ differs from the ♀ only as follows:—1. The clypeus and face are white except the terminal foveæ on the face, and the whole scape is white beneath. 2. The whole mesosternum and its pleura half way to the wing is bright pale rufous. 3. The carinæ on abdominal joint 1 extend nearly to the tip, and the whole space between them is glabrous and polished. 4. The anterior and middle coxæ, besides all the trochanters of all 6 legs, are white immaculate. Length. ♂ 30 inch. Front wing ♂ .24 inch.

One ♂; three ♀. Easily known from my ♂ of *inquisitor* by the white face, the white orbits, and very remarkable white line beneath the antennæ ♀, the rufous mesosternum ♂ ♀, and the white scutel ♂ ♀.

Pimpla vidua, n. sp.—♀.—Differs from the normal *inquisitor* ♀ only as follows:—1. A white orbit extends from the insertion of the antennæ to the occiput. 2. It is only the last joint of the scape and the basal joint of the flagellum that is rufous beneath, the rufous color terminating suddenly. 3. The metathorax is rather closely aciculate up to the 2 carinæ, leaving the space between them, the posterior declivity, and the lower part of the pleura, all highly polished. Tegulæ, a line under the front wing, a narrow line which is basally clavate underlying the humeral suture nearly to its tip, a transverse line at the tip of the scutel and another behind it, all white. A small, indistinct, rufous spot above the origin of the middle coxæ. 4. In abdominal joint 1 the highly polished surface is confined to the anterior excavation, the carinæ only extending half way to the tip, and there is no sanguineous tip to any of the joints. 5. The ovipositor is less than $\frac{1}{2}$ as long as the body, and pubescent rather than hairy; and the venter is distinctly dull rufous. 6. In the front legs the coxæ and both trochanters are white; in the middle legs the 2d trochanter is white, and there is a faint fuscous annulus on the second $\frac{1}{5}$ of the tibia; and in the hind legs the 2d trochanter is white, the femur is tipped with black up to the white knee, and the tibia has its 2d and terminal $\frac{1}{5}$ black. Otherwise as in *inquisitor* ♀. Length ♀ .26 inch. Front wing ♀ .20 inch. Ovipos. .10 inch.

One ♀; ♂ unknown to me. Distinct at once from *inquisitor* ☿ by its short white orbits, its white bands on and behind the scutel, and the rufous mesosternal spot; and from *scriptifrons* ♀

by its immaculate black face, black mandibles, immaculate abdomen, and rufous venter.

Pimpla cœlebs, n. sp.—♂.—Differs from the normal *inquisitor* ♀ only as follows:—1. The whole face, excepting the terminal foveæ but including a short orbit just passing the origin of the antennæ, is white. 2. The antennæ are full ½ as long as the body, the scape white below, the flagellum rufous below. 3. The metathorax is rather closely and finely aciculate up to the two carinæ, leaving the space between them, the posterior declivity, and the lower part of the pleura, all highly polished. Sometimes on the hind edge of the scutel there is a pair of small, obscure, whitish spots, transversely arranged. 4. The 1st joint of the abdomen is full ½ longer than wide, and its carinæ extend nearly to the tip, and are loftier and more acute than in ♀ *inquisitor*, though the entire joint exactly resembles that of my ♀ of *inquisitor*. All the joints immaculate. 5. . . . 6. The legs are pale rufous. The 4 front legs with the coxæ, both trochanters, knees, tibiæ, and tarsi, all white. Hind legs with the 2d trochanter white; femora with their extreme tips black; tibiæ white, with their 2d and terminal ⅙ black; tarsi white, with the extreme tips of the joints black. Length ♂ .30-.35 inch. Front wing ♂ .23-.29 inch.

Two ♂; ♀ unknown to me. But for the white orbits not extending to the occiput, and the absence of the white spot under the front wing, this might be taken for the ♂ of *vidua* ♀, n. sp. But in all the numerous cases known to me where the ♀ in *Ichneumonidæ* has white orbits and a black face and the ♂ a white face, the ♂ has orbits as long as those of ♀. And there seems scarcely any sexual variation in the 3 typical white spots before and under the front wing. Readily known from my ♂ of *inquisitor* by its white face and clypeus; and from *scriptifrons* ♂ by the very short orbits, the absence of the white spot under the front wing, the black metasternum, and the longer 1st abdominal joint.

[This is without doubt the true ♂ of *inquisitor*, Say, as the Entomological Society possesses specimens of both sexes of the latter species bred from the same cocoon. The ♂ correlated with the true ♀ *inquisitor* by Mr. Walsh evidently belongs to another species allied to *alboricta* and *indagatrix*.—CRESSON.]

Pimpla? indagatrix, [Walsh, Trans. Am. Ent. Soc. iii. p. 146.]—♂.—Differs from the normal *inquisitor* only as follows:—1. The antennæ are full ½ half as long as the body, the 1st joint of the flagellum 3 times as long as wide; the scapus is whitish below, and the extreme base of the flagellum is often rufescent. 2. The abdomen has the normal tubercles subobsolete and joints 2-to 4 elongate. Joint 1 is ⅙ narrower at tip than the base of 2, full ½ longer than wide, and nearly of uniform width except at the extreme base. None of the joints are perceptibly sanguineous at tip.

3. The 4 front legs are white, generally immaculate, but occasionally with the femora tinged with rufous. In the hind legs both trochanters are white; the femora have a distinct white knee preceded by a black annulus; and the tibiæ on their second $\frac{1}{6}$ have only a short lateral black vitta. 4. The wings are hyaline; veins black, radius whitish; stigma black, basally whitish. Radial area short, with a posterior angle of only 110° or 115°. Length ♂ .17-.24 inch. Front wing ♂.15-.18 inch.

Four ♂; ♀ unknown to me. Three ♂ were taken Apr. 18 in the window of a dwelling-house infested by carpet-moths (*Tinea tapetzella*, Lin.), on which they had probably been preying. Known easily from my ♂ of *inquisitor* by the oblong 1st abdominal joint, and from that ♂ and all my other *Pimpla* ♂ ♀ by the short radial area and the elongate intermediate joints of the abdomen. The sides of the abdomen are parallel, and joint 2 is $\frac{1}{3}$ longer than wide, the succeeding joints each gradually shorter till joint 5 is square. Hence, strictly speaking, it does not belong to *Pimpla* as defined by authors, and it might be referred to *Ephialtes* with almost equal propriety, though the tarsal claws are simple. I refer it provisionally to *Pimpla*, partly on account of its having no tooth on the tarsal claws, partly on account of its coloration, and especially that of its legs, agreeing so closely with that of the species which precede it and being quite different from that of any *Ephialtes* known to me, and partly on account of the short radial area which is utterly abhorrent from *Ephialtes*. For in most *Ephialtes* and in *Pimpla melanocephala* the radial area is very elongate, while in all my other *Pimpla* it is of medium length, its posterior angle being about a quadrant and a half, or 135°. *Indagatrix* is in reality one of those aberrant species which so often perplex and annoy systematists and delight the souls of Lamarck and Darwin.

SECTION 3.—*Areolet triangular.* (*Hind tibiæ as in Section* 2, †††.)

Pimpla investigatrix, n. sp.—♀.—Differs from the normal *inquisitor* ♀ only as follows:—1. The antennæ are full $\frac{1}{2}$ as long as the body. 2. The quadrangular white spot before the tegula is always prolonged in an acute white line which generally reaches half way to the tip of the humeral suture. 3. The abdomen is much more coarsely, and although closely, yet not confluently, punctate. 4. The ovipositor is bright rufous, sometimes so pale as to be almost ochreous. 5. In the front legs both trochanters are always white, but in the middle legs the 2d trochanter is never so. 6. The areolet is subpetiolated and triangular, the 2d recurrent vein entering it at its extreme tip. 7. The bulla A is represented only by an indistinct semi-bulla on the outer side of the petiole, while in all my 7 specimens of *inquisitor* it is very distinct and straddles its vein as usual. Length ♀ .28-.40 inch. Front wing ♀ .24-.36. Ovipos. .16-.26 inch.

Three ♀; ♂ unknown to me. Would be almost certainly taken for a variety of *inquisitor*, so closely does it resemble that species, but for the difference in the areolet, which is perfectly constant in all my specimens of both species.

Pimpla [**alboricta**, Cress., Trans. Am. Ent. Soc. iii. p. 147.]—♂.—Differs from the normal ♀ of *inquisitor* only as follows:—1. The clypeus and the mandibles, except their teeth, are white. 2. The antennæ are ½ as long as the body, and the scape is white below. 3. The abdomen is comparatively much more coarsely, and although closely, yet not confluently, punctate. 4. The 4 front legs are entirely white except the femora, and except that the middle tibiæ have a rufous exterior vitta. In the hind legs both trochanters are white, and the tibiæ have their second $\frac{1}{6}$ and terminal $\frac{2}{6}$ (not $\frac{1}{6}$) black. 5. The wings are hyaline; the stigma is whitish at its extreme base; and the areolet is sessile and triangular. The bulla A is entirely absent, the others normal, C and D pretty wide apart. Length ♂ .27 inch. Front wing ♂ .19 inch.

One ♂; ♀ unknown to me. Might be taken for the ♂ of the preceding but for the white clypeus and mandibles, which parts do not vary sexually in *Ichneumonidæ*, so far as I am aware, where both sexes have a black face. In the coloration of its legs and its general appearance it resembles much my ♂ of *inquisitor*, but is distinguishable not only by its very different areolet, but by the much shorter 1st joint of its abdomen.

Genus POLYSPHINCTA, Gravenhorst.

The insects which I refer to this genus are, to my knowledge, the first representatives of it hitherto described as North American, and apparently belong to two different genera, since the areolar cross-vein in Section 1 is subobsolete, as is said to be the case in *Polysphincta*, and in Section 2 is fully developed. In both the venter is as much excavated as in *Pimpla*, but in Section 2 the 1st joint of the scapus is truncate from inside to outside more obliquely, and the 2d joint is comparatively smaller, than in Section 1. As the 1st Section agrees pretty well with the characters of the genus, and the 2d does not, it is consequently the latter that is aberrant; but I dislike establishing a new genus from a single specimen of one sex, and therefore leave it provisionally as a Section of the old genus. In Section 1 there are three bullæ, C, D, and E; in Section 2 four, A, C, D, and E; and in both cases C and D are wide apart.

SECTION 1.—*Areolet obsolete.*

Polysphincta nigriceps, n. sp.—♂ ♀.—*Head* black, subpolished, with very fine, sparse punctures, and a longitudinal carina on the disk of the face. Mandibles, except their extreme tip, and palpi, whitish. Antennæ brown-black, $\frac{3}{4}$ as long as the body, joint 2 placed nearly at the tip of 1 and larger than usual; 1st joint of flagellum about 4 times as long as wide, the scapus and one or two joints of the flagellum whitish beneath. *Thorax* pale rufous, polished and glabrous, with the parapsidal grooves deeply impressed, and the anterior lobe of the mesonotum very prominent; scutel pale luteous. Tegulæ, a contiguous spot before them, and a line under the front wing, all whitish. Metathorax dark rufous with the pleura pale rufous, opaque and minutely rugoso-punctate, with 4 more or less distinct longitudinal carinæ, the two on each side confluent behind, and the two outer ones $2\frac{1}{2}$ times further from the middle ones than these are from one another. *Abdomen* subopaque, very minutely rugoso-punctate, subpolished towards the tip and at the tips of the joints. Joint 1 longer by $\frac{1}{2}$ than wide, $\frac{3}{4}$ wider behind than before, its sides straight except that they converge at the extreme base, the two carinæ enclosing a shallow, triangular excavation on the basal $\frac{1}{3}$, thence subsolete to the tip. Joints 1-5 with an obliquely transverse, impressed, lateral stria, rather beyond the middle, and sloped the contrary way to those of *Glypta*. Joints 1-5 ♂, 1-6 ♀, dark rufous tipped with black; 2-5 stained with translucent clay-yellow on basal $\frac{1}{5}$ ♂, or basal $\frac{1}{2}$ ♀; 6 and 7 ♂, or 7 only ♀, entirely black. Ovipositor exserted. twice as long as the abdomen is wide, and, as well as its sheaths, black. Venter whitish, its tip black. *Legs* white; all the 6 femora, the 4 front tibiæ, and the hind coxæ, pale rufous; hind femora with a terminal, superior, dusky vitta; hind tibiæ with their second $\frac{1}{6}$ dusky externally, and their terminal $\frac{2}{6}$ black all around; hind tarsi dusky with their basal $\frac{2}{3}$-$\frac{1}{3}$ of joints 1-5 gradually whitish. *Wings* subhyaline; veins black; stigma pale dusky, $\frac{1}{2}$ as long as wide. Radial area short, its posterior angle about 100°; the areolar cross-vein subobsolete, so that the sides of the radial area almost decussate with the two adjoining veins. Bullæ 3, distinct but small; A and B obsolete, C and D wide apart, C placed well forwards, E $\frac{2}{3}$ of the way to the angle of the 1st recurrent vein. Length ♂ .15, ♀ .18 inch. Front wing ♂ .13, ♀ .15 inch. Ovipos. .03 inch.

One ♂; one ♀. An elegant little species.

Polysphincta nigrita, n. sp.—♂.—Differs from the preceding ♂ only as follows:—1. The thorax is black, except that the entire metathoracic pleura and the anterior and posterior margins of the metathoracic pleura are rufous. Tegulæ and a spot before them, a line under the front wing, and the hind edge of the pleura of collare, all white. 2. The 1st joint of the abdomen is scarcely $\frac{1}{2}$ wider than behind than before, and its two carinæ are distinct and acute nearly to the tip, and here there is no obliquely transverse stria as on 2–5. 3. Abdominal joints 2–5 have no basal yellow band, and 5 has its terminal ½ black. 4. In the hind legs the tibiæ have their basal $\frac{2}{6}$ dull rufous and their terminal $\frac{2}{6}$ dusky; and the tarsi are entirely dusky except the extreme base of joints 1 and 2. Length ♂ .13 inch. Front wing ♂ .10 inch.

One ♂; ♀ unknown to me. Might be taken for a variety of the preceding but for the structural differences in the 1st abdominal joint.

SECTION 2.—*Areolet pentagonal, but terminally subobsolete.*

Polysphincta pimploides, n. sp.—♀.—Black. *Head* glabrous and polished, with a longitudinal carina on the disk of the face. Palpi . . . . . Antennæ $\frac{3}{5}$ as long as the body, with the 1st joint of the flagellum 4 times as long as wide, dull rufous above, paler below, and whitish towards the 1st joint, which is dusky above and below. *Thorax* highly polished, glabrous. Tegulæ whitish. Metathorax polished, with rather sparse, fine punctures, and the usual two carinæ pretty distinct half way to the tip; the lower half of pleura pale rufous. Abdomen subopaque, with rather coarse, confluent punctures, more polished towards the tip and the tips of the joints. The same tubercles on joints 2–5 as in the normal *Pimpla*, and behind them, as well as on the hinder part of joint 1, a shallow, impressed, obliquely transverse, lateral stria, sloped the contrary way to those of *Glypta*. Joint 1 longer by ¼ than wide, ¾ wider behind than before, with the two carinæ distinct ⅓ of the way to the tip, and enclosing on the basal ⅓ of the joint a triangular excavation, but on the terminal ⅔ entirely obsolete. Joints 1–3 and the basal part of 4 luteo-rufous. Ovipositor ½ as long as the body; sheaths pubescent and scarcely tapered, luteo-rufous inside, dusky outside. *Legs* pale rufous; the 4 front legs with their trochanters, tibiæ, and tarsi, whitish; the front tibiæ with an exterior basal dusky vitta; middle tibiæ with their 2d and 3d terminal $\frac{2}{7}$ pale dusky, and middle tarsi with the tips of the joints obfuscated. Hind legs with the extreme tip of the femora narrowly white, preceded by a black annulus; tibiæ white with their second and third $\frac{1}{7}$ and their terminal $\frac{2}{7}$ black; tarsi white with the terminal ⅓–½ of joints 1–3 dusky, 4 and 5 pale rufous. *Wings* svbhyaline; veins dusky; stigma twice as long as wide, pale dusky, paler at the extreme base. Radial area moderate, its posterior angle about 135°. Areolar cross-vein as long as usual, and beyond it, but only in certain lights, a very slender, hyaline cross-vein so as to make a completely regular pentagonal areolet. Bullæ 4 small but distinct, one (A) on the forward end of the areolar cross-vein, C and D pretty wide apart, and E rather nearer to the angle of the 1st recurrent vein than to the areolar cross-vein. Length ♀ .16 inch. Front wing ♀ .14 inch. Ovipos. .08 inch.

One ♀; ♂ unknown to me. Has exactly the general appearance of *Pimbla inquisitor*, Say; but, besides the difference in the neuration, is distinguishable by having no white spot before the tegulæ, by the pale bands on the abdomen, by the different structure of the 1st abdominal joint, and by having no foveæ in the suture behind that joint.

GENUS EXETASTES, Gravenhorst.

In this genus the mouth is a little rostriform, the clypeus and mandibles being elongated so that the whole extends beyond the eyes by a space nearly equal to their longer diameter. The clypeal suture is obsolete. In both my species the 1st joint of the antennæ is obliquely truncate rather laterally than beneath as Brullé describes it. The areolet is large and rhomboidal, and varies occasionally by being slightly peduncled. The bullæ are 4, or sometimes 3 only; A small and indistinct, and sometimes entirely obsolete, normally located; B normal; CD well forwards on its vein, and E in *suaveolens*, n. sp. (22 specimens), remarkable for being always nearer to the areolet than to the angle of its vein, but in *fascipennis*, Cress. (1 specimen), exactly in the middle. In a single ♂ of the former species the normal stump of a vein on the 1st recurrent vein is obsolete. Judging from the one species of which I have numerous specimens, the coloration varies but very slightly, the size is remarkably constant, and there are none but the necessary sexual distinctions.

Exetastes suaveolens, n. sp.—♂ ♀.—Black. *Head* opaque, with fine, dense punctures; clypeus as long as wide, its terminal ½ glabrous, polished, and semicircular. Palpi blackish. Antennæ as long as the body, brown-black, very rarely ♀ with the flagellum reddish-brown; 1st joint of the flagellum 4½ times as long as wide; joint 2 half as long as 1; the rest gradually shorter. *Thorax* subopaque, with fine, dense punctures; scutel elevated. Metathorax square, coarsely rugoso-punctate, with the lunate area and 6 parallel longitudinal carinæ, including the 2 lateral ones, all more or less indistinct, but generally present; the cross-carinæ obsolete. The hind angles above the hind femora terminating in 2 small, robust thorns, transversely arranged. *Abdomen* glabrous and highly polished, more or less curved, usually in a quadrant. Joint 1 thrice as long as wide, twice as wide behind as before, its sides straight, save that the spiraculiferous tubercle projects a little laterally ⅗ of the way to the tip, behind which points the whole dorsal surface is gently excavated; carinæ obsolete except at the extreme base. Joint 2 longer by ⅕–⅓ than wide, according to the degree of compression; the rest gradually shorter. Ovipositor and sheaths rufous or blackish, very short, exserted, but scarcely projecting beyond the tip of the abdomen. Venter generally protuberant, sometimes excavated, always more carinate longitudinally, except in a single

♂ where the carination is subobsolete. *Legs* black; more or less of the tips and of the superior surface of the 4 front femora yellowish-rufous or rufous; all 6 tibiæ and tarsi bright gamboge yellow, the tarsal tips not obfuscated. *Wings* subhyaline, more or less strongly tinged with fuscous, especially at tip. Veins and stigma black, the stigma occasionally reddish-brown. Radial area elongate. Areolet rhomboidal, occasionally with a short petiole, the side that faces the apex of the wing $\frac{1}{3}$-$\frac{1}{2}$ longer than the other 3 (which are equal), and more or less convex externally. Angle of the 1st recurrent vein about 135°; the 2d recurrent vein biangulated, but with the salient angle more or less subobsolete. Length ♂ .47 -.54, ♀ .43-.53 inch. Front wing ♂ .39-.46, ♀ .38-.43 inch.

Eighteen ♂, four ♀, all taken in July, 1865, on umbelliferous flowers, except a single ♀. When handled alive, this species gives out the same peculiar smell as do most, if not all, species of *Bombus*. Very near *niger*, Cress., but differs in the wings not being "uniform dark fuliginous," and in the hind tibiæ and tarsi being always yellow (not black). Mr. Cresson's other ten species are quite dissimilar.

Exetastes fascipennis, Cress.—♀.—The wing-band is "beyond the middle," as is correctly stated in Mr. Cresson's diagnosis, not "before the middle," as is stated in his description, probably through some clerical or typographical error. There are the same subobsolete carinæ on the metathorax as in *suaveolens*; the areolet is shaped precisely as in that species, and the 4 typical bullæ are all present. Length ♀ .45 (.37-.50 Cress.) inch. Front wing ♀ .34 inch. Ovipos. .07 inch.

One ♀; ♂ unknown to me. In having only the 1st joint of the scape rufous, and in many other characters, this species singularly recalls *E. castaneus*, Brullé (S. A.), but differs in the thorax being punctate, not "granulated or rugose."

LEPTOBATUS, Gravenhorst.

This genus seems to differ from *Exetastes* only in there being no stump of a vein on the 1st recurrent vein, in the mouth being scarcely rostriform, in the longer ovipositor, and in the prolongation of the 6th ventral beyond the tip of the abdomen. The character assigned to the European species of the 1st abdominal joint being a little contracted at tip, I do not find in mine. As the only strongly distinctive characters between these two genera are peculiar to the ♀, I suspect, from the pattern of coloration being so similar on the thorax, that Mr. Cresson's *Ex. flavitarsis* and *Ex. consimilis*, the ♂♂ only of which are known to me, are congeneric with my *Leptobatus*. The bullæ are 3, B, CD, and E; B normally located, CD well forwards on its vein, and E nearer to the areolet than to the crook of its vein, as in *Exetastes*.

Leptobatus illinoiensis, n. sp. — ♀. — Black. *Head* subopaque, with very minute, rather dense punctures, obsolete towards the tip of the clypeus. A small, hunched, longitudinally oval tubercle on the disk of the face, polished on its tip. Clypeus, except its extreme base, and a lateral dot on the vertex adjoining the eye, pale luteous. Palpi blackish. Antennæ brown-black, $\frac{2}{3}$ as long as the body, rather convolute at tip; 1st joint of the flagellum $4\frac{1}{2}$ times as long as wide; the 2d joint $\frac{1}{2}$ as long as the 1st; the rest very gradually shorter. *Thorax* subpolished, with minute, rather dense punctures. Pleura of metathorax finely, its notum rather coarsely, rugoso-punctate; its carinæ entirely obsolete. Tegulæ, a short, slender line under the front wing, a very broad line overlying the humeral suture nearly to its tip and connecting from its tip with a pair of transversely arranged, discoidal spots on the mesonotum by a vitta only $\frac{1}{2}$ as wide as either the line or the spot, and the sides (but not tip) of the scutel, all yellowish-white. *Abdomen* glabrous and polished, arched nearly in a quadrant. pale rufous except the basal $\frac{3}{4}$ of joint 1. Joint 1 geniculate $\frac{2}{5}$ of the way to its tip, twice as long as wide, twice as wide behind as before, its sides straight save that the spiraculiferous tubercle projects slightly $\frac{2}{5}$ of the way to its tip; carinæ only represented by a shallow, oval excavation before the geniculation, and an abbreviated, narrow, shallow, longitudinal one behind it. Joints 2, 3 and 5 about square; 2 with a small, subbasal, lateral tubercle. Joint 4 rather longer than wide, owing to the compression of the tip of the abdomen; 6 short; the rest retracted above, but obliquely a little exserted below. Venter basally blackish, terminally rufous, basally excavated, terminally protuberant, longitudinally carinate throughout; joint 6 projecting far beyond the dorsal tip of the 6th dorsal, so that, when seen in profile, the tip of the abdomen is obliquely truncate in an angle of 45°. Ovipositor dark rufous, nearly $\frac{1}{3}$ as long as the body; sheaths black, not tapered, rather wider than the last tarsal joint of the hind legs. *Legs* black; the 4 front legs with the superior surface of the femora, the whole of their tibiæ and tarsi, and an elongate spot on the anterior tip of the anterior coxæ, all pale luteous. Hind legs with the superior surface of their femora, except basally, pale luteous; tibiæ and tarsi pale luteous, with the inferior surface of the tibiæ and of the 1st tarsal joint fuscous. *Wings* hyaline, tinged with smoky yellow. Veins black; stigma black, its basal $\frac{1}{3}$ whitish. Radial area elongate. Areolet rhomboidal, the side facing the apex of the wing a litttle convex externally, and $\frac{1}{2}$ longer than the other 3 which are equal. First recurrent vein crooked, but without any stump of a vein at the crook; the 2d subobsoletely biangulated, its bulla occupying nearly the whole 2 sides of the salient angle. Length ♀ .43 inch. Front wing ♀ .33 inch. Ovipos. .13 inch.

One ♂; ♀ unknown to me. The first N. A. species hitherto described. But for the black mandibles, the blackish palpi, and the different pattern of ornamentation in the legs, this might be taken for the unknown ♀ of *Exetastes flavitarsis*, Cress. In the 2 tubercles on the 2d abdominal joint it resembles *Ex. consimilis* ♂, Cress., the ♀ of which is also unknown, but disagrees in the same respects with that species, and in addition in not having the 1st abdominal joint "distinctly punctured."

GENUS AROTES, Gravenhorst.

In this genus, which is remarkable for the cubito-discoidal cell receiving both recurrent veins, as in *Ophion* and the allied genera, there are three distinct bullæ, C, D, and E; C and D separated by a space as long as either of them, the 2d recurrent vein being not angulated but slightly convex externally, and E about in the middle between the angle of the 1st recurrent vein, which is very nearly straight, and the areolar cross-vein.

[In *formosus*, Cress., *vicinus*, Cress., and *venustus*, Cress., the second recurrent nervure is confluent with the areolar cross-vein.—CRESSON.]

Arotes (*Acænitus*) **decorus**, Say.—♀.—Black. *Head* subopaque, with dense, rather fine, shallow punctures; vertex glabrous and polished. Labrum small, semicircular. Face, except a longitudinal, cariniform tubercle on its disk and the foveæ at its tip, orbits very wide on the cheeks and behind the eyes, but interrupted widely opposite the ocelli and narrowly or sometimes scarcely by a dusky suture separating the cheeks from the face, clypeus, labrum, basal ½ of mandibles, and palpi, all white. Antennæ ⅘ as long as the body, brown-black, the extreme tip pale brown. Joints 11 or 12 to 23 or 24 of the flagellum white. First joint of the flagellum 3½ times as long as wide; joint 2 shorter by ⅓; the rest slowly shorter and shorter. *Thorax* subopaque, with dense, rather fine, shallow punctures; the disk of the lobes of the mesonotum, and of the mesothoracic pleura, glabrous and polished. Metathorax above subpolished with some coarse rugæ, the carinate areas all complete. Basal and central areas each subquadrate, but the latter rather wider than the former. The hind angles of the lateral areas not prolonged into a thorn, and the hind angles of the metathorax itself rounded off. Tegulæ, a broad line under the front wing, a dot or sometimes a triangular spot under the humeral suture near its base and a dot under it near its tip, a broad line overlying the humeral suture from near its tip to behind the tegula, a large quadrate spot on the disk of the mesonotum divaricating in a broad clavate line on the lateral margin of its anterior lobe, both scutels extending into the areas on each side of them, the posterior ½ of the metanotum, a large spot on the metathoracic pleura, a line on the hind edge and a broad abbreviated band on the front edge of the mesothoracic pleura, the latter sending off a curved branch on to the disk of the pleura, and the two connected by a broad vitta at the bottom of the pleura which sends off obliquely forwards a narrow linear branch on the lower face of the sternum, a triangular spot on the anterior lateral margin of the collare, and another in front of each anterior coxa, all white. *Abdomen* glabrous and polished. Joint 1 narrower at tip by ¼ than the base of joint 2, 3½ times as long as wide, 2½ times as wide at tip as at base, its sides straight and scarcely convergent half way from the tip to the base, where the spiraculiferous tubercle is placed, thence gently concave to near the base, the narrowest part of the joint being ⅘ of the way from the tip to the base; the carinæ only represented by a small, shallow, basal excavation. Joint 2 slightly shorter than wide; 3–8 slowly shorter and shorter. Tips of the joints with a white subequal band ½ as long as joint 4, which on 1–3 does not quite attain the extreme tip. Venter whitish; the 6th ventral elongate-semiconical, full 3 times as long as wide, its tip and inferior edge obfuscated. Ovipositor piceo-rufous, as long as the body; sheaths brown-black, rufous at tip, slowly tapered, basally ⅔ as wide as the last tarsal joint of the hind leg. The 4 front *legs* honey-yellow, with their coxæ and both trochanters white, and their tarsi tinged with white; the 2d trochanter of the middle leg blackish above. Hind legs pale bright rufous, with the coxæ, the 2d trochanters, and the extreme tips of the femora, black; the coxæ superiorly and inferiorly white except at tip; the basal trochanters and the tarsi white. *Wings* subhyaline, tinged with smoky yellow, with a large fuscous spot occupying the apex. Veins black; stigma black, basally paler. Radial area elongate. Length ♀ .60–.64 (nearly .60 Say) inch. Front wing ♀ .52–.54 inch. Ovipos. .60–.63 inch.

Two ♀, captured in South Illinois in June or July; ♂ unknown to me. The ornamentation of the mesosternum in this and the following species strongly recalls that of [*Lampronota scutellaris*, Cress.], except that here the two prongs of the Y differ in thickness as in the Roman Y. Differs from Say's brief description of the ♀ in the mandibles being basally white (not black immaculate); in the markings of the pleura being as white as those of the dorsum of the thorax (not yellowish); in the coxæ and trochanters of the 4 front legs being white (not honey-yellow); and in the hind coxæ not being "honey-yellow with 3 large yellow spots"(!!) but black with 2 large white spots. From the promiscuous way in which the items of Say's description are put together, the thorax being described piecemeal in three different places, it seems to have been drawn up in a hurry, and probably the four differences noted above are not variations but mistakes. The species is stated by Say to have been taken in Indiana, most probably near his residence on the Wabash, only 100 miles N.E. of the point where I took my specimens. Say describes the ♂ of what he supposes to be this species as differing from the ♀ in having "prominent spines" on the metathorax. This is not a sexual character in *Ichneumonidæ*, and consequently his ♂ is probably a distinct species [belonging to the genus *Mesostenus*, Grav. —CRESSON].

Arotes [**amœnus,** Cress.]—♂.—Differs from the above ♀ only as follows:—1. The face, including the 2 foveæ, is white immaculate, and the orbits are not at all interrupted below. 2. The antennæ are full as long as the body, the scapus and the base of the flagellum whitish below; and the flagellum white from about joint 15 or 16 to the last joint or two, which are brown. Joint 1 of the flagellum only 2½ times as long as wide. 3. The hind angles of the lateral carinate areas of the metathorax are prolonged into a short, robust, blunt thorn directed upwards and backwards. 4. The whole pleura of the collare, except an abbreviated black line on its hind margin, is white. The white spot covering the hind ½ of the metanotum extends forwards so as to cover the central area and the hind ½ of the basal area; and the broad abbreviated band on the front edge of the mesothoracic pleura is absent, except the curvee branch of it that occupies the disk of the pleura. 5. Abdominal joint 1 is 4½ timer long as wide, scarcely twice as wide at tip as at base, its sides nearly straight except that the tubercle is very large and prominent in the middle, and the extreme base is a little widened. The carinæ are further represented by a shallow, longitudinal excavation extending from opposite the tubercle nearly to the tip. Joint 2 slightly longer than wide. 6. Besides the terminal white band on joint 1, there is a dorsal white vitta extending ⅗ of the way to the tip, and it is only on joint 1 that the terminal white band does not quite attain the extreme tip. 7. The 6th ventral, of course, is small, and, as well as the 7th, white; the 8th is black. 8. The legs are white; the hind legs with their coxæ superiorly and on their extreme base black; their femora and tibiæ, except the knees, superiorly black. 9. The basal ¼ of the stigma is white. Length ♂ .46 inch. Front wing ♂ .41 inch.

One ♂, found dead, but uninjured, in an oak stump; ♀ unknown to me. Differs from the ♀ described by Say as *decorus*, in the mandibles not being basally black; in the antennæ being subterminally white, instead of having a white postmedian annulus of about 8 joints; in the scutel not having a black disk; in the pectus not being "pale honey-yellow"; in the 1st and 2d abdominal joints being differently marked; in the legs being white, not honey-yellow; and in the hind femora and tibiæ being vittate above with black. In the metathoracic thorns it agrees with it.

ACŒNITES, Gravenhorst (=*Acœnitus*, Latreille).

In this genus, which is readily distinguishable from *Arotes* not only by its very robust legs and antennæ, but by the cubito-discoidal cell receiving only the 1st recurrent vein; there are 3 very distinct bullæ, C, D, and E, besides a semi-bulla representing the bulla B opposite the anterior tip of the 2d recurrent vein, which semi-bulla is always indistinct but never entirely absent. C and D are wide apart, the 2d recurrent vein being convex externally, and E is pretty close to the angle of its vein, which is angulated at about 135°. Brullé says that the tarsal claws are bifid; Latreille does not so state, and they are certainly simple in both sexes in my species. He says also that the 1st joint of the antennæ is truncate obliquely below; it is truncate laterally in my species.

Acœnites rupinsulensis, [Walsh, Trans. Am. Ent. Soc. iii. p. 144.]—♀.—Rufous. *Head* subopaque, with dense, rather fine, shallow punctures, sparse on the subpolished vertex and clypeus. Orbits, except above, tinged with yellow; tips of the mandibles, orbits of the ocelli, and a quadrate space above the organ of the antennæ and extending to the ocelli, all black. Antennæ ⅔ as long as the body, very robust; joint 1 of the flagellum twice as long as wide, 2–6 gradually shorter till 6 is square; the rest slowly shorter and shorter. *Thorax* subpolished, with dense, rather fine, shallow punctures, finer and more sparse on the notum; the disk of the mesothoracic pleura glabrous and highly polished. Metathorax above rather finely rugose; the normal carinate areas all present, save that the central is confluent with the lunate area, which last is glabrous and polished. Scutel tinged with yellow. Inferior angle of the collare, and edges of the 4 front acetabula, black. *Abdomen* obovate, polished, with sparse, almost microscopic punctures. Joint 1, 2½ times as long as wide, 2½ times as wide behind as before, its sides nearly straight save that the tubercle forms a gentle convexity on their middle; carinæ obsolete except at the extreme base; a small, transverse, lateral fovea in the terminal suture. Joint 2 wider by ½ than long; the rest gradually shorter. Venter basally tinged with yellow, more or less excavated, and always longitudinally carinate; joint 6 elongate semiconical, more or less projecting beyond the tip of the dorsal joints as they are more or less retracted. Ovipositor as long as the body, piceo-rufous; sheaths brown-black, rufous at tip, not tapered, basally ⅔ as wide as the last tarsal joint of the hind leg, and on their terminal ¼ expanded to full as wide. *Legs* rufous. Four front legs with their tibiæ and tarsi tinged with yellow. Femora of the hind legs with their basal sutures, and a cloudy spot under their tip, black. *Wings* subhyaline, the terminal edge clouded with dusky. Veins black; stigma rufous, edged behind with black. Radial area rather elongate, its posterior angle 135°. Length ♀ .32–.35 inch. Front wing ♀ .30–.32 inch. Ovipos. .30–.33 inch.

The ♂ differs from ♀ only as follows: — 1. The face, orbits up to the ocelli, cheeks, clypeus, and mandibles except their black tips, are all yellow. 2. The antennæ are full ¾ as long as the body, and the joints slightly more elongate. Joint 1 yellowish beneath. 3. The collare is immaculate and the scutel yellow. 4. The abdomen, as usual, is narrower, 5½ or 6 times as long as wide, and elongate-rhomboidal, the tip of the 2d joint abutting on the lateral angles of the rhomb, and the extreme base and tip of the rhomb being truncate. Joint 2 only ⅙ wider than long. Ventral joint 6 small. 5. There is no spot under the tip of the hind femora. Length ♂ .37 inch. Front wing ♂ .35 inch.

One ♂ ; three ♀. *Ac. stigmaterus,* Say, is a *Xylonomus. Ac. decorus,* Say, is an *Arotes.* The only remaining N. A. species that has been referred to this genus is *Ac. melleus* ♀, Say, which probably belongs here, but differs from *rupinsulensis* ♀ in the antennæ being white with their basal ⅓ black above (not rufous immaculate), in the occiput having a dusky spot, and in the sutures round the scutel and on the abdominal dorsum being blackish.

[Genus PHYTODIETUS, Grav.]

Head with the face triangularly hunched under the antennæ. Clypeus small, transversely oval, hunched, and prominent. Mandibles bidentate. Antennæ slender, about as long as the body, the 1st joint laterally and obliquely truncate; joints of the flagellum rather long. *Thorax* with the parapsidal grooves subobsolete; the metathorax nearly smooth. *Abdomen* minutely punctate and polished, with no striæ or tubercles, elongate-oval, subsessile ♂, subpetiolated ♀, the 1st joint long and tapered gradually to its base; joint 2 much shorter; the remaining joints slowly shorter and shorter. Venter longitudinally carinate throughout, ♂ slightly depressed, ♀ slightly depressed towards the base, strongly compressed and protuberant towards the tip. Terminal joints of the abdomen not ♂ ♀ retracted, and the 6th ventral ♀ not materially prolonged. Ovipositor moderately long. *Legs* long and slender, especially the hind legs; tibiæ all with an irregular double external row of minute thorns directed obliquely backwards, more conspicuous on the hind tibiæ; spurs normal; claws pectinate; pulvillus shorter than the claws. *Wings* long; radial area and stigma rather long; areolet small, sometimes peduncled, triangular, the 2d recurrent vein, which is regularly convex externally, entering it at its extreme tip; 1st recurrent vein curved suddenly and strongly near its base. Bullæ four, B, C, D, and E; B small and indistinct, normally located; C and D separated by a wide space, and E normal.

Allied to *Banchus* by its pectinate claws, but differs by its abdomen not being sessile, by its ovipositor not being rather long, and by its areolet not being large and rhomboidal. From *Leptobatus* and *Exetastes* it differs by the "anus being slit," by the pectinate claws, and by the areolet not being large and rhomboidal; and from the former, in addition, by the 6th ventral ♀ not being prolonged. From *Coleocentrus* it seems to differ only by the much shorter ovipositor and the 6th ventral ♀ not being enormously prolonged, and by the pectinate claws. In coloration it partly resembles *Arotes*, but it is separated at once from *Arotes*, *Tropistes*, and *Acænites*, by the pectinate claws and by the areolet not being obsolete. I know of no other Ichneumonidous genus where the tibiæ are thorned except *Labena*.

[**Phytodietus vulgaris**, Cress., Trans. Am. Ent. Soc. iii. p. 166.]—♀.—Black. *Head* subopaque, with very minute, dense punctures, sparse on the subpolished vertex. Mandibles, except their teeth, palpi, and a short line on the vertex adjoining the eye, all white. Antennæ full as long as the body, brown-black, rufous beneath towards their tips; 2d joint of the scapus and 1st of the flagellum white exteriorly; 1st joint of the flagellum 4 times as long as wide, the next joint $\frac{1}{3}$ shorter, the following ones very slowly shorter and shorter. *Thorax* opaque above, subopaque beneath, with almost microscopic punctures somewhat coarser on the metathorax; carinæ of metathorax only represented by a shallow, obtuse, dorsal stria fading out towards the tip. Tegulæ, a spot under the front wing, a spot under the humeral suture in front of the tegula, and a more or less clavate line above it reaching more or less nearly to its tip, a pair of small spots transversely arranged on the disk of the mesonotum, tip and sides of the scutel or sometimes only the basal $\frac{2}{3}$ of its sides besides the tip, the whole of the metathoracic scutel, a capillary line leading from either scutel respectively to the front and hind origin of the hind wing, and near the tip of the metathorax a lunate band, broad at each end, and in the middle very broad and advanced forwards in an angle the apex of which is bifid, all white. Lower face of the mesosternum and meso- and metathoracic pleura half way to either wing, pale bright rufous. *Abdomen* polished, with very minute but not sparse punctures. Joint 1 longer by $\frac{1}{2}$ than wide, $2\frac{1}{2}$ times wider behind than before, its sides straight or scarcely convex; carinæ only represented by a triangular excavation on the basal $\frac{1}{4}$. A small, transverse, lateral fovea cutting off the acutely prominent anterior angle of joint 2 so as to simulate a continuation of the suture. Joint 2, $\frac{2}{3}$ as long as 1, and $\frac{1}{3}$ wider than long. A white line on the tip of joints 1–7, narrower on the hindmost of them. Venter blackish, the base of joint 1 and the tips of 1–6 all whitish. Ovipositor as long as the abdomen, piceo-rufous; sheaths black, finely pubescent, not tapered, as wide as the last tarsal joint of the hind legs. *Legs* pale rufous. Front legs with the coxæ, both trochanters, knees, tibiæ, and tarsi, white, the tibiæ exteriorly infuscated. Middle legs with the tip of the 1st and the whole of the 2d trochanter, broad knees, tibiæ, and tarsi, all white, the femora obfuscated at tip inside the white knee, the tibiæ, except the white knee, with an exterior fuscous vitta which on their middle $\frac{1}{3}$ is more or less obsolete, and with a narrow, terminal, fuscous annulus, and the tarsal joints with their extreme tips fuscous. Hind legs, with the tip of the 1st and the whole of the 2d trochanter and broad knees, white; the base of the 1st trochanter, the extreme base and a subterminal annulus on the femora, the tibiæ except the white knees and except an exterior white vitta occupying their middle $\frac{1}{2}$, and the tarsi, except the basal $\frac{1}{2}$-$\frac{2}{3}$ of the 1st joint which is white, all black. Spurs whitish. *Wings* hyaline; veins black, radius rufous; stigma rufous edged with black. Radial area rather long, its posterior angle 135°. Areolet triangular, its interior side $\frac{1}{3}$ shorter than either of the others, peduncled, the peduncle about $\frac{1}{2}$ as long as the triangle. Bullæ 4; B at the extreme posterior end of its vein, C close to the anterior end of its vein, D very widely separated from C, and E rather further from the areolet than from the angle of its vein. Length ♀ .28 inch. Front wing ♀ .27 inch. Ovipos. .14-.15 inch.

Variety.—♀.—Differs from [normal] ♀ only as follows:—1. The short white lines on the vertex are reduced to mere white dots. 2. The 2d joint of the scapus and the 1st of the flagellum are pale brown, not white, exteriorly. 3. Only the basal $\frac{1}{3}$ of the side of the scutel, in addition to its tip, is white. 4. The white band on the metathorax is reduced to 4 white dots arranged in a transverse curve with its convex side forwards; and there are no rufous markings on the sternum, except a large spot above the hind coxa and a small one above the middle coxa. 5. The ovipositor is very pale rufous. 6. In the middle legs there are no fuscous markings, save that the extreme tip of the tibiæ and of the tarsal joints is fuscous. In the hind legs the vitta on the tibiæ is pale brown, so as to be scarcely noticeable, not white; and the tarsi are dusky, not black, and with no vestige whatever of any white annulus on joint 1. Length ♀ .31 inch. Front wing ♀ .30 inch. Ovipos. 14 inch.

The ♂ differs from [normal] ♀ only as follows:—1. The face, cheeks, orbits to the top of the vertex and half way up behind the eye from the cheeks, and the clypeus, are all white. 2. The entire scapus is white below, and the 1st joint of the flagellum is only $3\frac{1}{2}$ times as long as wide. 3. The carinæ of the metathorax are entirely obsolete. 4. In addition to the white markings of ♀, the entire lower face of the pro- and meso-sternum and half way up the mesothoracic pleura, a line on the anterior margin of the collare, and a short longitudinal line before the hind coxa, are all white. No rufous markings. 5. The 1st abdominal joint is only $\frac{3}{4}$ wider behind than before, and joint 2 is scarcely wider than long. 6. The venter is mostly whitish except at tip, and the carina is protuberant at base but not at tip. 7. In the middle legs, the coxæ as well as both trochanters, broad knees, tibiæ, and tarsi, are white; and there are no fuscous markings save that the extreme tip of the tibiæ and of the tarsal joints is fuscous. In the hind legs, the coxæ are inferiorly white towards their tips, both trochanters are white except two dusky lines on the upper face of the basal one, and on the tibiæ the exterior median white vitta becomes a median white annulus. Length ♂ .29 inch. Front wing ♂ .26 inch.

One ♂ ; three ♀. The sexual distinctions, especially the 4th, are very striking.

[**Phytodietus distinctus,** Cress., Trans. Am. Ent. Soc. iii. p. 166.]—♀.—Differs from [*vulgaris*, normal] ♀ only as follows: 1. The disk and anterior edge of the clypeus, a narrow orbit interrupted for a short space just behind the vertex and also on the cheeks, the palpi, and all but the tip of the mandibles, are yellowish-white. 2. The antennæ are pale brown exteriorly from the 2d joint of the scapus inclusive to their tip. 3. The carinæ of the metathorax are entirely obsolete; only the tegulæ, a dot before them under the humeral suture and another above it near its tip, the tip and basal ½ of the sides of the scutel, the whole of the metathoracic scutel, and a capillary line leading from either scutel respectively to the front and hind origin of the posterior wing, and near the tip of the metathorax a broad, subequal, lunate band, are white; and there are no rufous markings. 4. Abdominal joint 1 is 2½ times as long as wide, twice as wide behind as before, its sides straight save that there is an obtuse salient angle near the base, and that half way to the tip the tubercles project a little laterally; carinæ commencing at the apex of the salient angle and fading out opposite the tubercle. Only the tip of ventral joints 1–5 (not 1–6) is white. Ovipositor pale rufous. 5. The legs are pale rufous immaculate, save that in the front legs the basal ½ of the coxæ and the tarsal claws, in the middle legs the last tarsal joint, and in the hind legs the terminal ⅓ of the tibiæ and the whole of the tarsus, are fuscous. Length ♀ .33 inch. Front wing ♀ .29 inch. Ovipos .15 inch.

One ♀ ; ♂ unknown to me. Remarkably like the preceding, and yet quite distinct by the simple coloration of the legs. The front trochanters are very slightly tinged with yellow, so that the ♂ will probably have them yellow.

CRYPTOCENTRUS, new genus (= *Cryptocentrum*, Kirby?).

Head with the face triangularly hunched under the antennæ. Clypeus short, wide, and transversely truncate for its whole breadth. Mandibles bidentate. Antennæ slender, about as long as the body, the 1st joint laterally and obliquely truncate; the joints of the flagellum rather long. *Thorax* with the parapsidal grooves subobsolete, the metathorax with the carinate areas mostly distinct, scutel trapezoidal. *Abdomen* polished, very minutely punctate, with no striæ or tubercles, elongate-oval, ... ♂, subpetiolated ♀, the 1st joint rather long and tapered gradually to its base, joints 2–6 slowly shorter and shorter, 7 and 8 almost retracted so that the tip of the abdomen is almost squarely truncate. Venter ♂ . . . . , ♀ slightly depressed towards the base, strongly compressed and protuberant towards the tip, and longitudinally carinate throughout, the 6th ventral squarely truncate. Ovipositor and sheaths very short. *Legs* long and slender, especially the hind legs. Tibiæ without thorns. Spurs normal. Claws unarmed, the pulvillus as long as the claws. *Wings* long. Radial area and stigma rather short. Area obsolete, the areolar cross-vein transverse and as long as usual. First recurrent vein much curved but not angulated; 2d recurrent vein obsoletely bi-angulated. Bullæ 4, A, C, D, and E; A subobsolete and placed on the anterior end of the areolar cross-vein, C and D close together on either side of the salient angle of their vein, and E pretty close to the curve of its vein.

Differs from *Tropistes*, *Arotes*, and *Acœnites*, by its very short ovipositor; from *Arotes*, by the cubito-discoidal cell receiving only one recurrent vein; and from *Arotes* and *Acœnites*, by the 6th ventral ♀ not being prolonged. From the other Banchoid genera it is separated at once by its obsolete areolet. Kirby's genus *Cryptocentrum* disagrees with mine in the anterior margin of the face being "crenate" and in the abdomen being "sessile," so that the first joint is "rather wider at the apex."

Cryptocentrus [(*Tryphon?*) **submarginatus**, Cress., Proc. Ent. Soc. Phil. iii. p. 274.]—♀.—Black. *Head* subopaque, with very minute, rather sparse punctures, obsolete on the polished vertex. Clypeus, 4 equidistant small spots adjoining it behind, the outer one on its lateral extremity, mandibles except their teeth, and palpi, all white. Antennæ brown-black, the 1st joint of the flagellum 4 times as long as wide, the 2d joint ⅓ shorter, the rest slowly shorter and shorter. *Thorax* subpolished, with very minute, rather sparse, shallow punctures. Metanotum minutely rugoso-punctate, subopaque; the basal area equilaterally triangular, the central area obovate and truncate at tip; lateral areas with their exterior side obsolete and no cross-carinæ; posterior area distinct and bisected lengthways by a carina. Tegulæ, a line under the front wing, a spot under the humeral suture before the tegula, and a broad line overlying it nearly to its tip and terminally clavate, and also both scutels, all white. Lower face of the mesosternum and meso- and meta-thoracic pleura half way to either wing, all pale rufous. *Abdomen* polished, densely and very minutely rugoso-punctate; the 1st joint subopaque, longer by ½ than wide, 2½ times wider at tip than at base, its sides straight, its carinæ distinct nearly to the tip, its terminal ⅓ with one or two longitudinal striæ on each side of the carinæ; joint 2 square; 3–5 slowly shorter; 6 short; 7 and 8 very short. Tip of 2–7 and middle ⅓ of the tip of 1 with a white line; very slender on 1, 2, 6, and 7. Venter with the longitudinal carina whitish. Sheaths of ovipositor black, not quite attaining the tip of the dorsum. *Legs* pale rufous. Four front legs with their coxæ and trochanters white, except the basal ⅔ of the middle coxæ; middle legs with the basal ½ of their tibiæ and of their tarsi whitish; the tarsal tips fuscous. Hind legs with their 2d trochanters white; the upper face of their 1st trochanters, the tibiæ, and the tarsi, black; the second and third $\frac{1}{5}$ of the tibiæ white. Spurs whitish. *Wings* subhyaline; veins black; radius rufous; stigma black, its extreme base whitish. Radial area with its posterior angle about 120°. Length ♀ .30 inch. Front wing ♀ .29 inch.

One ♀; ♂ unknown to me. Has the general appearance of [*Phytodietus vulgaris*, Cress.], but is generically very distinct. Differs from *Cryptocentrum lineolatum*, Kirby (Lat. 65°), in the face, orbits, and inferior surface of the scape, not being white; in the abdominal white fasciæ not being interrupted behind, and in the smaller size (.30 instead of .50 inch).

Xylonomus [**albopictus,** Cress., Trans. Am. Ent. Soc. iii. p. 168.]—♀. —Black. *Head* subpolished, with very minute, sparse punctures, and on the face with some rugæ. Face projecting beyond the eyes $\frac{1}{3}$ of their shorter diameter. Clypeus pale rufous, slightly longer than the flagellum of the antennæ is wide. Labrum semicircular, very pale rufous. Mandibles unarmed. Palpi pale luteous. Orbits very wide on the occiput, but with a very narrow interruption just beneath the antennæ and a wide one on the vertex, and also two dots transversely arranged on the disk of the face, all white. Antennæ $\frac{3}{4}$ as long as the body, perceptibly clavate at tip; the 1st joint of the flagellum thrice as long as wide; joints 3–5 a little longer than 1; 2, 6 and 7 about equal to 1. Joint 10–13 of the flagellum white. *Thorax* subopaque, with very minute, dense rugæ, coarse on the pleura of the metathorax but subobsolete on the front $\frac{1}{2}$ of its notum, which is subpolished. Carinate areas of the metathorax all present, save that the basal area is obsolete by the confluence of its two sides. Central area $\frac{1}{2}$ longer than wide, truncate-ovate, with its base angular. Lateral areas apically prolonged in a somewhat slender thorn directed upwards and backwards. Tegulæ, a line under the front wing, a line underlying the humeral suture nearly to its tip from a little in front of the tegula, a transversly oblong spot on the scutel and a line behind it, posterior declivity of the metathorax including its thorns, and a line on the anterior edge of its pleura, all white. Mesonotum in front of the scutel rufo-piceous. *Abdomen* subopaque, with very minute, dense rugæ. Joint 1 thrice as long as wide, thrice as wide behind as before, the two carinæ indistinctly traceable to the tip, where they coalesce in a subpolished tubercle, but with the space between them level; the sides of the joint straight, save that the spiraculiferous tubercle is placed $\frac{2}{5}$ of the way to their tip. Joint 2 with a deeply indented stria cutting off an isosceles triangle on its basal corner, so that the stria strikes the side of the joint $\frac{1}{3}$ of the way to its tip, from which point proceeds a short, shallow stria sloped the contrary way. Joint 2 longer by $\frac{1}{5}$ than wide; 3 wider by $\frac{1}{5}$ than long; 4–7 short; 8 as long as wide; 7 and 8 concave above, and 8 tapered and obtusely pointed when viewed from above, acutely pointed in profile. Joint 1 with a lateral, longitudinally oval, white spot at tip; 2 with a longitudinally obsemioval spot at tip; 3–7 with terminal white fascia, interrupted on its middle $\frac{1}{3}$, and in 3 and 4 not quite attaining the lateral margin. Ovipositor $\frac{2}{3}$ as long as the body, piceous; sheaths black, tapered, slightly expanded at the extreme tip. Venter dull luteous except at tip, much inflated, and longitudinally carinate. Four front *legs* pale rufous; middle legs with the knees white, the upper face of the femora and the subbasal suture of the tibiæ obfuscated, and the last tarsal joint black. Hind legs black, with the trochanters, the inner surface of the middle of the tibiæ, and tarsal joints 1–4, cloudy rufous; and the basal $\frac{1}{7}$ of the tibiæ white. *Wings* subhyaline; veins black; stigma black, its basal $\frac{1}{4}$ white. Radial area $3\frac{1}{2}$ times as long as wide. Length ♀ .43 inch. Front wing ♀ .30 inch. Ovip. .26 inch.

One ♀; ♂ unknown to me, but in all probability will have a white face. By far the smallest N. A. species yet described, and distinct at once by its semifasciate abdomen.

GENUS ECHTHRUS, Gravenhorst.

This genus may be recognized by its subpetiolated abdomen and nearly cubical head, and by its pentagonal areolet. The group in which the areolet is obsolete would seem to belong to a distinct subgenus. In my species the clypeal suture is obsolete, but the two foveæ that normally lie in that suture are present, and indicate that the clypeus is typically as short as it is in *Odontomerus* and *Xylonomus*, thus exposing a large portion of the labrum in all these genera. I do not find this character referred to anywhere by authors, but it is obvious in *E. reluctator* (Europe). The mandibles are toothed as in *Odontomerus.* The bullæ are large and generally 4 in number, A, B, CD, and E; A indistinct, rarely obsolete; B sometimes occupying the whole exterior side of the areolet; CD often with a dark dot between them and together occupying the middle $\frac{1}{3}$ of the 2d recurrent vein, which is usually perfectly straight; and E pretty close to the crook of the 1st recurrent vein. In *E.* (*Cryptus*) *ornatipennis*, Cresson, which is an aberrant species in other respects, the 1st recurrent vein is nearly straight, E is close to the areolet, and CD adjoins the areolet.

Echthrus annulicornis, n. sp.—♀.—Black. *Head* opaque, very minutely and densely rugoso-punctate, subopaque on the vertex. Mandibles (except their teeth and their lower edge) and labrum rufous. Palpi whitish. Antennæ brown-black, $\frac{2}{3}$ as long as the body, obviously clavate, the terminal $\frac{1}{4}$ of the flagellum being nearly twice as thick as the extreme base; joint 1 of the flagellum slender and 4 times as long as wide, 2 shorter by $\frac{1}{4}$, and the following joints very slowly shorter; joints 7–9 of the flagellum whitish. *Thorax* opaque, very minutely and densely rugoso-punctate, subglabrous and polished on the pleura. Parapsidal grooves subobsolete. Metathorax with the basal area small and elongate, the central area enormously large and divaricated widely behind so as to cut off the lateral areas, which have no cross-carina, from the posterior area. Tegulæ white. ***Abdomen*** regularly oval, opaque, very minutely and densely punctate, subpolished towards the tip and the tips of the joint. Joint 1 strongly arched, 2½ times as long as wide, thrice as wide behind as before, its sides straight except at the extreme tip, where they are first incurved and then excurved in a blunt tubercle, behind and outside which in the following joint is a similar tubercle; the two usual carinæ faintly traceable to the tip, and enclosing a shallow excavation. Joints 2 and 8 as broad as long, and 8 curved upwards at tip as in *Xylonomus* ♀; 3 and 7 shorter by ½ than broad; the rest short. The extreme terminal edge of 3–7 whitish, which in 5–7 is due only to the connecting membrane being white. Ovipositor ⅖ as long as the body, inserted ⅖ of the way from the tip of the abdomen to its base; sheaths black, tapered, pubescent, basally half wider than the last tarsal joint of the hind leg. Venter longitudinally carinate, scarcely excavated, black, the sutures whitish. *Legs* rufous; front legs with the tibiæ strongly inflated; middle legs with the basal ⅓ of the tibiæ, and the basal ½ of the 1st tarsal joint, white; tip of tarsus brown. Hind legs with the terminal ⅓ of the femora and the tibiæ and tarsi black, save that the knees, the basal ⅓ of the tibiæ, the spurs, and the basal ½ of the 1st tarsal joint, are all white. ***Wings*** hyaline; veins black; stigma black, its extreme base white. Radial area moderate; its posterior angle about 120°. The 1st recurrent vein slightly curved inside the middle; the 2d slightly convex outside. Length ♀ .25 inch. Front wing ♀ .20 inch. Ovipos. .10 inch.

One ♀; ♂ unknown to me. The front tibiæ are similarly inflated in *E. reluctator* (Europe), in two Canadian species [*niger*, Cress., and *abdominalis*, Cress.] and in *Cryptus? ornatipennis*, Cress. (Cuba), which, like *annulicornis*, has the last two abdominal joints very large, and the last upcurved as in *Xylonomus* ♀. It is only this last joint that is here rufous, and not the last two as is stated by Cresson.

GENUS LABENA, Cresson (=***Mesochorus***, Brullé ***non*** Gravenhorst).

Head subcubical; the space between the eyes widest at the insertion of the antennæ, thence narrowed rapidly towards the vertex, more slowly towards the mouth, so that the eyes are slightly but distinctly emarginate. Clypeus moderate, transversely suboval, almost entirely concealing the labrum. Mandibles bidentate. Antennæ ♂ about as long as the body, ♀ about ⅔ as long as the body; ♂ ♀ neither tapered nor clavate; joint 1 very obliquely truncate on the outside, and enclosing nearly the whole of joint 2; joints of the flagellum rather short. *Thorax* with the parapsidal grooves almost obsolete, the space behind the wings about as long as that before them. Scutel subquadrate, flattish. Metathorax subcubical, its sides a little convergent behind, the carinate areas generally, except the posterior one, all distinct. *Abdomen* subpetiolated, elongate-clavate ♂, clavate ♀, ♂ ♀ with their sides nearly straight to beyond the middle, the tip of joint 5 ♂, joint 6 ♀, being about the widest part. Joint 1 ♂ ♀ very long; joint 2 longer than wide; 3–6 ♂ nearly square; 3–7 ♀ shorter than long and subequal. Venter unusally corneous, flattened, and with a slight longitudinal carina; anus ♀ slit, as it is termed. Ovipositor about as long as the abdomen; sheaths moderate, not tapered. *Legs* moderate; in all 6 legs ♀ tarsal joints 3 and 4 very short, and joint 3 acutely bilobate; in the middle legs ♀ tarsal joint 2 likewise short, and the tibiæ twisted as in *Odontomerus* ♀; in all 6 tarsi ♂ only joint 4 very short, and all the joints simple. Both front and middle tibiæ ♀ inflated near their tip. Hind coxæ ♂ ♀ long and slender, and about as long and stout as the femora. Spurs normal. Claws simple, moderately long, much longer than the pulvillus. *Wings* moderate. Stigma and radial area elongate. Areolet large, rhomboidal, its anterior angle often more or less truncate. The 1st recurrent vein almost straight; the 2d recurrent vein biangulated. Bullæ 4, B, C, D, and E; B on the posterior end of its vein, C close to the areolet, D between the two angles of its vein, and E nearer to the tip than to the base of its vein.

Closely allied to *Xorides*, Grav., by its face narrowed below, and to *Odontomerus* by the singularly twisted middle tibiæ ♀, which character is here subobsoletely shown also in the front tibiæ ♀. Differs from all the other genera belonging to this group, except certain *Echthrus*, viz., *annulicornis*, n. sp., and *ornatipennis*, Cress., by the obsolete parapsidal grooves and the large areolet. From *Echthrus* it is at once separated by the emarginate eyes, the long clypeus, the singular structure of ♀ legs, and the separation of bullæ C and D. The abdomen ♂ is not greatly elongate and almost linear, as in *Xorides* ♂ and *Xylonomus* ♂, nor has it the tips of its joints emarginate as in *Xorides* ♂. Brullé entirely overlooked some of the most remarkable characters of this genus, e.g. the face narrowed in front, the subcubical head, and the bilobate 3d tarsal joint ♀, and confounded it with *Mesochorus*, Grav., which appertains to an entirely different group, and has a transverse head, a short ovipositor, and normal tibiæ and tarsi ♂ ♀. He was unacquainted with ♂, and therefore of course failed to recognize the singular sexual differences in the tarsi. Cresson, on the other hand, as well as Say, entirely overlooked the twisted 4 front tibiæ and the short 3d and 4th tarsal joints of the ♀.

Labena grallator, Say (= *Mesochorus fuscipennis*, Brullé).—♀.—Rufous. *Head* polished and glabrous; face and clypeus opaque, with rather coarse, transverse rugæ; the foveæ at the tip of the face rather small and indistinct. Clypeus with its base in a circular arc of 60°, its tip in a circular arc of 120°. Orbits, especially in front, tinged with yellow; tip of the mandibles black. Antennæ $\frac{2}{3}$ as long as the body; the flagellum with its extreme base and tip slightly tapered, its 1st joint $2\frac{1}{2}$ times as long as wide, the 2d shorter by $\frac{1}{3}$, the rest very slowly shorter and shorter. The third $\frac{1}{4}$ of the flagellum tinged with yellow, the terminal $\frac{1}{4}$ with black. *Thorax* subopaque, finely and confluently punctured, the disk and hind edges of the mesothoracic pleura glabrous and polished. Metathorax with the basal area subquadrate, the central area hexagonal and $\frac{1}{2}$ longer and wider than the basal area with its posterior side sometimes indistinct, the lateral areas strongly constricted by their cross-carinæ and open behind, so that the posterior area is almost obsolete. Tegulæ, a line under the front wing, both scutels and the areas on either side of them, a longitudinal line on each side of the mesonotum, a line under the humeral suture, the hind part of the metathorax and the anterior edge of its pleura, all tinged with yellow. Many of the sutures, both above and below, stained with black. *Abdomen* glabrous and polished at base, subopaque, with very minute, dense punctures towards the tip. Joint 1, $3\frac{1}{2}$ times as long as wide, $2\frac{1}{2}$ times as wide at tip as at base, its sides straight for $\frac{2}{5}$ of the way to the tip, thence with the usual tubercle, immediately behind which they are slightly constricted and thence to the tip very gently convex. Joint 2 longer by $\frac{1}{2}$ than wide and shorter by $\frac{2}{5}$ than joint 1. Extreme tip of joint 1, and obsoletely so of one or two of the following joints, yellow; the sutures toward the base of the abdomen blackish. Venter reddish-brown except at tip, the tip of joints 1 and 2 tinged with yellow. Ovipositor $\frac{2}{3}$ as long as the body, rufous, its tip black; sheaths yellowish rufous, their tips black. *Legs* with the tarsi and especially the tibiæ tinged with yellow. Front tarsal joints proportioned as 14, 7, 2, 2, 7; middle tarsal joints as 14, 4, 2, 2, 12; hind tarsal joints as 14, 7, 2, 2, 9. *Wings* shining umber brown, with their extreme base and an ill-defined cloud reaching from the base of the stigma to the hind edge of the 2d cell of the limb, hyaline; hind wings with the postcostal space and sometimes also with an elongate discoidal cloud, hyaline. Veins black; stigma rufous, $4\frac{1}{2}$–5 times as long as wide. Areolet large, rhomboidal, with the 2d recurrent vein entering it slightly beyond the middle, and with its anterior angle slightly truncate. Bullæ all distinct, large, white, and encroaching on the brown membrane of the wing. Length ♀ .76 (.60 Brullé) inch. Front wing ♀ .64 inch. Ovipos. .53 (.43 Brullé) inch.

The ♂ differs from the ♀ only as follows:—1. The entire face, front up to the ocelli, and clypeus, are yellow; and the mandibles, except their teeth, and palpi are tinged with yellow. 2. The antennæ are nearly as long as the body, immaculate except the black tip, and except that 1st joint of the scapus is yellowish beneath. 3. The parts of the thorax that in ♀ are tinged with yellow are here yellow; and in addition there is a large yellow spot on the upper part of the mesothoracic pleura, and an indistinct yellowish vitta on its lower part; and the lateral disk of the collare is yellow. Moreover the sutures are more generally and more strongly black, and there is a black line dividing the two yellow spots on the mesothoracic pleura. 4. The tip of the abdomen is almost microscopically punctured and subpolished. Joint 1 is $3\frac{3}{4}$ times as long as wide, and joint 2 is $\frac{3}{4}$ longer than wide. The tip of joints 1–5 is yellow, less widely and distinctly in each successive joint. In the venter the tip of 1–5 is yellowish. 5. In all 6 legs the tarsal joints are proportioned as 10, 6, 5, 2. 6. The wings are subhyaline, except that the principal veins are clouded with brown, and the tip beyond the areolet in the front wing, and a corresponding portion in the hind wing, is brown. The areolet is also more strongly truncate in front, so as to be almost rhomboido-pentagonal, and the bullæ are much less distinct. Length ♂ .48 inch. Front wing ♂ .41 inch.

One ♂, taken at large; one ♀, bred from Hickory-wood infested by the Coleopterous *Cerasphorus cinctus*, Fabr., and one ♀ from *Coll. Ent. Soc.* The genus may perhaps inhabit other timber-trees as well, but like the genus *Carya* (Hickory) it seems to be peculiar to America, the only other known species—*rufus*, Brullé—occurring in Guiana. Brullé's specimen was taken in Carolina. His specimen (♀) approximated to the ♂ somewhat more than mine in the yellow markings of the mouth and thorax, and he says nothing of the hyaline markings of the wings, nor of the black tip to the ovipositor. This is the only Ichneumonidous species known to me where the abdomen is more strongly sculptured and more opaque behind than before.

Genus ODONTOMERUS, Gravenhorst.

There are here three very distinct but very small bullæ, C, D, and E—C and D widely separated from each other, and E rather nearer to the angle of its vein than to the areolet—besides two indistinct semi-bullæ occupying the position of A and B. It is singular that Say should have noticed the bullæ in *Od. mellipes*, when they are so very much more obvious in many other species where he has said nothing at all about them.

Odontomerus (*Anomalon*) **mellipes**, Say.—♀.—Black. *Head* polished, with fine, shallow, not thick-set punctures, subobsolete on the vertex. Face finely rugose on the disk, which projects beyond the eyes by ½ their shorter diameter. Clypeus scarcely as long as the flagellum of the antennæ is wide. Labrum truncate-triangular, rufous, with long rufous hairs. Mandibles toothed as usual, and basally rufous. Palpi pale luteous. Antennæ ⅘ as long as the body, with the 1st joint of the flagellum 3 times as long as wide, and the following 6 or 7 joints rather shorter, the 3d joint the longest of them; the scapus black, the flagellum reddish-brown. *Thorax* polished, with very fine, sparse, shallow punctures, the spaces on each side of the two scutels with oblique striæ. Metathorax a little rugose, its carinate areas complete save that the basal is confluent with the central area, which thus becomes thrice as long as wide. Lateral areas angulated behind, and terminating in an acute thorn directed upwards and backwards. *Abdomen* polished, with very minute, sparse, shallow punctures. Joint 1 with a few rugæ and with the 2 usual carinæ indistinctly traceable to the tip, 2¾ times as long as wide and 2¾ times as wide behind as before, its sides straight save that their extreme tip is a little constricted and the spiraculiferous tubercle is placed ⅗ of the way to the tip. Joints 2 and 7 as long as wide, 2 with some close-set, transverse rugæ at its extreme base; the other joints short. Dorsal surface of 7, and especially of 8, concave, and 8 tapered to a point acute in profile view and obtuse when viewed from above. Ovipositor ⅓ longer than the body, its sheaths full ½ wider on the terminal ⅓ than at base. Venter excavated, of an obscure gray except at tip. *Legs* pale rufous; the tips of the middle tarsi and the whole of the hind ones fuscous; the middle tibiæ twisted as usual; the tooth on the hind femora placed ⅗ of the way to the tip. *Wings* subhyaline slightly tinged with smoky yellow; veins black; stigma black, basally whitish. First recurrent vein slightly angulated at ⅓ of the way to its tip; 2d recurrent vein slightly convex towards the tip of the wings. Length ♀ .38 (.34 Say) inch. Front wing ♀ .28 inch. Ovipos. .50 inch.

One ♀; ♂ unknown to me. Distinct from *Æthiops*, Cress., and *abdominalis*, Cress., by its metathoracic thorns and by its wings not being fusco-hyaline, and from the latter by its rufous coxæ and trochanters and black abdomen. From *striatus*, Brullé (Europe), it is separated at once by the tooth on its hind thighs

Genus XYLONOMUS, Gravenhorst.

This genus is very remarkable for possessing the same subbasal, oblique, connate suture on the tibia which occurs in certain of the true Spiders, and which becomes a free suture in the Phalangioid Spiders—a peculiarity which does not appear to have been hitherto noticed by authors. The tendency hereby exhibited is further exemplified in the double trochanters found throughout the entire family *Ichneumonidæ*. If we can trust to Westwood's figure, there exist in the tibia of the degraded Dipterous genus *Nycteribia two* subequidistant transverse sutures, whether free or connate does not appear. But Latreille says nothing of any such character in his description of the genus, and I find no traces of any sutures, whether free or connate, in the tibia of the allied genus *Ornithomyia.* (See Westw. *Intr.* ii. p. 580, fig. 15, and Latr. *Gen. Cr. Ins.* iv. p. 364.) The bullæ of *Xylonomus* are very distinct but exceedingly minute, being stouter than the width of the vein they occupy. They are three in number, C, D, and E; C and D equidistant from each other and from the tips of their vein, and E much nearer the tip than the base of its vein. There are no semi-bullæ, such as exist in *Odontomerus*, probably because the areolar cross-vein is here subobsolete.

Xylonomus (*Acœnitus*) **stigmapterus,** Say.—♀.—Black. *Head* opaque with fine, dense rugæ, subopaque on the vertex. Face projecting beyond the eyes ⅓ of their shorter diameter. Clypeus scarcely as long as the flagellum of the antennæ is wide. Labrum longitudinally semi-oval, with rufous hairs. Mandibles unarmed. Palpi black, the last 3 joints whitish. Antennæ ⅔ as long as the body, scarcely clavate at tip; the 1st joint of the flagellum thrice as long as wide, and 6 or 7 of the following joints ¼ longer than the 1st; a white annulus extending from the middle of the 9th to the middle of the 14th joint of the flagellum. ***Thorax*** finely and closely punctured, subpolished below, subopaque above, with 8 or 9 coarse, close-set longitudinal striæ at the bottom of the collare, and some finer bi-flabellate ones at the base of the middle lobe of the mesonotum. Metathorax finely rugoso-punctate, coarsely on its pleura; the carinate areas all perfect save that the basal is confluent with the central area, the latter equally long with the former but 2½ times as wide, of a truncate-ovate shape, and ⅓ longer than wide. Tip of each lateral area prolonged into a robust thorn directed upwards and backwards. Mesonotum in front of the scutel (except the striate space), and also the mesothoracic pleura, rufo-piceous. ***Abdomen*** subopaque, with very minute, dense, shallow rugæ; coarser on the 1st joint, especially towards its tip. Joint 1, 3½ times as long as wide, thrice as wide behind as before, its sides straight except that their extreme tip is a little constricted and that the spiraculiferous tubercle is placed ⅔ of the way to their tip; the two carinæ indistinctly traceable to the tip, where they coalesce in a small, subpolished tubercle, the intervening space level except that there is a shallow groove opposite the spiracles. On joint 2, from the tip of each carina of joint 1, there proceeds an oblique, impressed stria to the middle of the lateral edge so as to cut off an elongate triangle. Joint 2 longer by ½ than wide; 3 longer by ¼ than wide; 4–7 short; 8 rather longer than wide, curved upwards and tapered to an acute point when viewed in profile, truncate-triangular when viewed from above. Ovipositor piceous, ⅓ longer than the body; sheaths black, regularly and slowly tapered to the extreme tip, where they expand nearly to their basal width. Venter inflated and longitudinally carinate. *Legs* black; front knees, extreme base of all 6 tibiæ, basal ½–⅓ of the 1st tarsal joint in all 6 legs, and in the 4 front legs the whole of joints 3 and 4, but in the hind legs of 4 only, all white. *Wings* hyaline, the front ones slightly tinged with smoky yellow; veins black; stigma black, its basal ⅕ white. Radial area nearly 4 times as long as wide. Length ♀ .93 (over 1.00 Say) inch. Front wing ♀ .64 inch. Ovip. 1.10 inch.

One ♀, taken in August on a decayed Elm infested by *Physocnemum brevilineum*, Say, and *Leptura americana*, Hald.; ♂ unknown to me. Distinct from *Cincticornis*, Cress., by the white annulations of the legs. Say, in referring this species to *Acœnitus*, evidently mistook the prolongation of the 8th dorsal joint of the abdomen for the prolongation of the 6th ventral found in that and other allied genera.

Atmosphhcric Elcctricicity.

By A. WISLIZENUS, M.D.

YEARLY REPORT OF ATMOSPHERIC ELECTRICITY, TEMPERATURE, AND HUMIDITY, FROM OBSERVATIONS MADE AT ST. LOUIS, MO.

1.—*Monthly Mean of Positive Atmospheric Electricity from* 1861–1872, *based on daily observations at* 6, 9, 12, 3, 6, *and* 9 *o'clock, from morning till night.*

ATMOSPHERIC ELECTRICITY.

YEAR.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	M'n of Year.
1861........	16.5	12.1	9.8	8.8	7.8	4.0	3.7	3.4	3.0	7.1	10.0	14.3	8.4
1862........	12.1	16.0	9.4	10.6	7.5	3.0	2.2	2.3	3.0	7.7	12.6	13.9	8.4
1863........	16.9	15.9	13.6	8.8	4.7	2.0	2.8	4.4	4.8	12.5	12.1	11.5	9.2
1864........	15.8	11.3	11.0	8.5	5.1	4.0	2.3	0.9	1.8	5.4	6.6	9.0	6.8
1865........	12.2	9.5	5.9	3.3	2.4	3.4	2.6	5.9	1.2	5.3	10.1	6.4	5.7
1866........	5.9	8.1	5.7	2.1	3.3	2.1	2.4	5.1	3.2	7.0	10.2	7.0	5.2
1867........	9.2	8.2	6.5	3.3	2.9	2.8	2.7	5.2	3.5	3.0	4.2	4.2	4.6
1868........	4.1	5.0	2.5	1.7	1.1	0.4	0.5	0.4	1.4	2.6	4.3	6.3	2.5
1869........	8.7	2.5	4.6	1.6	0.7	0.9	1.1	0.3	1.3	7.8	4.7	1.6	3.0
1870........	8.6	10.2	5.5	6.9	5.0	1.3	0.8	0.4	0.1	0.1	5.9	8.7	4.5
1871........	6.9	8.5	6.1	3.1	1.6	1.6	2.5	1.2	4.0	2.7	7.7	7.5	4.5
1872........	10.7	12.3	9.0	5.1	3.0	1.5	0.5	0.4	1.7	4.1	4.0	2.7	4.6
Mean......	10.6	10.0	7.5	5.3	3.8	2.2	2.0	2.5	2.4	5.4	7.7	7.8	5.6

2.—*Monthly Mean of Temperature and Relative Humidity from* 1861–1872 *based upon daily observations contemporaneous with those of Atmospheric Electricity.*

TEMPERATURE, F.

YEAR.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	M'n of Year.
1861........	32.2	40.4	44.8	58.1	64.1	76.9	77.5	78.6	69.1	57.9	46.0	39.7	57.1
1862........	28.9	30.2	43.2	55.0	69.7	75.1	81.2	80.7	72.1	57.3	42.6	41.3	56.4
1863........	36.8	35.7	43.6	57.4	65.5	71.9	77.2	77.5	69.2	48.0	43.7	35.9	55.2
1864........	29.2	38.3	40.7	51.4	69.4	78.9	83.5	78.8	72.9	53.1	44.9	30.4	56.0
1865........	28.1	38.4	46.7	56.8	68.8	80.7	77.7	78.1	77.8	58.8	48.0	30.8	57.5
1866........	32.2	33.4	42.2	61.2	66.3	75.3	82.2	76.8	64.0	59.3	46.6	33.3	56.0
1867........	25.4	39.1	34.1	56.7	61.1	76.9	81.3	81.4	68.5	59.6	49.2	36.1	55.8
1868........	26.0	35.8	51.6	53.6	68.4	76.9	88.0	77.2	65.7	56.5	44.9	29.9	56.2
1869........	39.4	36.9	39.9	56.3	66.6	74.7	80.7	82.1	68.2	47.9	40.9	33.8	55.6
1870........	33.1	36.6	41.3	58.8	71.9	76.2	85.0	76.3	72.1	59.7	48.5	31.6	57.6
1871........	34.6	39.7	51.9	62.2	68.4	81.2	81.6	80.1	68.3	60.4	38.7	31.7	58.2
1872........	28.8	32.9	39.8	60.4	70.0	79.9	82.1	82.9	71.8	59.4	37.0	25.1	55.8
Mean......	31.2	36.4	43.3	57.3	67.5	77.0	81.5	79.2	68.3	56.6	44.2	33.2	56.3

RELATIVE HUMIDITY.

1861........	72.2	63.3	64.5	61.5	66.3	70.8	66.3	69.6	77.3	76.6	69.0	74.3	69.8
1862........	85.3	73.9	70.8	67.0	57.3	67.0	66.8	64.3	74.2	67.2	69.5	74.6	69.9
1863........	79.2	81.7	68.1	57.2	59.4	67.7	68.6	70.7	68.2	74.4	67.4	79.5	70.5
1864........	75.6	62.7	70.0	69.8	56.4	61.5	62.8	69.0	64.1	67.9	74.2	75.5	67.4
1865........	74.6	72.0	66.1	66.8	62.1	67.9	77.4	71.7	76.8	74.1	62.3	78.8	70.9
1866........	75.1	70.6	69.1	60.6	59.7	66.0	68.2	66.7	81.8	71.7	72.5	76.8	69.2
1867........	76.2	73.5	75.7	59.1	61.4	64.8	63.9	60.0	63.7	67.9	64.9	77.6	67.4
1868........	72.4	68.6	67.7	61.9	64.7	60.7	61.7	61.8	72.9	69.7	68.1	75.1	67.1
1869........	76.1	76.1	74.7	61.2	66.1	69.3	70.3	74.2	75.4	73.2	79.2	81.8	73.1
1870........	76.2	67.2	67.0	56.2	59.1	62.7	62.2	73.4	73.3	74.4	68.8	75.2	68.0
1871........	79.4	76.4	69.3	56.9	65.7	65.1	68.9	70.1	63.4	70.7	72.7	74.7	69.4
1872........	77.7	76.7	71.2	69.7	72.0	70.3	79.1	72.7	71.9	67.0	72.3	74.0	72.9
Mean......	76.6	71.8	69.5	62.3	62.5	66.1	68.0	68.8	71.9	71.2	70.0	76.5	69.6

3.—*Yearly Mean of Positive Electricity, of Temperature, and of Relative Humidity of the Atmosphere at the hours of* 6, 9, 12, 3, 6 *and* 9, *from morning till night, based upon daily observations at those hours from* 1861–1872.

ELECTRICITY.

YEAR.	6 A. M.	9 A. M.	12 M.	3 P. M.	6 P. M.	9 P. M.
1861	8.5	9.9	9.9	7.7	8.5	6.8
1862	8.9	10.0	9.1	7.3	8.1	6.8
1863	10.5	10.6	10.0	7.5	9.1	7.4
1864	7.9	8.8	7.4	5.4	5.9	5.5
1865	6.4	7.1	6.0	5.3	5.4	3.8
1866	5.5	6.2	5.2	4.5	5.2	4.4
1867	5.2	5.6	4.9	4.2	4.3	3.8
1868	2.7	3.0	2.7	2.2	2.5	1.9
1869	3.3	3.5	2.8	2.4	3.2	2.7
1870	4.7	5.3	4.3	3.6	5.0	3.9
1871	6.0	5.2	4.1	3.6	4.2	3.7
1872	4.9	5.7	4.7	3.8	4.6	3.7
Mean ...	6.2	6.7	5.8	4.8	5.5	4.5

TEMPERATURE, F.

1861	48.9	54.9	61.6	63.6	59.3	54.3
1862	48.9	55.0	60.9	62.3	58.0	53.6
1863	47.5	53.6	59.7	61.0	57.2	52.2
1864	48.0	54.1	60.5	62.2	58.1	53.0
1865	50.4	55.8	61.8	63.3	59.3	54.7
1866	48.4	54.6	60.3	61.9	57.9	53.4
1867	48.4	54 2	60.0	61.4	57.4	53.3
1868	49.2	54.8	60.4	62.1	57.4	53.5
1869	48.4	54.2	59.8	61.4	57.2	52.7
1870	50.2	56.2	62.3	63.5	59.0	54.6
1871	50.8	56.6	62.4	64.0	60.0	54.8
1872	48.5	54.0	60.6	62.1	57.1	52.7
Mean ...	49.0	54.8	60.9	62.4	58.2	53.6

RELATIVE HUMIDITY.

1861	86.4	71.3	60.3	57.2	65.1	77.3
1862	85.3	70.6	60.0	57.5	67.6	78.0
1863	86.8	71.4	60.2	58.0	66.7	77.9
1864	83.9	69.3	57.7	55.0	64.0	74.8
1865	84.7	71.7	61.3	59.0	68.3	78.9
1866	84.9	70.1	60.6	58.6	67.4	78.8
1867	83.1	68.4	57.9	55.0	64.6	75.4
1868	80.5	68.1	57.9	55.9	65.0	75.4
1869	86.9	73.8	64.6	62.4	71.2	80.0
1870	82.9	69.2	58.1	56.6	65.9	75.2
1871	81.0	69.6	61.7	60.2	67 0	77.0
1872	83.6	72.6	64.4	64.2	72.2	80.4
Mean ...	84.2	70.2	60.4	58.3	67.0	77.4

4.—*Direction of Wind from* 1861-1872 *at St. Louis, Mo.*

Year.	E.	N.	N.E.	W.	S.	S.W.	N.W.	S.E.
1861	136	169	190	324	293	279	293	522
1862	112	211	230	259	265	191	351	550
1863	148	180	228	282	271	302	307	458
1864	53	176	234	330	245	327	319	492
1865	53	164	250	287	308	296	242	572
1866	81	195	293	237	243	295	268	510
1867	72	184	251	231	231	245	292	527
1868	86	169	271	196	243	307	274	417
1869	74	125	202	195	273	296	305	363
1870	54	155	174	208	243	285	299	287
1871	91	158	201	124	214	294	298	371
1872	75	173	220	171	186	348	256	399
12 years	1035	2059	2744	2844	3015	3465	3504	5468
Percentage ...	4.2	8.5	11.4	11.8	12.5	14.4	14.5	22.7

Percentage of Direction of Wind during the Twelve Years, in the different Months.

	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept	Oct.	Nov.	Dec.	
E.	3.7	5.0	6.0	4 7	4.6	3.9	3.0	5.3	5.1	3 3	4.1	3.1	E.
N.	6.9	9 1	9.3	7.7	10 0	8.1	9.9	11 3	9.1	7.2	6.0	7.5	N.
N.E....	7.4	11 0	12.5	13.3	11.4	11.1	12.2	18 6	11 0	11 0	7.7	9.3	N.E.
W.	14.9	15.9	14 5	12 6	13.8	7.3	5 5	5 3	6 1	13.2	16.3	13 3	W.
S. ...	9.1	7.7	8.6	11 2	12.3	16 9	18.7	13.3	14 1	14.3	13 5	11.0	S.
S.W. ..	13 7	11 0	10.1	13.2	15 7	19 1	20 6	12.6	12 0	16 0	14 4	14.3	S.W.
N.W. ..	19 1	17.6	18.3	14 0	12.0	10.0	9.0	11.8	13.1	14 5	17.0	16.8	N.W.
S.E. ...	25 2	22.7	20.7	23 3	20.2	23 6	21.0	21 8	29.5	20.5	21 0	24.7	S E.

REMARKS.

The foregoing tables give a summary of my observations, during 12 years, of positive atmospheric electricity, with the correlative observations of temperature, of humidity, and of direction of winds, so that the reader may judge himself to what extent those meteorological phenomena influence electricity.

The electrical observations were made in the same way as described by me in the *Transactions of the Academy*, vol. ii., with Dellmann's apparatus, and without any change in the fine glass-thread of the measuring instrument. The movable collecting apparatus of Dellmann seems to me far preferable to any stationary instrument, because the first develops the momentary electricity of the atmosphere, and the latter that collected and accumulated for some time. But his measuring apparatus is too delicate to be moved; and if it could be supplanted by an instrument as delicate in action but of easier transportation, electrical observations would become more general and their results more valuable. Local meteorological observations are certainly useful and instructive; but meteorology, as a theoretical and practical science, will attain its climax only when spread as a net-work over the whole globe. A galvanometer of suitable strength may perhaps answer the purpose as a more convenient measuring instrument. I will give it a trial this year and report on it at some future time.

As an important addition to our knowledge of atmospheric electricity, I consider the discovery, resulting from my observations, of its *threefold periodicity*—the *daily*, the *annual*, and the *secular* (perhaps better called the *cyclical*). The daily one has been partially guessed at by some observers without proof positive, while the two others were not even thought of. The daily waves of positive atmospheric electricity are not so constant that they would show themselves every day: meteorological influences—especially temperature, humidity, and direction and force of wind—modify it so often, that the regular order of electricity appears even sometimes reversed; but in the course of a week, a month, or a year, these conflicting influences counterbalance each other, so that the steady undercurrent of periodicity becomes always visible and unmistakable. Thus we see in Table 3, in which the mean of the six daily observations is given for each year and for the twelve years successively, at the different hours of observation, two maxima and minima of electricity, with two intermediate points. The first *maximum* appears at 9 A.M., the first *minimum* at 3 P.M.; the second *maximum* at 6 P.M., the second *minimum* at 9 P.M. The daily periodicity is thus sufficiently proved; a trial of 12 years with about 25,000 observations leaves no doubt on that point.

The second periodicity is the annual, exhibiting itself in the regular, gradual increase in quantity or intensity of electricity during the six colder months of the year, culminating generally in January; and of a gradual decrease of electricity during the six warmer months, with its lowest point generally in July. Slight deviations between two consecutive months will take place in different years, but in the mean of the twelve years strict regularity is preserved, as Table 1 will show. The existence of the annual electricity is thus as clearly proved as the daily. But a point, which I raised in a former paper in regard to it, is not yet decided. I asked myself, if the regular increase of electricity in the colder season (and vice versa) was caused directly and exclusively by the change in temperature, or by some internal connection between atmospheric electricity and terrestrial and solar magnetism, of which I consider atmospheric electricity an emanation and offspring. If the latter hypothesis should be correct, our nearer approach to the Sun during the colder season (*perihelion*) might explain this regular increase of electricity during our winter (and vice versa). But in that case our southern hemisphere would in all probability be simultaneously affected, and electricity, like magnetism, would show there similar phenomena in their summer as with us in winter. Regular and careful observations, continued for years in both hemispheres simultaneously, with the same instruments, can decide that question.

A third periodicity is the cyclical. In Table 1 the last column contains the yearly means of electricity for the twelve years. We find there from 1861 a gradual increase for three years, with a maximum of 9.2 in 1863; then a gradual decrease for five years, with a minimum of 2.5 in 1868; then an increase again for four years, up to 1872 inclusive. This regular increase and decrease cannot be merely accidental, but is in all probability governed also by a law of periodicity. If 1873 should show a second maximum, it would establish a cycle of ten years, similar to that of magnetic phenomena and of the Sun-spots. How far this cycle coincides with the cyclical changes of magnetism in St. Louis I was not able to ascertain, because no regular observations of magnetism are made here. Neither are any observations for Sun-spots accessible to me, except those of Mr. Schwabe in Germany, with a computed maximum in 1861 and the last minimum in 1867, differing from mine respectively two years and one year. There may be various reasons for this discrepancy. The instruments for electrical observations still require improvement; my own observations may be sometimes defective, not having leisure to make them with the regularity I could wish. Electricity is, unlike magnetism and Sun-spots, often disturbed by other meteorological phenomena, and the most important of these disturbances, as by thunderstorms and windstorms, ought to be excluded from the calculations for periodicity; the observations of Sun-spots themselves are liable to mistakes on account of the numerous days in the year when clouds prevent observation; all these investigations are of comparatively recent date and as yet far too isolated, so that, with more perfection, future observers may establish a still closer approximation between them. Our present knowledge certainly warrants us to accept a near relationship between terrestrial magnetism, Sun-spots, and atmospheric electicity, and by more extended observations we will reach at last the final aim of all scientific research—truth.

As to the practical use of electrical observations for meteorological predictions, I believe that, in their present state, they cannot surpass the barometer, but prove a valuable aid to it. Thus, they will often predict storms by a sudden change from positive into negative electricity; snowstorms develop locally a high degree of positive electricity, while for great distances they create a vacuum, a total absence of electricity; during an Aurora high positive electricity prevails, with sudden fluctuations in intensity, etc. If observations of electricity were made as generally as those of barometer, their usefulness in that respect would be greatly enhanced.

The interest in meteorological observations has been awakened in this country. Our meteorological Signal Bureau, under supervision of the government, has in the short time of its existence fulfilled all reasonable expectations, and promises to become more useful every year. If it could be so arranged, that perhaps at a dozen stations, well-selected throughout the United States, the usual meteorological observations were combined with those of magnetism, electricity, and Sun-spots, a most desirable object would be obtained with comparatively little expense.

Such investigations offer also a fine field to young men of a scientific turn of mind. St. Louis is no longer the village of old, with a coon-skin currency and a small Indian traffic. It has grown in population to be the fourth city of the Union; millionaires and rich merchants reside here, whose sons receive a liberal education and they are not under the necessity of working hard for a living; they are in a position to cultivate the arts and sciences, and to aspire to the higher pursuits of life; the increase of human knowledge by scientific research is within their compass. History tells us that the trophies of Miltiades disturbed the slumbers of Themistocles. Should not some young man in our midst, of independent means and higher ambition, be aroused by the fame of a Tyndall, a Bunsen, a Secchi, and others, to erect here a physical observatory for original investigation in Magnetism, Electricity, Sun-spots, and that most wonderful of recent discoveries, Spectroscopy; to naturalize these studies amongst us, and to build up for himself, during his lifetime, a monument "more durable than brass" and more solid than greenbacks? The restless spirit of youth requires only direction to useful activity—may that seed-grain of advice from an older man fall upon fertile soil!

Catalogue of Earthquakes for 1871.

PREPARED FROM THE RECORDS IN THE DAILY PRESS,

By RICHARD HAYES.

Time.	*Place.*	*Characteristics.*	*Authorities.*
Jan. 1	New Zealand	One of the smartest for some time	Nature iii. 414
12 P.M. Jan. 1	Guzerat, Ind.		" " 394
9	Guayaquil, Ecuador	Slight; movement from interior towards the coast	" " "
15	Oaxaca, Mex.	*Several* days about this time shocks were felt.	Daily papers
18	Laconia, N. H., U.S.	Quite severe for that region	" "
26	Accra, Africa	Some severe shocks	Nature iii. 394
27	Assam	One shock	" " "
28	Monado, Celebes	Slight local shock	" iv. 85
31	Bombay	Extended over a large tract of country	" iii. 394
Last part of month	Cartal, Asia Minor	Shock of several seconds; slight damage	" " 395
	Mexico	An eruption of the Coloruceo volcano during the month	" " 394
Feb. 5	Rye, N. H., U. S.	Slight	Telegram
5	Guanape Isl.	From the 5th to the 9th the water around them was violently agitated, causing whirlpools and injuring the shipping	Nature iv. 169
7	Minatitlan, Mexico	Two shocks followed by a wave rising 1 foot.	" " "
7	Honolulu	Three shocks, lasting over a minute; houses in many of the valleys were greatly shaken.	Daily papers
9	Illapel, Chili	Very strong shock; freshest from the mountains	Nature iii. 472
11 4 A.M.	Valparaiso	Strong shock	" " "
16	Burmah	Somewhat severe and extended	" v. 7
17	Hayti	Felt also in other W. I. islands	Daily papers
18 10–11 P.M.	Hawaian Isl.	Lasted about one minute, preceded by a roaring sound heard far out at sea; rocks were thrown down from the mountains, clefts opened in the ground and houses were overthrown. Also a bright light was seen in the east at the same time	Am. Jour. of Science
19	Hayti	Slight	Daily papers
20	Santiago de Cuba	Several shocks	" "
21	" "	" "	" "
Previ's week	Trinidad	" "	" "
22	Puno, Peru	" "	Nature iv. 169
22	Hawaian Isl.	Slight shock	" " 230
23	Puno, Peru	" "	" " 169
24	Hawaian Isl.	" "	" " 230
25	Chili	Severe shocks	" " "
28	Jolisco, Mex.	A meteor fell, followed by an earthquake	Daily papers
Mar. 2	Humboldt Co., Cal.	Severe; chimneys thrown down, &c.	" "
3	Janesville, Wis., U. S.	Slight	" "
4	Bogota, U. S. Col.	"	Nature iv. 51
4	Arequipa, Peru	After many rainy days; slight.	" " 169
5	New Hamp.	Slight	Daily papers
5	Monado, Celebes	"	Nature iv. 85
6	Cartago, U.S. Col.	"	" " 51
6	Puno, Peru	"	

Time.	*Place.*	*Characteristics.*	*Authorities.*
Mar. 14	Peru	For *several* days previous shocks were felt in various places, preceded by an electric storm	Daily papers
17 11 P.M.	England	All the northern counties	Nature iii. 413
18 7 A.M.	"	" " "	" " "
24	Salvador, Cen. Amer.	Slight	" iv. 74
25	Chili	Severe shocks	" " "
26	Arequipa, Peru	Slight	" " "
30	Salvador, Cen. Amer.	Two shocks	" " "
—	Yagolanda Island ...	From the 2d to the 14th the volcano Roewang was active. On the 5th, a wave swept over the island destroying three villages and 416 persons	" " 286
April 1	Melbourne ..	Severe	Daily papers
2	San Franc'co	Two slight shocks	" "
3	Valparaiso .	Severe shock	" "
10	Shetland.....	Attended by loud noises along the Stony Hill range	" "
11	Burmah	Slight	Nature iv. 169
11	Arequipa, Peru	"	" " "
15	Argyle	"	Daily papers
16	Wilmington, N. C.	"	" "
16	Burmah	"	Nature iv. 169
18	Scotland.....	"	Daily papers
25	Chili	*Several* days	" "
30	Hayti	Slight	" "
	Lat. 30° N., Lon. 140° E.	During the month a volcano was seen and a severe earthquake felt........	Honololu Gazette
May 1	Camiguin, Phill. Isl.	For some months previously, especially in March, there was a succession of violent shocks, causing crevices &c., in the open country. On May 1st, about 5 P.M., a level plain near the village of Cotarwen began to subside till the tops of houses became level with the surface of the earth, when suddenly the whole plain fell in, engulfing 150 persons. This became the crater of a volcano 1500 feet wide, from which smoke, ashes and stones were sent into the air. A pause till dark succeeded when there was another explosion, and the volcano continued to eject stones and earth........................	Nature iv. 375
11	India......	Two slight shocks	Daily papers
20	Bingtang Isl.	Very destructive.........	" "
21	Canada	Two shocks. Also in Georgia, U. S.	Nature iv. 169
22	Gelghit, Asia, Agra, India, &c.	Two were felt, on the 22d and 23d...........	" " 287
23	Himalayas	Causing a lake to emit sulphurous odor	" " "
June 7	Marmoritza, Asia Minor	Almost destroyed...................	" " 169
8	Wagga-Wagga, Austral.	Two heavy shocks. About a dozen since.....	" " 350
13	Minahassa, Celebes, 7½ P.M.	Extended throughout Minehassa	" v. 225
18	Long Island, N.Y., 10 P.M.	Slight shock	Daily papers
19	New Jersey..	Water in a canal disappeared through a sinking of the land	" "
19	Simla, 9.40 PM	Slight; weather had been very sultry........	Nature iv. 325
20	Tacna, Peru, 7 P.M. . .	Strong shock	" " 418
20	Madeira, 6 PM	Slight	" " 436
21	California .	Sharp shock	Daily papers
26	Chiriqui, 7.50 P.M.]	Severe	Nature iv. 350

Time.	Place.	Characteristics.	Authorities.
July 5	San Franc'co	Slight	Telegram
5	Tacua, Peru.	"	Daily papers
10	S. Lat. 20° 30', E. Lon. 14° 4'	Two violent shocks at sea	" "
11	Valparaiso	Strong; preceded by a rumbling noise	Nature iv. 454
13	Boston	Slight	" " 326
15	Gorontalo, 12½ & 10½ P.M.	Two shocks	A. B. Meyer
19	Gorontalo, 12½ A.M.	Heavy	"
20	Santiago de Chili	Very severe	Nature iv. 454
20	N.Eng. States	Two severe shocks lasting four seconds	Daily papers
24	Cairo, Ills.	Slight	" "
25	Bell'ville, Ill. 12.40 P.M.	This seems to have been felt throughout St. Clair county. A rumbling noise and sensible vibration of buildings were experienced.	Lebanon Jour.
30	New Hampshire.	The water near the centre of Winnepisseoge lake appeared to sink suddenly and was followed by large waves, there being no breeze stirring at the time	Telegram
Aug. 7	Ternate	Eruption of the volcano; stones and ashes thrown as far as Halmaheira. The Batavia Handelsblad, Sept. 25, states that on the afternoon of Aug. 7 a violent earthquake was felt. Exact direction unknown. The Ternate mountain had from 9 A.M. caused a dull, rumbling sound to be heard, varied at intervals by loud reports, and began in the course of the day to cast out streams of lava. A southerly wind changed the direction of the lava streams flowing landwards, and led the fire in seven currents to the ravines. The eruption of fire and stones lasted about twelve days, after which it became less. This outburst was the most violent known at Ternate within the memory of man. The whole island shook from the under-ground motion. On Aug. 28 the volcano was again at rest, only a small cloud was seen coming out of the crater.	A. B. Meyer Nature v. 225
9	Wolfeboro, New Hamp.	Slight	Daily papers
19	Gorontalo, 5 A.M.	"	A. B. Meyer
20	Jamaica	No damage done	Nature iv. 387
21	Callao, 8½ P.M.	Severe. Also felt at sea	" v. 14
21	St. Thomas, W. I.	Several shocks in the afternoon. In the forenoon a violent hurricane swept over the island, scarcely a house remained standing.	Telegram
21	Off Peru	Seaquake. Quite severe.	Daily papers
25	Gorontalo, 3 P.M.	Seaquake	A. B. Meyer
28	Worthing, Eng.	Two slight shocks	Nature iv. 349
29	" "	One shock	" " "
31	Gorontalo, 1 P.M.	Very strong vertically	A. B. Meyer
Sept. 3	Jamaica, 4 P.M.	Slight	Nature iv. 454
20	" 9.20 "	Sharp shock accompanied by rumbling	" " 387
25	Carrizal Bajo Chili, 4.3 PM	Preceded by a loud noise	" v. 212
29	Bombay	Slight	" " 89
Oct. 4	Arequipa	No damage	Daily papers
5	Peru, 12.50 PM	Considerable damage to buildings in Iquiqui, Pica, Mortilla, Tarapaca, Usmagama, Guasquina, and Pachico. The steamer Panama felt the shocks at sea.	Iquiqui Mercurio, Oct. 8
8	Constantinople	Violent	Daily papers
9	New Jersey, 9.40 A.M.	Felt also in Pennsylvania and Delaware	" "

Time.	*Place.*	*Characteristics.*	*Authorities.*
Oct. 10	Arequipa'	Not very severe	Daily papers
10	Salvador, C'l Am. 8.27 A.M.	Slight	Nature v. 212
12	" " 11.36 P.M.	Strong shock lasting 19 seconds	" " "
after 12		Two others. Dates not given	" " "
13	Nicaragua, 11 P.M.	Shock at fort La Libertad	" v. 132
22 / 23	Buenos Ayres.	The shocks commenced at 11 P.M. of the 22d and continued till 8 A.M. of the 23d. Thirty-eight or forty shocks were felt in all. The town of Oran was entirely destroyed. It was also reported that a volcano had burst out in the province of Jujuy.	Dispa'h of Lt. Gov. Hilarion Carrasco and letter of Dr. J. Aguirre.
27	Wolfeboro, N. H.	Violent	Daily papers
30	Dominica	Felt also in others of the W. I. islands	" "
—	Chiriqui	Near beginning of the month	Nature v. 90
—	Bombay	Middle of the month. Slight	" " 412
Nov. 7	Smyrna, 2.30 P.M.	Slight	" " 132
10	Salvador, Cen. Am.	"	" " 212
12	" "	Strong	" " "
25	Simla	Characteristics not given	" "
26	Macedonia, 11 P.M.	Two shocks	" " 132
30	Portsmouth, N. H.	Slight	Daily papers
—	Valparaiso	On two days in early part of the month.	" "
—	Brazil	On nine days during the month	" "
Dec. 5	Utah, U. S.	Two severe shocks in Iron Co. dur'g the night.	Telegram
6	" "	One slight shock in the morning	"
12	Serampore	Two shocks between 10 and 11 P.M; the second and strongest lasted ten seconds, moving from north to south. These were felt also at Rangoon, Prome, Hazadak, Calcutta, Ducca, and Akyab.	

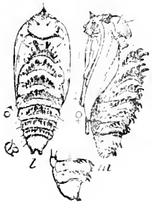
In preparing the foregoing catalogue, I have endeavored to make it as reliable as possible, though I have met with not a little difficulty on account of the great lack of definiteness in most of the cases reported. Shocks that are characterized as severe in some localities would doubtless have been reported as slight ones if they had occurred in places where earthquakes are frequent. Also, where a series has occurred at a given place, it is often the case that only a few of the most prominent are reported, or that they are spoken of as having taken place on "several days." Thus A. B. Meyer writes as follows:—"In the month of August there was at Gorontalo a series of earthquakes, all of which I did not notice in my diary, some of them very severe. Shocks so severe and numerous have not been experienced for years at that place." Though the catalogue is, doubtless, far from being complete, yet I think it will be readily seen that there was an unusual number during the year. It will be remembered by members of the Academy, that, at the second meeting in February, 1871, I read a paper showing the number of different days in each year on which earthquakes have been reported from 1739 to 1842, and that the largest maxima occurred in the years of the heliocentric conjunction and opposition of Jupiter and Saturn, with but three exceptions, and in those cases the increase began in those years, but the maximum was not reached till the following year. I also suggested that these planets induce electric currents which *call into action* those forces to which the causes of siesmic phenomena are usually ascribed. My subsequent investigations have only tended to confirm the opinion then expressed. I cannot see why there should be any regular periodicity at all, unless the superinducing cause is outside of the earth itself; and, as it seems to me, it cannot be gravitation, for, if it were, the periodicity could not be so so strongly marked as it is in respect to these two planets, since their effect upon the tides is inappreciable. The physical condition of those two bodies and their exceedingly rapid axial rotation would seem to fit them for exerting, in some of its forms, a greater amount of repelling force than any other heavenly body in our system excepting the Sun.

 June 21, 1873.

Supplementary Notes on Pronuba Yuccasella.

BY CHAS. V. RILEY, M.A.

[FIG. 3.]



In the paper on this insect which was communicated to the Academy last fall, and which is now in print, the latter part of the natural history of *Pronuba*, as there given, needs to be substantiated: and I now take pleasure in supplementing and completing it.

As I suggested it would, the larva remains in its cocoon unchanged all through the fall, winter and spring months, and does not assume the chrysalis state till a fortnight or so before the blooming of the Yuccas. It is one of the hardiest larvæ I have had to do with, and will not only repeatedly mend its cocoon when this is cut or torn, but, when extracted from it, will survive for months if afterwards kept in a tight vessel. This tenacity of life makes its safe transportation from one country to another all the more sure and easy.

The chrysalis works its way through a long dorsal rent in the larval skin, so that this latter is not compressed into a little mass, as is the more usual way with *Lepidoptera*, but retains nearly its original length.

DESCRIPTION OF CHRYSALIS, ♀ (Fig. 3, *m*, lateral view). — Average length 0.30 inch; greatest diameter about $\frac{2}{7}$ the length. Thick and stout, with the dorsum greatly arched. Head with a prominent, conical projection on top, and two smaller ones between the eyes. Most characteristic feature a series of six dorsal, arcuated, horny plates—one on the anterior half of each of joints 5–10. These plates have anteriorly 10–12 blunt, flattened, recurved projections, the largest in the middle, from which the others are successively lessened. The ends of some of the larger ones are shaped like the share of the more common shovel-plow. In the first row the arcuation is greatest, and the projections largest and directed most forward; all which features are gradually lessened with each succeeding joint. Joint 11 has no plate, and but four posteriorly-directed spines, while joint 12 has two broad and flattened dorsal processes. Tip of abdomen rounded and reaching beyond the processes. Each joint has a transverse series of stiff yellow hairs and four such are quite conspicuous on mesothorax, and others on top of head and on face. Color when fresh pale green, with the wing-sheaths darker. When mature, and just before giving forth the moth, the head, thorax, breast between the antennæ, and tip of abdomen, are light brown; the eyes, dorsal plates, and projections, darker brown; the wing-sheaths and interspaces between dorsal plates whitish; and the sides greenish.

♂ (Fig. 3, *l*, dorsal view) distinguished generally by his somewhat smaller size; by the dorsal projections not diminishing on joints 8–11, but rather increasing in size; by the greater shortness of joint 11, and greater length of joint 12; and by the apex not being so rounded, and not extending beyond the broad anal horny processes. At maturity the maxillary pieces are somewhat flatter, owing doubtless to the fact that in ♀ the spiny cylindrical tentacles lie stretched nearly their whole length and cause them to bulge more.

Thus in the chrysalis state this insect is as abnormal and as admirably adapted to its conditions and wants as it is in the larva and imago states. Sexual distinctions are very rarely observable in chrysalides; but after I had learned to distinguish between them I could readily separate the sexes in this case, and my judgment was confirmed upon the issuing of the moths. By a series of contortions, but more especially by alternate forward and backward movements of the dorsal projections, this chrysalis easily ascends to the surface of the ground, the cephalic spines serving to open the end of the cocoon and the dorsal projections making excellent levers by which it pries its way through the soil.

I found it very difficult to hasten the natural process of development, for notwithstanding that, in my anxiety to force a few specimens, I kept them throughout the winter in a mean temperature of about 80° F., I did not succeed in getting a chrysalis till May 5th. As the blooming season of our filamentous Yuccas is comparatively brief, and as all moths issuing before or after such blooming would be likely to die without issue, we find the habit of developing at the proper season very strongly fixed. My first moths issued (three of them, all forced) May 30th, leaving their exuviæ lying on the top of the ground. The cocoons out-doors, and which are seldom more than five or six inches below the surface of the ground, yet contain (June 2d), many of them, the unchanged larva.

In my fifth Report will be found evidence to show that in a single case *Yucca filamentosa* has produced seed in England. This exceptional fact indicates either that *Pronuba* occurs there; that other insects may occasionally be the pollenizers, or, as suggested by Dr. Engelmann (*ante* p. 29), that self-fertilization may exceptionally take place. The first view may not appear very plausible, but, to quote from the Report mentioned, "if both sexes of the insect were, by some chance, introduced into a locality where Yuccas of blooming age were growing, there is no reason why they should not multiply; and such chance introduction is not impossible, since the larva not unfrequently remains in the capsule after the seed is ripe, where it fastens a number of the riddled seeds together into a sort of cocoon, which might easily pass unnoticed in gathering seed; and, if buried in the ground with such seed, would in time give forth the moth."

As bearing on the subject of the insect's range, we have proof that it occurs on Long Island and around New York. Since writing my former paper I have examined the wild *Y. angustifolia* around Manhattan, Kansas, and always found traces of *Pronuba;* but of seventy plants, including several species, examined in the garden of Mr. Meade Woodson, of Kansas City—a gentleman who is a great admirer of the genus—not one has yet produced seed. Mr. Edgar Sanders, of Chicago, tells me that plants of *Y. flaccida* do not there produce seed. Mr. Henry Wheatland, of Salem, Massachusetts, says that *Y. filamentosa* never produces seed there; and I learn from Professor Gray that it is equally barren at Cambridge.

On the Occurrence of Iron Ores in Missouri.

By JAS. R. GAGE, M. E.,

ASSISTANT STATE GEOLOGIST OF MISSOURI.

During my connection with the State Survey I have made a collection of the Iron-ores, which I wish to donate to the Society, and at the same time would make a few remarks upon the occurrence of these ores.

There are but four ores from which iron is extensively derived, viz.:

Spathic Iron (Carbonate of Iron, iron spar);
Red Hematite (Specular, Oligist, iron glance);
Brown Hematite (Limonite, bog-ore, hydrous oxide);
Magnetite (magnetic iron).

As the first mentioned ore has as yet not been found in sufficient quantities in this State for mining purposes, we will now pass to the consideration of the three latter in regard to their geological position and occurrence in Missouri.

These Iron-ores are found in what are known in Missouri as the Saccharoidal Sandstone, 2d Magnesian Limestone, and 2d Sandstone (all of which are included in the Lower Silurian formation), and in the Porphyries which geologically lie below and belong to the Primary or Palæozoic age. These ore deposits are found in the above-mentioned rocks, and appear as veins, lodes, beds, segregations and impregnations, and may be the result of direct precipitation from a solution, especially in cases where they occur as beds, or from a variety of causes, all of which we will consider.

Theories in explanation of vein-formations were offered almost as early as Geology may be termed a science. From the time of Agricola, who was the first to propound a theory, down to the time of Werner and Hutton, who systematized Geology and really established its claims to be ranked as a science, each has had a theory to account for the origin of vein-formations; some of which we will now examine, and see if any is sufficiently well supported by facts to explain the vein ore-deposits in Missouri.

According to Cotta's classification, in his work entitled *Erzlagerstättenlehre*, they are divided as follows:

1. *Theory of Contemporaneous Formation:* the lodes are not mineral matter filling fissures, but were formed synchronously with the enclosing rock, or subsequently by a metamorphosis of the altered regions of the

same.—This theory was held by Stahl, Zimmerman, Von Charpentier, and Von Trebra.

2. *Theory of Lateral Secretion:* the lodes, fissures, or veins, have been filled from the neighboring rock.—Delius, Gerhard, Lasius.
3. *Theory of Descension:* the veins or fissures have been filled by material furnished from some source above.—Baumer, Werner.
4. *Theory of Ascension:* this theory claims that the veins were filled by material brought from below, and may have been introduced in the following manner:
    - *a.* By Infiltration: the material was deposited from an aqueous solution, as mineral water.—Lasius.
    - *b.* By Sublimation: *α.* the material was introduced into the fissures by ascending steam.—Lehmand and perhaps Becher.
      By Sublimation: *β.* the fissures were filled by sublimation from matter in a gaseous condition.
    - *c.* By Injection: an igneous force has injected the matter while in a fluid condition into the fissures, where it afterwards solidified.

Cotta says that neither the theory of contemporaneous formation nor that of descension has had any upholder since Werner, thus leaving only a choice between the theories of Lateral-secretion and Ascension.

Now if by the former a literal interpretation is rendered, and it is understood in the sense that the ore-deposits resulted from the *immediate contact* rock, through which some solvent passed dissolving out the ingredients and afterwards depositing them in the veins or fissures, then this theory would not account for the ore-deposits which have come under my observation; but if we may interpret the term *lateral* not as applied literally, and look upon the contact rocks not as the *source* of the material furnished, but merely as conductors through which the solvents passed holding the material in solution, then the Lateral-secretion theory, in my opinion, accounts for all the *vein* ore-deposits which I have carefully examined.

The ore-deposits of this State which occur in the Lower Silurian formation may have resulted, especially the bedded ore, by a direct precipitation from a solution, or by the Ascension theory as defined by Cotta, as, for example, the veins of specular-ore in the 2d Sandstone formation in Crawford County; for, though having seen these formations, I have not been able to correlate the few facts gathered, and can offer no theory for their origin. But the Ascension theory will certainly not account for many of the ore-deposits found in the porphyries of the Palæozoic formation; for neither by sublimation nor by injection could, for example, the ore-deposit on Pilot Knob have been formed; neither by infiltration, if the material deposited was necessarily introduced in a state of aqueous solution from *below*: but if we interpret Infiltration to mean that a solvent passes through the enclosing rock to the fissures, and may either before reaching the rock hold in solution the material to be deposited or dissolve the particles on its passage—but *geographically* the source of the solvent is *below* the point where the deposition is made—then the Infiltration of the Ascension Theory resolves itself into the Lateral-secretion Theory, and they become one and the same. It is only by the process of lateral-secretion I can account for many of the ore-deposits in the Porphyries; for example, in the Pilot Knob formation this seems to me the only tenable theory. For we have in Pilot Knob a large iron-ore bed lying in Porphyry: we cannot account for it having been deposited directly from water; for we would have to imagine first a bed of Porphyry, then a large body of water holding the material in solution, then a precipitation, and afterwards a *porphyritic mass formed on top of the ore-bed.* And where shall we look for the origin of this Porphyry? Echo must answer, Where? for science certainly will not. It cannot be accounted for by Sublimation, for fissures were necessary for the reception of the sublimated material, and also as channels for conduction; the bed is not a fissure caused by contraction or some other force of nature, and, if it were, no trace of fissures exists below through which the material could have been conveyed to the existing bed.

The same reasons can be urged against Injection, the deposition of the bed is too regular to be the repository of injected matter; and if the ore had been injected into its present position, traces of veins or fissures would exist in the underlying Porphyry, but no such traces exist. Consequently all these theories are untenable, and for a solution of the problem as to the origin of ore-deposits we only have the Lateral-secretion Theory, but which, I think, is all that is necessary for an explanation.

When I first examined the ore-deposit on Pilot Knob, I was at a loss to account for its origin; the conglomeratic *porphyry* mass overlying the ore-bed forbid the thought of the ore having been precipitated directly from a large body of water which had previously held the ore in solution. And, for reasons previously stated, an igneous origin was equally untenable: the formation on Cedar Mountain originated the germ of the thought, which afterwards became conviction, as to the process by which these ores were deposited. Cedar Mountain is, in the greater portion, a mass of Porphyry, more or less dense in texture, with little or no quartz; the lesser portion is a conglomeratic porphyry mass. Wherever a section of this conglomeratic mass is exposed to view it shows irregular deposits of iron-ore, which, when carefully examined, seem to be younger than the conglomerate, and the conviction is forced upon the examiner that the deposit has been formed by *replacement*, and that some solvent has gradually removed the porphyry and at the same time deposited the iron-ore in the vacated place: this could not have been accomplished in the present physical condition of the mountain, as the ore extends to the very highest point, and it is not probable that a solvent would force its way upwards unless acted on by some subterranean force; then, for an explanation, we must imagine the present localities of the ore-deposits to have been at a much greater depth during the formation than they at present occupy. This being granted, the theory of a replacement of the porphyry by the ore through lateral-secretion would fully account for the origin and present condition of the ore-bed.

Being convinced of the process by which the ore-deposits were formed at this locality, I turned to Pilot Knob to see if this theory would not account for the formations there. But the question was forced upon me to inquire why there was so much *regularity* in the latter formation — if a solvent passed through the conglomeratic mass, why was the porphyry dissolved in *one direction* and always with an average thickness, the whole mass being chemically and geologically the same. But here arises another question, *were they homogeneous?* Above and below the bed of ore lie porphyry conglomerates; but was the space now occupied by the ore at one time filled by the same overlying and underlying porphyry conglomerate, or by some less durable substance with a *slaty* or *bedded* texture? If the latter, then the problem was easily solved, because a solvent percolating the mass would be most likely to attack that material which offered least resistance. A stratified or bedded porphyry would offer much less resistance to a solvent than a dense homogeneous porphyry. These questions and their answers occurred to me, and I immediately sought for some sign of bedded porphyry, but on the Knob found none. I looked further, and discovered east of the Knob a singular formation of a slaty texture, with dip and strike, though not precisely the same, yet similar to the ore-beds of Pilot Knob: this formation passed from ferruginous slates almost to pure seams of iron, and in fact the formation lying in the porphyry hill contained in the same bed specular-ore.

These iron-slates were no doubt at one time first banded, then stratified porphyry; then the texture became bedded; finally slaty: and when it reached this stage, and was ready to be easily acted upon, the solvent came, dissolved the porphyry slates away, and replaced in their stead these ferruginous slates and iron-ore.

I felt fully warranted in drawing this conclusion from the facts already gathered; but to remove all doubt, and make the chain of evidence complete, another link was wanting. I had seen the gradual change from porphyry slates into ferruginous slates and these into ore-beds, but as yet no indication of the origin of the porphyry slates. The last link needed was furnished in the ravine on the south-west slope of Buzzard Mountain; here there is a gradual transition of texture from banded into stratified, stratified into bedded, bedded into slates: thus the chain is complete, and fully accounts for the bedded texture of the Pilot Knob ore. And in order to fully understand all the changes we have but to imagine the present position of the ore-bed, when occupied by slates, to have been situated at a great depth; and by replacement, according to the theory of lateral-secretion, the slates disappeared, the ore-beds were formed, and later, through some subterranean force, the whole formation, including the ore-beds and the overlying and underlying conglomeratic porphyries, were slowly elevated to their present position.

Having examined into the origin and present position of the ore-deposits found in the porphyries, we will glance at their mineralogical and chemical properties. These iron-ores may be divided into three classes—Magnetite, Specular Iron, and Manganiferous Iron. The magnetite is the richest iron-ore, yielding 72.4 per cent. of the metal. Magnetite is found only in one locality to any extent, occurring in veins on Shepherd Mountain, the enclosing rock being a red porphyry with a dense matrix containing crystals of a triclinic feldspar with no free quartz; the vein-formation is the predominating occurrence of the ore in this district.

The specular-ore occurs much more extensively, being found throughout the whole porphyritic district, with a variety of texture: in beds, as on Pilot Knob; in true veins, as on Shepherd

Mountain and Iron Mountain; lenticular veins, Iron Mountain and Hogan Mountain; as segregations and impregnations, in the Porphyry matrix throughout what is known as the iron region.

Manganiferous iron-ore was discovered at several points, but only in one place to my knowledge does it occur in sufficient quantities for mining purposes: here it has a thickness of fourteen feet, and yields from 10 to 12 per cent. of manganese. I would here remark that this ore is one of the most important of the iron ores, yielding one of the finest products for the manufacture of steel.

On the table you will find specimens of iron-ore with the analysis of each attached: the iron-ores from other localities have also been analyzed, but I did not feel at liberty to make known their results until after the publication of this year's Report on the Geology of Missouri. After the said Report appears, I will attach to each their respective analysis.

The following analyses are made from specimens from Pilot Knob, Cedar Mountain, Shepherd Mountain, Buford Mountain, and Iron Mountain. From Pilot Knob there are two varieties, one from above the seam, the other below the seam of clay slate. The lean ore contains a large per cent. of porphyry: below the seam is the richer ore, from which most of the iron is derived.

The Buford Mountain ore is rich in manganese, and will furnish a fine Spiegeleisen, from which no doubt, later, a fine quality of steel will be manufactured.

	PILOT KNOB.			
	Below the Slate Seam.		Above the Seam.	
	No. 3.	No. 4.	No. 6.	No. 8.
Insoluble silicious matter,	14.75	5.57	- -	- -
Peroxide of iron,	84.33	90.87	77.02	52.18
Protoxide of iron,	0.15	1.67	- -	- -
Alumina,	0.75	0.53	- -	- -
Lime,	0.21	1.76	- -	- -
Magnesia,	0.14	0.13	- -	- -
Manganese,	0.00	0.00	- -	- -
Sulphur,	trace	0.078	- -	- -
Phosphoric acid,	0.035	0.069	- -	- -
	100.365	100.677		
Metallic iron,	59.15	64.91	53.91	36.52
Phosphorus,	0.015	0.031		
Specific gravity,	4.386	5.019		

	Cedar Hill.	Shepherd Mountain.		Buford Mt.
		No. 2.	No. 3.	
Insoluble silicious matter,	5.62	6.76		8.54
Peroxide of iron,	93.54	88.56	96.70	68.30
Protoxide of iron,	- -	2.97		
Alumina,	- -	1.55		
Lime,	- -	0.35		
Magnesia,	- -	0.04		metallic
Manganese,	- -	0.00		12.3
Sulphur,	00.00	0.00	00.00	0.011
Phosphoric acid,	0.90	0.039	0.032	0.102
		100.269		
Metallic iron,	65.47	64.31	67.69	47.8
Phosphorus,	0.039	0.017	0.014	0.044

All of these analyses were made by Mr. Andrew J. Blair.

The following, of Iron Mountain ore, was made by Mr. Otto Wirth:

	Iron Mountain Ore.	
	Quarry Ore.	Surf'e Ore.
Peroxide iron,	93.57	95.42
Magnetic oxide of iron,	0.76	0.86
Manganese,	0.12	0.07
Alumina,	0.08	0.06
Lime,	0.46	0.32
Magnesia,	0.23	0.21
Phosphoric acid,	0.35	0.36
Silicic acid,	4.75	3.02
	100.005	99.996
Metallic iron,	66.049	67.416
Phosphorus,	0.016	0.016
Specific gravity,	4.944	5.002

There is a number of porphyry mountains in this district, some isolated like Shepherd Mountain, and some connected by saddles as Pilot Knob. These mountains vary in height from two or three to over six hundred feet, Pilot Knob being 562 above the valley, 1112 above the directrix in St. Louis, and 1521 above tide.

These mountains are composed of porphyries, with various textures, there being no other rock in the immediate neighborhood except some low chert and limestone knolls belonging to the Lower Silurian formation; the limestone is found throughout the valleys, reaching as high up as the 300-foot contour line on the mountains.

The term "porphyry" was originally applied to any igneous rock of a red or purple color, without any regard to its constituents or structure; but by the term "porphyry" I mean a compact, microcrystalline, feldspathic base, in which crystals of feldspar or quartz, or both, are developed.

Nauman proposed to call any feldspathic base, whether it contained crystals of quartz alone or associated with crystals of feldspar, "porphyry," and collect all the quartzless porphyries under the name of "Porphyrite." This nomenclature has been pretty generally accepted, especially in Europe; and although thinking it the best yet proposed, and being accustomed to it myself, yet, as the members of the Survey, in speaking of porphyry, have understood the rock as first defined, I shall include all under the general name of Porphyry according to their definition.

In this district there are several varieties of porphyry; a dense pink-colored porphyry predominates, and is the characteristic porphyry of all that region lying back of Pilot Knob. This porphyry is usually flesh-colored, but varying in shade, sometimes passing into a deep liver color, with dense matrix, no crystals of quartz or feldspar; fracture sometimes smooth, again jagged, but generally inclining to half conchoidal: the texture is very varied. A mile east of the Knob, it passes from massive into stratified, slaty, and bedded; immediately in rear of the Knob, mostly massive, but a few points show magnificent columnar structure. These porphyries seem to be older, and apparently belong geologically below the porphyries of Pilot Knob.

The *general* character of the Pilot Knob porphyries is conglomeratic, but the porphyries vary in texture, color, and the material which acts as a *cement*. All that mass of porphyry overlying the ore-bed is a conglomerate, having a granular iron-ore matrix (the iron-ore acting as a cement) containing weathered, angular and rounded fragments of porphyry lying firmly fixed in the mass; the exposed surface presents a bright, metallic lustre, produced by the fine points of iron-ore. On the exposed parts of the outcrop the porphyry is very much weathered and shows little structure; but on a fresh surface, where the fracture is very ragged and uneven, a greyish-white weathered porphyry is seen lying, breccia-like, in the mass.

On the south-west side of the Knob is a large outcrop of a light purple colored, lustreless, earthy porphyry, very much weathered; and farther down, an accumulation of a white steatite mineral in a conglomeratic porphyry: this mineral is probably a product from the decomposition of the feldspar in the porphyry.

Immediately underlying the conglomeratic porphyry which forms the top of the Knob is a bed of lean iron-ore, or flag-ore, 16 feet in thickness; this flag-ore is composed of alternate layers of silicious iron-ore and a light liver-colored ferruginous porphyry, the layers of neither being less than $\frac{1}{10}$ and not more than $\frac{1}{4}$ of an inch in thickness. The flag has a slaty texture, and cleaves with an even granular fracture *parallel* to the bed; with more difficulty it breaks in the direction of the strike, and when broken presents a fresh, granular, uneven fracture. The flag also possesses a *jointed structure* (similar to the columnar porphyry east of the Knob and the plate porphyry on Buzzard Mountain), being cleft internally by fissures or joints; the jointing is very regular, the clefts or fissures observing one general direction, causing pieces severed from the mass to form regular plates and columns, the axes of the jointed plates being at right angles to the plane of the larger cooling surface, or at right angles to the plane of bedding. When first seen, I thought this flag must be of sedimentary origin, having originally been deposited in horizontal layers, then depressed to a great depth, subjected to heat and afterwards elevated, and by unequal cooling had imparted to it this jointed structure; but I now think that the porphyry was formed by igneous action. Being at great depth, and under great pressure, different textures were assumed as the force most favorable to the formation of the massive or bedded structure predominated. This bed, now a flag-ore, which was at that time a porphyry, on cooling assumed a plate and columnar texture; and when the porphyry was removed, and replaced through *Lateral-secretion* action by the present occupants, the structure or texture was undisturbed.

Immediately underlying the flag-ore is the iron-ore bed proper, separated from the former by a clay-slate averaging two feet in thickness; this, included with both the iron beds, presents a thickness of forty feet. The strike of the formation is N. 50° W., S. 50° E. from the true meridian; dip at the upper cut 21°, and at the lower cut 14°.

I would here call especial attention to those specimens of iron-ore lying on the table which present a jointed structure; on the faces of some you will find thin sheets of *Calc Spar*, and in several pieces taken from the mass of iron-ore lying in the lower bed will be observed cavities filled with the same mineral. This is a very unusual occurrence, for, though Quartz particularly, Apatite, and other minerals, are frequently found associated with iron-ores, I have never before observed this paragenesis.

The porphyry of Buzzard Mountain comes under the same classification as that back of the Knob from the fact that it is a quartzless porphyry, but its texture is entirely different; here we have a conglomerate, with a dense feldspathic base containing pebbles and fragments of porphyry; this conglomeratic mass is several hundred feet wide, and is bounded by a porphyry of a dense massive texture; the conglomerate extends quite across the mountain, and on the south side comes flush up against a dense porphyry which presents a beautiful banded, stratified, and bedded structure. Nearly the same character of rock composes Cedar Hill, with the addition of a jaspery porphyry which is found massive in considerable quantities, and is considered by the miners as an indication of iron-ore deposits. On this hill is a large deposit of Specular and Micaceous iron-ore, in irregular lenticular veins, and irregular masses scattered through the conglomeratic formation. Portions of the porphyry here differ from the previously described porphyries in possessing amygdaloidal structure, in the cavities of which frequently crystals of Orthroclase and Oligoclase are found.

On Shepherd Mountain there are two varieties, one with a dark matrix containing abundant crystals of quartz; the other is a porphyry free from quartz, but containing large and abundant crystals of feldspar. (These different varieties you will find here on the table and can examine at your leisure.) Near the summit of the mountain is a dense flesh-colored porphyry, feldspathic base, matrix containing no crystals, and of a highly conchoidal fracture. This porphyry is very similar to those already described. Interest is added to this porphyry from the fact of its containing the magnetite deposits and specular iron-ore of this mountain. It seems to be younger than the dark liver-colored porphyry which constitutes the mass of the mountain. I judge it to be younger from the fact of finding fragments of the purple porphyry enclosed in its mass near their line of contact. This red porphyry has at some points a jointed structure, and along the seams I found a purple mineral which I first thought Amethyst, but afterwards judged to be Fluorspar from its degree of hardness, but have not yet had the time positively to determine.

The ores of Shepherd Mountain are highly magnetic, affecting the needle (compass) far out into the valleys; a large mass will support heavy weights of iron. The ores of Pilot Knob and Cedar Mountain, though not magnetic, possess polarity, and on the south spur of Pilot Knob my needle was so strongly affected that the solar compass had to be substituted. On the north-west slope of Cedar Hill the compass was similarly affected.

Now upon correlating all my facts, the result of several months' investigation, I find (certainly much of this may be called theory, for it does not admit of *direct* proof) that this region is composed of mountains of porphyry, sometimes isolated as Shepherd Mountain, sometimes several connected by saddles as Pilot Knob with Buck and Peck Mountains, the intervening valleys covered with limestone, chert, and sandstone, belonging mostly to the Lower Silurian, a portion of the limestone (south of the Knob) belonging to the Azoic age, the whole formation being devoid of any fossil remains: the porphyries composing the mountains varying in texture, sometimes with compact matrix, with and again without crystals, possessing here a slaty texture, then bedded or stratified, and again passing from a granular matrix into a conglomerate containing impregnations, segregations, veins and beds of iron-ores, which ores I have every reason to believe have been deposited—possibly(?) with the exception of the deposit on Shepherd Mountain—through replacement of the porphyry by lateral-secretion when the porphyry masses were at great depth, and later a subterranean force caused them to assume their present position: by elevating some portions and depressing others a rugged outline was given to the present shape of the mountains, and since their elevation no violent force of nature has acted on them, though rains and storms have taken an active part in giving the present contour lines by attacking material which offered least resistance, the sides have been eroded, new ravines (generally on the line where two porphyries of different texture came in contact) have been formed, old ones widened and deepened, and jagged promontories have been rounded off or worn away. Long after the mountains assumed their present general shape, the sea covered the valleys and deposited the Azoic limestones which crop out south of this region; then the sea probably receded, but again appeared to occupy its old ground, and during this latter occupation deposited the Silurian magnesian limestones which now cover the beds of the valleys, and which in places along the mountain sides reach as high as the 300-foot contour line. During the Silurian age, while this deposition was going on, if the sea was not too deep, all these porphyry knolls reared their heads above its surface and formed an archipelago of rocky islands. After many ages, as man counts time, the sea once more receded, not to occupy the ground again, unless it does so at some future time. After the disappearance of the sea, the quieter and less perceptible agencies of nature, but not the less active nor less powerful in their ultimate results, rain and storms, widened and deepened the ravines and valleys, wore away the rocks, and then covered the slopes of the mountains and beds of the valleys with soil from the removed débris.

Hackberry Butterflies.

Descriptions of the early Stages of APATURA LYCAON, *Fabr.*, *and* APATURA HERSE, *Fabr.; with Remarks on their Synonymy.*

By CHAS. V. RILEY, M.A., Ph.D.

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ERRATA.

On page 218, last line in column representing number of "feet in thickness," read 285½ feet.

On page 241, for "Shrank" read Schrank.

On page clxvi., strike out the second paragraph.

ing, and there are amusing accounts of the zeal with which the larva and chrysalis have been sought by some of the earlier entomologists, and of the pleasure which their discovery has afforded. The larva feeds on *Salix*.

In this country there are two butterflies belonging to the genus *Apatura*, as heretofore understood, viz., *Lycaon* Fabr. and *Herse* Fabr. The complete natural history of these has so far remained untold; and from any figures or descriptions extant they could not be distinguished from each other in their earlier stages. In Boisduval et LeConte's *Iconographie*,* to which we naturally look for something respectable, the figures are, to speak in their own language, *affreuses*. No characteristics are given by which the

* Hist. Gén. et Icon. des Lépid. et des Chenilles de l'Am. sept., 1833.

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One of the most beautiful of European butterflies, much coveted and prized by the collector, especially in England, where it is extremely rare, is that known as the Purple Emperor (*Apatura Iris* Fabr.) The wings in the male of this magnificent species exhibit now the deep brown which alone the female, as a rule, possesses, now a beautiful deep violet-blue, according to the direction from which we view them. This changeability of color is owing to the peculiar form, shape and arrangement of the wing-scales. If, by the aid of a good microscope, we examine these scales, we shall see that, besides the longitudinal imbrications so generally characteristic of the wing-coverings of the *Lepidoptera*, they are furnished, on the parts naturally exposed, with innumerable minute, transverse, angular ridges, each having a brown and each a blue surface exposed—a fact which, by means of his excellent magnifier, Rösel von Rosenhof demonstrated a century and a quarter ago, and which at once explains the peculiarity which renders the butterfly so conspicuous among its scaly-winged companions. The adolescent life of this butterfly is quite interesting, and there are amusing accounts of the zeal with which the larva and chrysalis have been sought by some of the earlier entomologists, and of the pleasure which their discovery has afforded. The larva feeds on *Salix*.

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* Hist. Gén. et Icon. des Lépid. et des Chenilles de l'Am. sept., 1833.

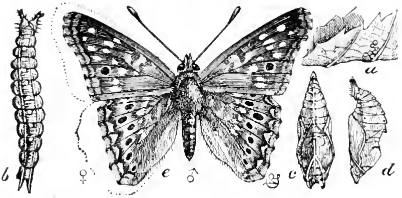
larvæ could be separated with any certainty, while the chrysalides are wrongly represented hanging by the tip of the body, at right angles from the point of attachment (which they never do), rounded and entire dorsally (they are notched and angular), and without a single generic character that belongs to them. Nor authors nor draughtsmen, if they ever saw the earlier stages of these butterflies, could have looked at them with any degree of care; and it is quite natural that neither the descriptions in Morris's "Synopsis," which are abridged from the *Iconographie*, nor the figures in Glover's unpublished Plates, which are copied from the same, should gain in lucidity. Dr. Asa Fitch* makes a brief allusion to *Herse*, but the information he communicates is evidently obtained from the *Iconographie* just mentioned, as it contains the same errors. None of our other standard entomological authors refer to these butterflies, for which reason a few facts regarding them may not be uninteresting.

They both feed on Hackberry (*Celtis*), and, so far, I have found them on no other plant. The Hackberry is sufficiently common in the bottom lands of Missouri, and two tolerably constant forms are easily recognizable: 1—(*occidentalis* Linn.) with broad, roughish, sharply serrate leaves, purple-black drupes, and rather pale bark, which on the trunk is rough and strongly cleft so as to look as if hacked; 2—(*Mississippiensis* Bosc.) with smaller, narrower, darker leaves, less serrate and often entire, yellow drupes, and darker bark, the trunk appearing knotty. A third form (*crassifolia* Lam'k), having most the aspect of *Ulmus*, occurs less frequently. It is much like *occidentalis*, but with more supple limbs, and rougher, thicker leaves, which, when plucked, wilt much more rapidly than do those of the other forms. Botanists differ as to whether these forms are specific or varietal. Dr. Gray refers them all to *occidentalis*, and, as intermediate varieties are found and the seedlings from the same tree are exceedingly variable, this seems the proper course. But Prof. Planchon, who has monographed the genus, considers 1 and 2 good species, and the third doubtful. The two butterfly larvæ I am about to speak of feed indiscriminately on all three, but, so far as my experience goes, show a preference for *occidentalis*.

* 3rd N. Y. Rep., § 83.

THE LYCAON BUTTERFLY (*Apatura Lycaon*, Fabr.)

[*Fig.* 3.]

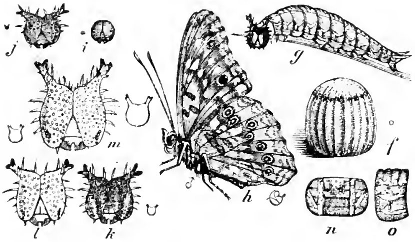


Apatura Lycaon—*a*, egg; *b*, larva, dorsal view; *c*, *d*, chrysalis, dorsal and lateral views; *e*, imago ♂, the dotted line showing form of ♀—all natural size.

During the month of May the larvæ of this species may be found on the above-mentioned trees, coming to their full growth, pretty uniformly, by the end of the month. They are then (Fig. 3, *b*, and Fig. 4, *g*) rather more than an inch long, of a pea-green color, with a series of yellow spots along the middle of the back, and three yellow lines each side, the intermediate one undulating, often obsolete on the anterior part of each joint, and containing a little lead-colored dimple. The body is more or less thickly granulated with pale papillæ, reminding one of *Paphia*, swells in the middle, from which it tapers both ways, the anal extremity ending in two horns. The back and sides are flattened, the latter sloping slightly, roof fashion. The most characteristic feature is the head, which, though variable in color, is always surmounted at this age with two antlers.

This larva is found when at rest on the underside of the leaf, usually on a carpet of silk, and often with a portion of the leaf bent around it. The lower part of the head is then drawn under the neck and the antlers thrown forward (Fig. 3, *b*). In preparing for the chrysalis state, it spins on the underside of a leaf a little bunch of silk in which to entangle its anal prolegs. Sometimes, but not often, it partially covers itself with a curled leaf, or with two leaves drawn together. Here it rests for about two days, when the larval head and skin split open, and the soft and unformed chrysalis works them back to the extremity of its body. It then secures itself, knocks off the shrunken skin, and soon assumes the delicate green color marked with cream-yellow, and the elegant form (Fig. 3, *c*, *d*) which Nature has imposed upon it. Most naked chrysalides, which have the bodies appressed to the object of attachment, are girded and supported by a loop adroitly constructed by the larvæ,* but our Lycaon chrysalis, by aid of its peculiarly elongate anal pad of crochets running under the end of the abdomen, is enabled to retain this position without any such loop. In this it differs from all the other members of its family (NYMPHALIDÆ) which simply suspend themselves by the tail, and which hang more or less directly at right angles from the object of attachment, when not supported by leaves.

[*Fig.* 4.]



Apatura Lycaon—*f*. egg, magnified; *g*, larva, lateral view; *h*, imago, underside—natural size; *i*, *j*, *k*, *l*, *m*, the five different larval heads; *n*, *o*, dorsal and lateral views of larval joint—enlarged.

The chrysalis state lasts about ten days, when the enclosed butterfly bursts the fragile shell and drags its limp self out. Clinging for a time to the ruptured husk, while the compressed wings visibly enlarge, the butterfly at last flies off—a perfected piece of Nature's unrivaled handiwork. Well known in cabinets under the old name of *Apatura celtis* Boisd., it is of a more or less intense russety-gray, inclining to olivaceous and shaded with dark brown, which, in certain lights, shows its relation to the European *Iris* by a faint purple reflection. The figures (3, *e*, and 4, *h*) will stand in place of more elaborate description. Aside from the genital organs, the sexes are, as a rule, quite easily distinguished by the

* This is well-known to be the rule in the Rhopalocerous families *Papilionidæ*, *Erycinidæ*, and *Lycænidæ*. It occurs also in some Heterocerous genera. I have bred the neat little Geometrid *Acidalia persimilata* Grote from *Ageratum*, and its chrysalis mimics *Papilio* not only in being supported by a loop, but in having ocellar tubercles. The same habit obtains in the European Tineid *Elachista cinereopunctella* Haw. which mines the leaves of *Carex* (see Stainton's Nat. Hist. Tin. III., Pl. 4. Fig. 1, *c*), and doubtless in others.

larger size of the female, and her less falcate front wings and broader, more rounded hind wings; but where these characters can not be relied on, as is sometimes the case, the sexes can yet be distinguished by the difference in the impotent front legs, the male having the feet (*tarsi*) and shanks (*tibiæ*) of these legs covered with soft whitish hairs, while in the female they are naked as in the other legs.

The butterflies begin to appear in the latitude of St. Louis by the middle of June, and by the end of that month the eggs may be found. These eggs (Fig. 3, *a*, and 4, *f*) are attached rather slightly to the underside of a leaf, either singly or in small clusters not exceeding a dozen. In form they are nearly globular, with very delicate longitudinal ribs, and still finer transverse striæ. In hatching, the enclosed larva pushes open the crown, which lifts like a cap. When first hatched this larva is of a uniform yellow, sparsely covered with a few soft hairs, and with a head (Fig. 4, *i*) which is jet-black and always hornless—thus differing materially from the head subsequently worn. The larvæ of this, the first, brood feed for rather less than a month, when they transform and give out the second brood of butterflies during August. These lay eggs again, which in due time hatch. But the second brood of larvæ thus hatching, instead of feeding with good appetite as did the first brood, is more lethargic from the start, and develops more slowly. Every worm, after passing through the second or third molt, ceases to eat; then shrinks in size and stations itself on the underside of a leaf. Here it changes its fresh green color for a dingy grayish-brown (caused by more or less distinct purplish marks on a dingy yellow ground), the better to keep in conformity with that of its dying support, with which, eventually, it falls to the earth, and there hibernates. A heavy snow may cover it many inches deep; a drenching rain may soak it through and through; the mercury may sink 22° F. below, or rise 80° above zero; but this little worm is indifferent to all, and sleeps a profound torpid sleep from the first of October till vegetation starts anew the ensuing spring. The weather in St. Louis is often delightfully mild and even warm long after this larva has gone into winter quarters, but nothing short of the animating breath of the vernal year prompts it to renew the activity it lost the fall before.

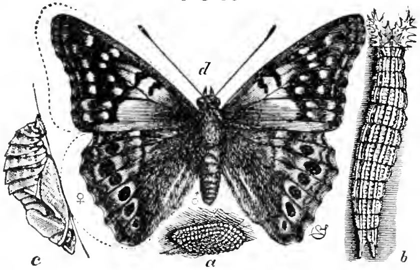
In acquiring its winter habit the joints are greatly contracted, the body becomes somewhat translucent, while the hairs from the papillæ become stouter; and in this condition it has a conchiliform appearance, and strongly recalls the young *Thecla* larva, or the young larvæ of such Heterocerous genera as *Euclea* and *Adoneta*.

Thus there are two broods each year, but they overlap each other so that a few of the later individuals of the first coëxist with the earlier individuals of the second, and the butterflies may be found more or less abundantly from early June till September.

The larva experiences four molts, so that there are four heads (*i*, *j*, *k*, *l*) which are shed entire, and a fifth (*m*) which is split open by the chrysalis and attached to the last larval skin. During the rest preceding each molt the antlers of the new head will be found laid back on the first joint, below the skin.

THE HERSE BUTTERFLY (*Apatura Herse*, Fabr.)

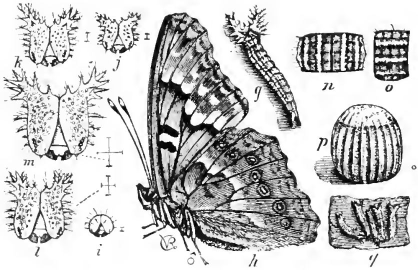
[*Fig*. 5.]



Apatura Herse—a, eggs: *b*, larva; *c*, chrysalis; *d*, imago ♂, the dotted line showing form of ♀—all natural size.

This butterfly (Figs. 5, *d*, and 6, *h*) is at once distinguished from Lycaon by its larger average size, more fulvous color and different ornamentation, especially of the front wings. Aside from the sexual characters already given in speaking of the previous species, the male in Herse is generally brighter colored than the female, with the markings, especially of hind wings, much more clearly defined: so that, instead of the distinct pattern of hind wing which I have illustrated (Fig. 6, *h*), the female has the marks more or less obsolete, and the general tint deeper and more uniform. The species extends farther north and east than Lycaon; but in the Mississippi Valley and the more southern States both species occur, and I have often found their larvæ feeding on the same tree. Herse is, however, less common than Lycaon. Boisduval gives *Prunus* as food-plant of the species, but it has never been since recorded as occurring on trees of that genus, and Mr. Samuel H. Scudder, of Plymouth, N. H., to whom I sent young larvæ, found that they refused plum-leaves, and died rather than eat of them.

[*Fig.* 6.]



Apatura Herse—*g*, larva, half grown, dorsal view; *h*, imago ♂ underside—natural size; *i*, *j*, *k*, *l*, *m*, the five different heads of larva; *n*, *o*, dorsal and lateral views of larval joint; *p*, egg—enlarged; *q*, larvæ as when hibernating—nat. size.

The eggs of Herse (Figs. 5, *a*, and 6, *p*), unlike those of its congener, are invariably deposited in dense batches of from 300 to 500, and two, or more often three, tiers deep. Otherwise they differ from those of Lycaon mainly in being a little broader on the crown. When first laid they are pale yellowish-white, but, towards hatching, the mass, if uninjured, acquires a deeper buff color.—The larva, in the first stage, is easily distinguished by its copal-yellow, instead of black, head; and in the other stages by having a dark medio-dorsal line, and a straight, instead of a wavy, supra-stigmatal line. The head is also larger, more pubescent, broader at top, and with the antlers larger, more spiny, and more hairy. The spines vary somewhat in sharpness and size, but are often very conspicuous in the third molt, when a worm at rest presents a really singular appearance (Fig. 6, *g*). These larvæ are more or less gregarious up to the third molt, after which they scatter. The habit, after they scatter, of hiding within leaves drawn around them, is more determined than in Lycaon; and the young of the second brood fall with the leaf and hibernate huddled together in companies of five and upwards (Fig. 6, *q*). They have a habit, before separating, of feeding side by side, eating the leaf from the tip downwards but leaving the stouter ribs. Spinning a thread wherever they go, they often, in traveling from leaf to leaf, make quite a pathway of silk; and if the branch be suddenly jarred they will drop and hang suspended in mid-air, and, after reassurance, climb up again with the thoracic legs.

I have not reared this species from the egg to the imago as I have Lycaon, but it doubtless goes through the same number of molts, as I possess five different sized heads. It is probable, however, that the number will not correspond in the æstival and autumnal broods; for I have reason to believe that some of my first brood of Lycaon larvæ went through but three molts; while I have watched Herse go through the third molt after it had ceased feeding in the fall, with scarcely any perceptible enlargement of the head—this third head being of smaller size and browner color than the corresponding one from the first brood.

Both species are found on the lower branches of the trees more especially, and very seldom on the higher.

Parasites.

The larger species is evidently most prolific, and one would suppose that it would be the most numerous; but its eggs, being laid in a batch, are more apt to be destroyed in great numbers by cannibal and parasitic insects. Such indeed is actually the case, for, while I have yet found no parasites on Lycaon, of ten batches of Herse eggs eight have been found more or less infested with a minute Chalcid fly, one fly to each egg.

The egg thus infested becomes purplish, so as readily to be distinguished from the sound ones, and even when empty an egg that has been parasitized is easily recognized by the crown being perforated instead of lifted up. I have not reared the parasite, and have been unable to extricate any perfect specimens. From fragments, the species seems to be blue-black; what appear to be the front tibiæ have a prominent spur lacking in the others, while the antennæ seem to be 6-jointed, 2 being twice as long as bulbus, 3, 4 and 5 subequal and half as long, 6 fusiform and as long as 2. It evidently belongs to the *Trichogrammidæ*, and comes near *Brachista*.

BIBLIOGRAPHICAL.

For forty years past these two butterflies have been known in entomological works by the names of *Apatura celtis* Boisd. and *A. Clyton* Boisd. Even in Mr. Edwards's recent work* these familiar names were retained. But in Mr. Scudder's Revision† these insects are referred to under the generic name *Doxocopa* and the specific names which I have here employed.

Of the generic name it need only be said that *Apatura* was created by Fabricius in 1807; *Doxocopa* by Hübner in 1816. From information kindly communicated by Mr. Scudder, the latter genus seems to differ from the former principally in the antennæ being proportionally more slender, the club shorter and less uniform, the palpi more slender and yet shorter, and the legs also more slender; while the hind wings in the male *Apatura* are not hollowed out as in *Doxocopa*. This last character is of little value, as it is variable in the same species. The other points of difference also appear trivial indeed when we consider the many points of resemblance. It is reasonable to suppose that many of the honored writers on diurnal Lepidoptera, since Hübner's time, have been familiar with his diagnosis of *Doxocopa*, and that they ignored the genus because they considered that the characters were not sufficient to separate it from *Apatura*. Kirby, as late as 1871, did so. Opinions will differ as to what should constitute a genus, and my own opinion is expressed in the name I here employ. Mr. Scudder may be able by study of the preparatory stages to establish more emphatic differences in his forthcoming work. If so, *Doxocopa* will doubtless be employed for our species, but it will be *Doxocopa* Scudder and not *Doxocopa* Hübner, as the latter knew nothing about those differences. Until that time I have thought best to follow preceding authors. Judging from figures of the European *Apaturas*, the most important differences between them and our two N. A. species will be found in the chrysalis state, and principally in the shape of the cremaster. The horns of the European larvæ are less branching, and the notum of the thorax in the chrysalis is more depressed; but our two N. A. species also differ in these characters.

* The Butterflies of N. A., by Wm. H. Edwards; Philad., 1868–72.

† Sys. Rev. of Some of the Am. Butterflies, by S. H. Scudder; Salem, Mass., 1872.

Regarding the specific names, *Lycaon* and *Herse* were named by Fabricius, as Mr. Scudder informs me, from paintings, "unquestionably representing our species, in the possession of a Mr. Jones," and now at Oxford, Eng. No locality was given for them. Did some rule prevail such as that which has been suggested by Prof. Westwood—viz., that after an insect has been universally designated, say for a quarter of a century, by a specific name, that name should nevermore give way to any that might be resuscitated—we should not now be called upon to change Boisduval's familiar titles for these familiar butterflies. So long as no such rule exists, the quickest way to get rid of the confusion now attaching to the specific nomenclature* is to follow Mr. Scudder, who has given the subject so much attention. In the higher animals, Audubon and Bachman did not hesitate to reject such names as *Anisonyx rufa* Rafinesque, or *Arctomys rufa* Harlan—names given to an animal which Lewis and Clark had described, but which the namers had never seen; and to adopt, instead, the *Aplodontia Leporina* Richardson, which, though it had not priority, was first coupled with a truly recognizable description from the animal itself. On similar grounds Mr. Scudder would have been justified in rejecting the Fabrician names. As a matter of interest to Lepidopterists, I produce these two descriptions (kindly copied for me by Mr. Scudder) which have remained so long unnoticed and unrecognized:

[FABRICIUS, *Entomologia Systematica*, Tom. iii., pars i., p. 228.]

Lycaon, 714.—P. S. Alis dentatis, anticis fuscis, flavo alboque maculatis, posticis ferrugineis, ocellis sex cæcis; subtus variegatis, ocellis octo.

Papilio Lycaon. Jon. fig. pict. 4, tab. 17, fig. 1.

Habitat ———, Mus. Dom. Drury.

Corpus medium, fuscum abdominis lateribus fulvis. Alæ anticæ supra fuscæ; flavo alboque maculatæ ocelloque cæco atro iride rufa; subtus basi flavæ, fusco maculatæ, apice fuscæ maculis tribus albis ocellisque duobus atris iride flava, anteriori pupilla alba, posteriori cæco. Striga marginalis flava. Posticæ basi obscuræ striga e maculis quinque flavis, apice rufis, maculis sex ocellaribus, atris. Subtus flavo fuscoque variegatæ, ocellis octo atris iride flava pupillaque cœrulea. [p. 229.]

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* For instance, *Lycaon* and *Herse* are referred by Kirby (Syn. Cat p. 87) to *Hipparchia?* and yet on p. 262 of the same work we have *Apatura Lycaon*, of which *Herse* is designated as ♀.

Herse, 718. P. S. Alis dentatis fusco ferrugineis: anticis albopunctatis, posticis utrinque ocellis septem cæcis. [p. 230.]

Papilio Herse. Jon. fig. pict. 4, tab. 7, fig. 2.

Habitat ———, Dom. Drury.

Corpus fusco ferrugineum. Alæ anticæ obscure ferrugineæ, pone medium fascia e maculis sex punctisque quatuor apicis albis, subtus pallidiores. Posticæ fusco ferrugineæ ocellis septem nigris iride ferruginea: secundo tertioque pupilla ferruginea, reliquis cæcis. Subtus pallidiores ocellis septem cœruleis iride flava, annulo nigro.

It will be seen that, aside from minor shortcomings, the difference in average size between the two species is not stated; nothing is said of the underside of the bodies; no sexual distinctions are given, while the description of the spots on the primaries of *Herse* as white is well calculated to mislead, for in all specimens which I have seen they are distinctly bright ferruginous or "ochry-yellow" as Boisduval describes them. The figure from which the description was made, if it represents our species, must be incorrect, or must have been made from an etiolated specimen. As to the number of the spots, it varies on the primaries; and on the secondaries, while in both species the seven ocellar spots are always distinct inferiorly, the first and last are often, one or both, partly or entirely obsolete superiorly, so as to leave but five or six. More generally six are visible in the ♂ and five only in the ♀. The eighth inferior spot in *Lycaon*, as described by Fabricius, can only refer to the small, more or less obsolete, and almost always simple, oval spot on the middle of the inner border.

It is doubtful if, without the drawings, these Fabrician species could have been satisfactorily determined; so that Boisduval can not be blamed for redescribing them. We should be justified in ignoring such inadequate descriptions in a modern author; but, for many good reasons, it is the custom to make the best of those of the older authors, who sometimes described a species in one single word.

Have we other Species of the Genus in the United States?

Besides the two species of *Apatura*, the natural history of which I have just detailed, three other supposed species have been described, viz., *A. Idyja* Hübn. (*Doxocopa I.*, Exot. Schm.), *A. Proserpina* Scudd. (Trans. Chic. Ac. Sc. I, p. 332), and *A. Ali-*

cia Edw. (Butt. of N. A. p. 135). I know nothing of the first; but from the fact that Kirby (Syn. Cat. Diurnal Lep. p. 262) considers *Clyton* Boisd. a synonym, it will, perhaps, turn out a variety of *Herse* Fabr. The other two are considered synonyms—*Proserpina* of *Herse* and *Alicia* of *Lycaon*—by Scudder in his latest published opinion (Syst. Rev. etc. p. 9); and from the descriptions I should agree with him in believing them mere varieties of the Fabrician species. It is, therefore, probable that we have but the two species I have figured.

Mr. Edwards informs me that he still considers *Alicia* a good species; and that he is confirmed in the belief from the fact that not a single *Alicia* was obtained from many specimens of *Lycaon* bred by himself last summer, or from those bred by me. But I should not expect to breed *Alicia* far away from its locality, any more than I should expect to breed the dark form of *Limenitis Misippus* or the dark female of *Papilio Turnus* in the more northern States. I am always suspicious of species founded on slight variations when one or two individuals only have been seen. *Herse* varies considerably, so that specimens as distinctly marked as my figure are the exception, and in the female the markings on the hind wings, both above and beneath, are often sufficiently obsolete to give the wing a uniform appearance, with the barest indication of a series of paler spots. *Lycaon* varies also not only in the intensity of color and distinctness of the marks, but in the relative size of many of the spots; that nearest the apex and that nearest the middle of the front wing being sometimes obsolete, while the dark ocellar spot on the same wing, which is usually simple, sometimes has a white discal speck. Mr. Edwards's *Alicia*, as may readily be seen from his excellent figures, is, so far as we now know, larger than the average size of *Lycaon* and the general color is more fulvous; but there is absolute similarity of pattern between the two. Now as *Lycaon* varies both in size and depth of color, we may reasonably infer that *Alicia* will be found to do so, and that, so far as these characters go, the description of *Alicia* is from two specimens and is of little value. The average size of *Lycaon*, in the locality from which I write, is much less than that of *Herse;* yet Boisduval (*auctore* Morris) gives his *celtis* the same size and form as his *Clyton*, while Fabricius mentions no difference in the size of his two species; so that if we really have to do with three instead of two species, then *Alicia* Edw., so far as size is concerned, is but a redescription of *celtis* Boisd., and the small form which occurs in the Middle and Western States remains undescribed. The fact that Boisduval cites his *celtis* from the Southern States, and that his description of the larva does not at all correspond with mine, would indeed give such a view a degree of plausibility; but, for my own part, I much prefer to believe that the differences in the butterflies are varietal, and that the discrepancies between the descriptions of the larva may be accounted for on the strong probability that Boisduval's description and figure of the larva are as untruthful as those of the chrysalis. But all such questions must be left to the future to decide; meanwhile Mr. Edwards's opinion is, in one sense, as rightfully held as Mr. Scudder's or mine.

Descriptive.

Apatura Lycaon. *Egg*—Average diameter 0.03 inch. When first laid, opaque white, becoming day by day more translucent. About and around the crown are a few pale purplish specks and marks, which deepen until they are sometimes black, and as the embryo develops its black head shows plainly through the crown and the egg becomes slightly grayer. Shape globular, the top flattened, the base still more so; about as wide as deep, averaging 0.025 inch either way, the depth most often exceeding. From 19–20 longitudinal, rather prominent ribs, and about twice as many very delicate transverse striæ, the latter best seen on the empty shell, and both ribs and striæ becoming obsolete on the crown.

Attached not very firmly and always on the underside of a leaf, in batches of from 1–12 (7, 7, 5, 7, 7, 1, 4, 2, 3, 7, 11, 12, observed). Egg period from 6–10 days.

Larva—Newly hatched 0.075–0.08 inch long. Body cylindrical, tapering very slightly behind, pale yellow, immaculate, with concolorous piliferous dots giving rise to short pale hairs, 4 of these dots dorsally trapezoidal and 3 lateral around each spiracle. Head twice as large as joint 1, polished black, slightly bi-lobed, with very minute pilose points and a few long hairs, but no horns whatever. Anal horns pale just after hatching, becoming dusky at tips, short, and terminating usually in three blunt, pilose lobes. When two days old the dorsum flattens and the characteristics of the second stage begin to show. In the *second stage* the color is green, the form less cylindrical, each joint with four tolerably distinct annulets and numerous pilose papillæ. A straight subdorsal, longitudinal, yellow stripe connects across dorsum on anterior annulet, and sometimes on second, leaving, in consequence, a series of subquadrate dark-green dorsal spaces; a suprastigmatal, undulate, paler and narrower line, and a substigmatal one straight and of the same thickness. Anal horns less blunt at tip. Head broader than long with the sides bulging and with two horns on top diverging at right angles from each other, and in length about one-third the width of head, each ending in a prominent, more or less acute, bifurcation, and giving out three lesser branches from the sides: also with a prominent lateral, slightly decurved and acute spine, a lesser one above and below this, and two on top between the bifurcate horns. The color is quite variable, sometimes being entirely dark-brown, but more often pale, with the jaws, sutures, ground of ocelli, and tips of horns, dark. It is furnished with a few short hairs. In the *third stage* there is but little change; joints 5–9 are proportionally somewhat more enlarged, and the spines on the head proportionally increased in length. The papillæ become more prominent and numerous, and the transverse yellow line connecting the subdorsal lines across the anterior wrinkles as well as the supra-stigmatal line become less continuous. The *fourth* and *fifth stages* are similar, the horns on the head are lengthened but the forks and the spines shortened, while the transverse stripes and the supra-stigmatal line are generally interrupted. The mature larva may be thus described:

Average length, 1.15 inches. Head as broad or broader than long, the cheeks bulging, the horns half as long as head, slender, the bifurcations reduced and rounded, the spines not prominent; shallowly punctate and sparsely pubescent; color either green with faint touch of brown on jaws, at ocelli and tips of horns, or brown-black with more or less pale color, and always four stripes in front, two short ones near ocelli, and two others running by the side of epistoma and tapering up the horns. Body bright pea-green, very small on joint 1, enlarging in middle, and tapering to extremity, which ends in two horizontal, slightly diverging anal horns. Each joint with about four annulets. A medio-dorsal series of yellow spots the width of first annulet; a pale white and yellow stripe, thickest at sutures, running each side of dorsum to tip of anal horns; a series of pale, oblique supra-stigmatal marks containing a lead-colored impressed point; and a straight substigmatal line. Covered with numerous irregular pale papillæ, largest on yellow parts. Ventrally more smooth, glaucous, and with soft colorless hairs. Legs pale, the pads of prolegs dusky. The supra-stigmatal oblique dashes are sometimes connected to form a wavy line, and there are are other minor variations of color and markings.

Chrysalis—General surface faintly aciculate. Dorsum narrow-edged, in outline strongly arched on abdominal joints 3–8 (6–11 of body exclusive of head); straight and falling at an angle of about 130° from 3rd abdominal joint to metathorax, thence rising at the same angle straight to middle of mesothorax, and falling again at an angle of about 120° direct to head. From a dorsal view the outline broadens regularly from anal extremity to wing-sheaths, is parallel thence to the region of the metathorax, then bulges and is broadest at the wing-shoulders, and gradually decreases again to the ocellar tubercles. The inferior surface forms a straight line from the eyes to the tip of the legs, then makes a slight upward curve and ends in a button or cremaster, which represents the anal larval prolegs and is on a plane with the longitudinal axis of the body; it is divided anteriorly, produced into a trigonate blunt point behind, and furnished along the flat inferior surface with soft ferruginous hooklets, which issue from it at right angles and form a long, narrow pad, united and most dense at posterior extremity, but divided anteriorly. The ocellar tubercles are trigonate, the sides of the abdomen slope skiff-like, joints 6, 7 and 8 admitting of very free side-motion by broad, smooth sutures, which narrow dorsally to a point. The dorsal edge is slightly carinate, especially on mesothorax, and more or less jagged, especially on abdominal joints 3–8, which have their anterior edges produced into small teeth, like saw-teeth, white with a polished black spot each side. A raised line starts from anterior edge of abdominal joint 3 and thickens to wing-shoulders; another, from middle of mesothorax, extends around outer edges of ocellar tubercles, while another margins the hind wings. The color is pale translucent green, with still paler and darker mottlings; a series of pale oblique lines and a longitudinal substigmatal one on the abdomen. The dorsal carina is yellow on the arched abdominal portion, except at anterior edges of joints already described; elsewhere it is cream-colored. The veins of wing-sheaths, joints of antennæ, and the raised lines, are all of the same pale color. Stigmata pale and barely noticeable.

APATURA HERSE. To avoid repetition it will be best to describe *Herse* by comparison with *Lycaon.*

Egg—On an average rather flatter on the top, with the sides more parallel. Pale yellowish-white at first, with the marks that afterwards appear around crown, fewer and never as dark as in *Lycaon.* Attached to the underside of a leaf in batches of 300–500, generally three tiers deep.

Larva—When newly hatched differs from *Lycaon* in the head being pale copal-yellow and translucent; the jaws are brown and the ocelli spots black; the anal horns are scarcely perceptible; the pale hairs from piliferous spots are nearly as long as the diameter of the body. Before the first molt takes place the characteristics of second stage begin to show. In the *second stage* it is easily distinguished from *Lycaon* by being longitudinally striped superiorly with 8 pale and 7 dark stripes, or, in other words, instead of the subdorsal pale stripes connecting transversely on the anterior annulets, there is a medio-dorsal dark, continuous line, bordered each side with a pale one, and the supra-stigmatal line is straight instead of wavy. The head has stouter lateral spines and is more pilose. It is yellowish and often with brown marks in front of the horns and around the mouth. In the *third stage* the colors are yet more intense and the antlers lengthen, and, compared with *Lycaon*, the base of these antlers is stouter, so as to give a straighter appearance to the sides of the head, which are more stoutly spined and thickly pilose. In the succeeding changes these characters are little altered, except that the head becomes greener, the papillæ more conspicuous, and the medio-dorsal dark stripe proportionally narrower. The mature larva may be thus described:

Length 1.25–1.50 inches. Head bluish glassy-green, longer than broad, the sides almost parallel; with dark ocelli-ground and rarely dark marks in front and at base of antlers; shallowly punctate and quite pilose; the antlers stout, with lateral prongs as stout as terminal. Color of body usually bright green, the dorsum paler or yellowish, with a deep blue medial vascular line bordered each side by a paler yellow one. A subdorsal, supra and substigmatal continuous straight line, each either white or cream-color, and the two former either simple or bordered above with green and below with blue-green; the papillæ quite prominent on the subdorsal and substigmatal lines.

Chrysalis—Differs only in being larger, in showing on the abdomen traces of the pale longitudinal larval lines, and in having the mesonotal ridge less angular.

On the Oviposition of the Yucca Moth.

By Chas. V. Riley.

My last summer's observations have enabled me to complete the natural history of *Pronuba yuccasella;* and as a sequence to what has already been published in the present volume of our Transactions (pp. 55–64 and 178–180), I condense the facts as to the method of oviposition from an article in the *American Naturalist* (vol. vii. p. 619), where they are given at greater length.

Analogy has proved a false guide, and the curious ♀ *Pronuba* adds to the anomalies which belong to her. Instead of being thrust into the stigmatic opening, as I was most inclined to believe, the eggs are actually conveyed into the young fruit from its side. The female, for the most part, gathers her load of pollen from the contracted and curled anthers. In ovipositing she almost always stations herself between two stamens, and, puncturing the fruit with her ovipositor, conveys the egg to its destination.

This egg is very narrow, elongate, soft, flexile, rather translucent, pointed anteriorly, and of the exact color of its surrounding. It lies curved in the ovarian cavity, always on the rounded side next to the primary dissepiments, and with the anterior end generally close to the placenta. The operation of thus consigning an egg lasts but a few seconds, and the ovipositor is no sooner withdrawn than the moth runs up to the top of the pistil, uncoils her pollen-bedecked tentacles, thrusts them into the stigmatic tube, and works her head vigorously as previously described.

"This carrying of the pollen to the stigma generally follows every act of oviposition, so that, where ten or a dozen eggs are consigned to a single pistil, the stigma will be so many times be-pollened. The ends of the tentacles, which are most setose and spiny, and which are always curled into the pollen-mass when not uncoiled, must necessarily carry a number of pollen grains each time pollination takes place; and I have noticed a gradual diminution in the size of the collected mass, corresponding, no doubt, to the work performed, which is indicated by the rubbed and worn appearance of the individual — the freshest specimens always having the largest loads.

"While oviposition is generally followed (and not preceded, as I formerly supposed) each time by pollination, yet the former sometimes takes place twice, thrice, or oftener, without the latter being performed; and I suspect that the converse of this is equally true.

" * * * I have little doubt but that the egg increases in bulk, before hatching, under the influences of impregnation and endosmosis, and Dr. Engelmann tells me that he has been able to trace the embryo larva under the extremely delicate egg-covering, and to observe it curled up at the anterior end of the egg, which greatly enlarges. This larva hatches on the fourth or fifth day after the laying of the egg, and usually commences feeding between two ovules, which, in consequence of its action, swell abnormally. Thus, in making a longitudinal section of the fruit, these swollen ovules often indicate the presence of the worm where it would otherwise be overlooked while very small.

"Though oviposition generally takes place in the manner described, the moth head outwards and straddling two stamens, an entirely opposite position must sometimes be assumed, since larvæ and punctures are not unfrequently found in the upper part of the fruit, especially where a single one is stocked with ten or a dozen larvæ, as is sometimes the case.* As the fruit enlarges, the mouth of the puncture forms a slight, discolored depression, more noticeable in some varieties than in others: but the passage-way becomes obliterated.

"My observations this summer might be extended much in detail. They have convinced me more than ever that *Pronuba* is the only insect by the aid of which our yuccas can be fully fertilized: for I have studied this fertilization diligently night after night, without seeing any other species go near the stigma. The stigmatic opening closes after the first night, and I know of no crepuscular or nocturnal species which could collect the requisite amount of pollen and bring it so to bear on the stigma that each ovule would receive the influence of a pollen grain. The species already enumerated† as frequenting yuccas are mostly diurnal and have nothing to do in the work; and wherever I have excluded the moth from the flowers, by enclosing the latter with netting, no fruit has been produced. I am there-

* I have counted as many as twenty-one larvæ in a single capsule of what is apparently *Y. flaccida*.

† *Ante*, p. 59.

fore led to believe that the few rare instances of yucca-fertilization in localities where *Pronuba* may be presumed not to occur, have been brought about by another insect accidentally, or by the stamens reaching an exceptional length, and the anthers being brought into contact with the stigma by the conniving of the closing petals. I have found the stamens of varying length in the flowers on the same panicle, and in some instances almost as long as the pistil."

Notes on the Genus YUCCA. *No.* 2.

BY GEORGE ENGELMANN, M.D.

Since my paper on Yucca was published (pp. 17–54 of this volume) I have been enabled to make the following corrections and additions:

Page 20. The examination of more seedling Yuccas has proved that the growth of the secondary axis and the young rootstock exhibits the following forms: In *Y. aloifolia* as well as in *Y. filamentosa*, var. *lævigata*. I have found a single horizontal branch; in *Y. angustifolia genuina* and var. *elata* a single perpendicular branch directed downward, and in *Y. filamentosa genuina latifolia* all the young plants examined at the end of the second year exhibited 2-5 secondary axes directed downwards ½ to 2 inches and then abruptly bent upwards. More observations are needed about these interesting peculiarities and their constancy in each species or variety; it is possible that the nature of the soil and the mode of cultivation may have some influence on them.

Page 26. The bunch of white wool is always present at the tip of the perigonial lobes, but is very slight and short in some, and longer and more copious in other species; the hairs constituting it consist of single or sometimes of several cells.

Page 27. *Yucca Treculiana* has, as is also stated on p. 43, very thick ovules, and thus *all* Sarcoyuccas have such ovules and can by them be readily recognized even in the flower and where the fruit remains unknown. *Y. gloriosa* with its thin ovules does not belong to this section at all, as will be shown below.

Page 28. The stigmatic tube does communicate directly with the three ovarian cells, but the passage closes immediately after the night of flowering.

Page 29. I have seen the vestiges of the moth, or rather its larva, in all the Sarcoyuccas as well as in all those with dry pods: but fruits which show no trace of the larva may be seen more frequently in the former than among the latter. This does not indicate that all may not have been fertilized by the action of the moth, but in such cases either no eggs were laid or they may have aborted.

Observations made last year by Mr. Riley and myself have proved that the filiform flexible egg of the moth is not deposited with the pollen into the stigmatic tube, but that the mother introduces it through a puncture in the side of the ovary directly into one of the cells just between two ovules, both of which at once begin to swell up to three or four times the thickness of the healthy ovules, and are thus preparing the sustenance of the young larva, which feeds on one or usually on both of them until able to attack the meanwhile more or less developed young seeds joining the former. In a few cases I have seen the very young larva at a place where four ovules, two from each side, meet, and here all four were prematurely enlarged.

Page 31. See below an account of the fruit of the *Clistoyucca*.

Page 34. At the end of the character of *Yucca* add: floribus majoribus pendulis nocturnis albidis nunc virescenti seu purpuruscenti colore tinctis olentibus.

Page 36. Southerners object to the remark, that the fruit of *Y. aloifolia* is "much eaten"; I should say that it is edible, and I am informed that on the coast of Florida this species makes almost impenetrable thickets in which bears have their passages and no doubt their lairs, and in the fruit of which they delight.

Page 37. *Y. aspera* and *Y. albospica* are erroneously introduced here; for their proper place see below.

Page 38. *Y. gloriosa* does not belong to *Sarcoyucca*, where, relying too much on the statements of others, I had placed it. Dr. A. Schott, who has repeatedly been mentioned by me as a close observer of Yuccas in the Southwest, was fortunate enough last autumn to discover a specimen loaded with fruit, growing in the open ground in the congressional garden at Washington. A photographic view was taken and specimens of the fruit and ripe seed were gathered, which latter have already germinated. The fruit is a pendulous, dry, leathery, not opening capsule or berry, of deep brown color, with (as the ovules, described p. 40, indicated) thin seeds; the species therefore belongs to *Clistoyucca*, the character of which section will have to be slightly modified. Those botanists who described the fruit as pulpy must have confounded it with that of *Y. aloifolia*, as indeed seedsmen in Europe also have done, whose wrongly-named seeds, raised in Italy or Sicily, I have on page 40 erroneously described as those of *Y. gloriosa*.

The best formed fruits, seen by me, were, before full maturity, 3 inches long, 1 inch in diameter, prismatic, cuspidate, the 3 wider sides forming the back of the carpels and opposite the outer segments of the flower, and 3 alternate sides, corresponding to the commissures, only half as wide as the others, depressed and separated from the others by 6 prominent ridges. The fruit at this stage is altogether like a small fruit of the *Y. aloifolia*, only more pointed. At maturity its parenchyma dries up, the texture becomes leathery and the markings less distinct. Fruits infested by larvæ are often smaller, constricted about the middle or variously twisted. In such fruits the rains of a wet autumn are apt to penetrate through openings made by the larvæ, and cause the germination of the seeds in the closed pod —Seeds 7–8 mm. in the longest diameter, 1–1¼ mm. thick, with an entire albumen; differing from the seeds of the capsular Yuccas only by the entire absence of a wing-margin.

Page 41. *Y. Treculiana* and *Y. canaliculata* are synonymous; if, as it is said, no sufficient character accompanies the name given by Carrière in 1858, and if the first description of *Y. Treculiana* was published by Herincq, 1863, in the *Horticulteur Français*, then Hooker's name of *Y. canaliculata*, published with description and figure in 1860, would have precedence. — Fruits lately obtained from Southwestern Texas are 3–4½ inches long and 1–1¼ in diameter, pointed but scarcely rostrate, somewhat less distinctly six-angled than those of *Y. aloifolia*. Seeds 7–8 mm. wide, 2–3 mm. thick, the smallest ones the thickest.— *Yucca aspera*, Regel, Gartenfl., is the same, to judge from a specimen cultivated here; *Y. gigantea*, Lem. Rev. Hort. 9 (1860), p. 222, fide Baker Gard.

Chron. l. c., would, from the size of the leaves ($4\frac{1}{2}$ ft. long), have to be referred here, if the leaves were not said to be glabrous and shining.

Page 47. The character of *Clistoyucca* is to be modified as follows:

> Fructus indehiscens, pendulus (in altera specie erectus?), demum siccatus: semina tenuiora, plana, vix marginata, albumine integro. — Plantæ caulescentes, altera arborescens, panicula sessili vel pedunculata.

* Folia serrulato-asperata.

YUCCA BREVIFOLIA, *Engelm.*: pericarp spongy (erect?) seeds thicker. — Dr. Parry has just sent a specimen, which shows the panicle to be ovate, dense-flowered; bracts wide and membranaceous, much like those of *Y. Treculiana* (as are also the flowers), the lower ones 2 inches wide, 3-4 inches long, tapering into a herbaceous serrulate point: the upper ones 1 inch long, oblong obtuse, of thinner texture, white; segments of perigon $2\frac{1}{4}$–$2\frac{1}{2}$ inches long, narrow; ovary attenuated into a short style, ovules 0.4 mm. thick.—In Southern Utah in flower about the end of April.

** Folia margine integra, etc.

YUCCA GLORIOSA, *Lin.*: pericarp leathery, pendulous; seeds thinner.

Page 50. *Y. constricta*, Buckley, Proc. Phil. Ac., 1862, page 8, seems to belong to *Y. angustifolia*, var. *elata*, and *Y. albospica* of European gardens to var. *mollis* of the same.

Page 51. *Y. filamentosa*: numerous specimens from South Carolina, Georgia, and Alabama, prove that the varieties are difficult to keep apart. Even the most marked forms of *genuina latifolia* have sometimes large, not contracted, capsules, with nearly complete secondary dissepiments and large seeds. As thus the characters, by which I have tried to distinguish the *forma genuina*, prove to be uncertain, this arrangement of the different forms will have to be abandoned; we may simply distinguish them as var. *angusta* (preferable to *angustifolia* on account of the species of that name), var. *lata*, etc. *Y. filamentosa* seems confined to the low country of the Southeastern States and not to penetrate into the interior more than perhaps 100 miles, while *Y. gloriosa* and *aloifolia* appear to be strictly sea-side plants. The westernmost specimens of *Y. filamentosa* I have seen came from the western border of Alabama; but it is said to grow also in Mississippi and Louisiana.

Var. *flaccida:* the contracted panicle is usually shorter than the peduncular part of the scape.

Var. *lævigata* I have now also seen in cultivation, remarkable for the narrow, smooth, flaccid or even prostrate leaves: the tall (6–9 feet high) scape purplish-brown; the narrow panicle three times as long as wide, about as long as the peduncular part of the scape; flowers and young fruit with purplish tinge: secondary dissepiments of large capsule very incomplete, or almost wanting; in the wild plant they are nearly perfect.

Page 54. *Y. Whipplei* does not occur north of Monterey: it abounds near San Luis Obispo, whence Dr. W. W. Hays has sent seeds and living plants.

The following synopsis exhibits at a glance the arrangement of the species and their geographical distribution:

YUCCA, Lin.

Sarcoyucca.

1. *Y. aloifolia*, Lin., southeast and south.
2. *Y. Yucatana*. Eng., south.
3. *Y. Guatemalensis*, Baker, south.
4. *Y. Treculiana*, Carr., southwest.
5. *Y. baccata*, Torr., southwest.
6. *Y. Schottii*, Eng., southwest.

Clistoyucca.

7. *Y. brevifolia*, Eng., southwest.
8. *Y. gloriosa*, Lin., southeast.

Chænoyucca.

9. *Y. rupicola*, Scheele, southwest.
10. *Y. angustifolia*, Pursh, west and southwest.
11. *Y. filamentosa*, Lin., southeast.

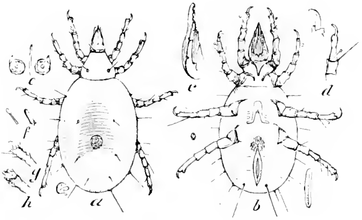
Hesperoyucca.

12. *Y. Whipplei*, Torr., southwest.

Descriptions of two new subterranean Mites.

By Chas. V. Riley.

[*Fig.* 8.]



Tyroglyphus phylloxeræ—*a*, *b*, dorsal and ventral views; *c*, enlarged jaw and palpus; *d*, tarsus; *e*, anal tubercles of male; *f*, forms of tarsal projections; *g*, *h*, tarsal terminations.

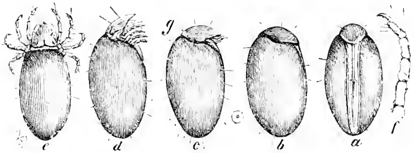
Tyroglyphus phylloxeræ, Riley & Planchon, fig. 8.—When full grown 0.03 inch long, and about half as broad. Color pale yellowish, with a brownish medio-dorsal circular spot, around which there extends a gamboge-yellow discoloration, in some specimens restricted, in others occupying nearly the whole upper surface of the abdomen: trophi, legs, especially two anterior pair, and cephalothoracic sutures, of a faint rosy brown; the epimera of a deeper brown. The hairs of the body arranged much as in *T. siro*, Linn, springing from minute papillæ, and not exceeding in length ⅓ diameter of body. Tarsal or terminal joint of legs with a short and prominent basal hair (*d*), sometimes fine and knobbed at tip, sometimes more fleshy and rounded at tip (*f*): often lacking on the two hind pair: also sometimes with other fleshy growths (*g*): tarsal claw usually distinct (*d*), but sometimes retracted or obsolete (*h*). The usual pair of small tubercles each side of vulva, and a larger flattened circular tubercle each side of anal slit in ♂.

When immature the color is whiter with less of the yellow, dorsal discoloration, and the hairs are relatively longer. The form varies according as the cephalothorax is retracted or not, and the abdomen instead of being oval is sometimes constricted in the middle, at others more spherical.

Many of the characters enumerated belong to all the species of the genus; and in studying large numbers it is difficult to give any specific diagnosis which shall at once distinguish it from all other described species. To do so will require continued study of all the stages from the moment of hatching, as well as of its *Hypopus* form—a study which I have not yet been able to give.

Found in considerable numbers on the roots of grape-vines, and feeding on *Phylloxera vastatrix*.

[*Fig.* 9.]



HOPLOPHORA ARCTATA—*a*, ventral view closed; *b*, side view closed; *c*, do. slightly open; *d*, do. more open; *e*, dorsal view, with legs fully extended.

HOPLOPHORA ARCTATA, n. sp.—Length 0.028 inch; diameter scarcely half the length. The horny shield of a highly polished, smooth, mahogany-brown. Legs and trophi carneous-brown. Dorsum arched. Differs from most described Hoplophoras in the very smooth and unarmed covering, and from all in the great narrowness of body.

Found associated with the preceding, and probably feeding on the decaying roots. It is, I believe, the first American species described.

On the Well at the Insane Asylum, St. Louis County.

By G. C. BROADHEAD.

(*Plate I.*)

This boring was made by direction of the St. Louis County Court, and prosecuted under "order of the court," and paid for out of the county treasury. The object was to obtain a good supply of fresh water for the use of the Asylum.

The work was superintended by Mr. C. W. Atkinson, who collected specimens from every few feet, and carefully arranged

VERTICAL SECTION OF BORINGS AT THE ST. LOUIS COUNTY INSANE ASYLUM.

BY G. C. BROADHEAD, State Geologist of Mo.

System	Formation	Thin Feet	No.	Strata Found in Well	Thin Feet	Total Depth
Quat.	Bluff.	40	I	Clay	40	40
Carboniferous.	Coal Measures.	80	II	Clay and Limestone.	31	71
			III	Coal, Clay and Limestone.	15	
			IV	Shales, Limestone, Coal and Clay.	34	120
	Lower Carboniferous.	670	V	Cherty Limestone.	139	
			VI	Shales.	8	
			VII	Drab, Cherty Limestone.	170	420
			VIII	Dark, Drab Limestone.	62	
			IX	Drab Limestone and Shales.	36	
			X	Hard, Blue, Cherty Limestone	92	
			XI	Limestone and Chert.	75	682
			XII	Sandstone.	6	739
			XIII	Chert and Limestone.	81	790
	Chouteau Group.	93	XIV	Red Limestone.	10	
			XV	Drab and Gray Limestone & Chert	35	
			XVI	Dark Limstone with some Clay & Chert	48	883
LOWER SILURIAN	Trenton, Black River and Birdseye Limestone	421	XVII	Clay.	83	
			XVIII	Blue Shales and Limestone	56	
			XIX	Limestone.	194	
				Cherty Limestone and Salt Water.	5	1225
				Light and dark Limestone.	79	1304
Magnesian Limestone Series.	First Limestone.	148	XX	Drab, Cherty Limestone.	49	
			XXI	Magnesian Limestone.	99	1452
	Saccharoidal Sandstone.	133	XXII	White and Brown Sandstone.	133	1585
	Second Limestone.	517	XXIII	Buff, Brown and Drab, Cherty Magnesian Limestone.	128	
			XXIV	Buff and Drab, Cherty Magnesian Limestone.	389	2102
	Second Sandstone.	82	XXV	Sandstone.	82	2184
	Third Limestone.	838	XXVI	Buff, Drab and Gray, Cherty Magnesian Limestone.	487	2671
			XXVII	Magnesian Limestone with some Sand.	172	
			XXVIII	Sandstone.	37	2830
			XXIX	Magnesian Limestone.	142	3022
	Third Sandstone.	98	XXX	Sandstone.	98	3120
	Fourth Limestone.	384	XXXI	Dark Magnesian Slate	13	
			XXXII	Magnesian Limestone with some Sand in lower Beds.	371	3504
	Potsdam Sandstone and Azoic.	299.5	XXXIII	Sandstone.	41	
			XXXIV	Sand and Limestone	13	3558
			XXXV	Brown and Red Sandstone Lower Beds Hard and Red.	245.5	
			XXXVI	Granite.	40	3843.5

them in boxes, which were stored away in the Asylum. He also filed with the County Clerk a section and record of the work.

Through the kindness of Dr. Hazard, Superintendent of the Asylum, I obtained a complete suit of these specimens, and from an examination of them I have made out the following Section, which differs but little from that of Mr. Atkinson:

SECTION OF BORING.

NO.		*Feet in Thickn.*	DESCRIPTION OF MATERIAL PASSED THROUGH.	*Total Depth below surface.*
I.	1	40	Clay	
II.	2	4	Tumbled masses of Limestone	44 ft
	3	5	Red Clay	49
	4	8	Limestone	57
	5	4	Red Clay	61
III.	6	5	Coal	66
IV.	7	2	Fire-clay	68
	8	3	Light-colored Limestone. Bottom of well dug before commencement of boring	71
	9	9	B ue and drab Clay, slightly calcareous	80
	10	6	Cherty Limestone	86
	11	21	Dark and bluish-gray Shales, slightly calcareous	107
	12	4	Cherty Limestone	111
	13	1	Coal	112
	14	8	Light-blue Clay	120
V.	15	139	Hard cherty Limestone, blue, drab, and gray; some of it cherty, the upper part fine-grained, the lower coarse, to	259
VI.	16	3	Blue Shales	262
VII.	17	176	Drab and gray Limestone, generally hard and cherty, but a portion of it is free from chert.—It is drab in color to	289
			" then dark ash-colored at	300
			" " " drab " to	362
			" " grayish and light drab to	420
			" " cherty at	420
			and is of a dark color to	438
VIII.	18	62	Dark-drab Limestone	500
IX.	19		The recorded Section reports white Limestone alternating with Shales from 438 to	536
X.	20	92	Hard blue cherty Limestone	628
XI.			Very hard Chert at	682
	21	75	Coarse bluish-gray Limestone from 628 to	703
			Buff and drab cherty Limestone at	703
XII.	22	6	Sandstone, very fine-grained, to	709
XIII.			Chert and Limestone at	721
			" " " "	732
	25		Mostly light-gray or drab Limestone to	790
XIV.	26	10	Red Limestone from 790 to	800
XV.	27	35	Light-drab and gray Limestone with some Chert from 800 to	835

NO.		*Feet in Thickn.*	DESCRIPTION OF MATERIAL PASSED THROUGH.	*Total Depth below surface.*
XVI.	28	5	Argillaceous Limestone to	840
	29	43	Limestone with some Chert; upper part light-gray, the lower of a still lighter color.........	883
XVII.	30	67	Mostly a light-gray or blue Clay	950
	31	16	Dark Clay....................................	966
XVIII.	32	56	Blue Clay alternating with thin Limestone layers	1022
XIX.	33	194	Blue and drab Limestone, with probably some Magnesian layers at 1139 ft., to	1216
			Cream-colored Magnesian Limestone at........	1216
	35	9	Light-blue cherty Limestone, with salt water at	1220
			extending to...........	1225
	36	27	Light-colored Limestone from 1225 to..........	1252
	37	52	Dark Limestone to....................	1304
XX.	38	49	Light-drab cherty Limestone to................	1353
XXI.	39	17	Yellowish-gray Limestone to	1370
	41	78	Dark Limestone from 1402 to	1448
	42	4	Light-colored Limestone	1452
XXII.	43	133	Mostly pure white Sandstone, the upper portion soft and consisting of pure, clear and rounded grains, and contains sulphurous water. The lower portion is somewhat brown. Extends from 1452 ft. to	1585
XXIII.	44	61	Buff-brown and drab-cherty Limestone to	1646
	45	67	Buff and brown Magnesian Limestone, some of it cherty, to	1713
XXIV.	46	389	Buff and drab cherty Magnesian Limestone, to..	2102
XXV.	47	82	Hard and mostly pure Sandstone, with some Limestone beds with Chert, buff and brown or reddish-gray, to	2184
XXVI.		487	Limestone and Chert—colors buff, drab, and gray. The Chert beds include probably one-half the entire series from 2184 to	2671
XXVII.	49	172	No Chert from 2671 to 2735. Sand often abundant to	2843
XXVIII.	50	37	Mostly Sandstone with a little Lime in the upper part to	2880
XXIX.	51	142	Limestone, mostly free from Chert and Sand. to	3022
XXX.	52	98	Sandstone, upper portion dirty, middle blue, and the lower part is reddish-gray with a blue tinge	3120
XXXI.	53	13	Dark Magnesian Slate to	3133
XXXII.	54	371	Yellowish-drab or gray Magnesian Limestone, hard, and contains but little Sand. The lower 66 ft. is thin-bedded dirty-reddish-gray, with some sandy beds, to........................	3504
XXXIII.	55	41	Mostly hard thin-bedded Sandstone, dark olive-gray in color—under the magnifying-glass it seems to be formed of white and black grains—to...	3545
XXXIV.	56	3 1	Sand and Limestone to.............	3558
XXXV.	57	5½28	Brown Sandstone near upper part, the lower mostly Granite—the lower 40 ft. is a hard red rock, and is certainly powdered Granite, for some of the grains are red Quartz or Feldspar—to..................................	3843.5

The above Section with specimens would indicate the formations about as follows:

NO.	THICKNESS.	GEOLOGICAL FORMATION.	TOTAL DEPTH.
1	40 ft.	Clays of "Bluff"	
2	80	Coal Measures	120 ft.
3	670	Lower Carboniferous Rocks	790
4	93	Chouteau Group	883
5	421	Trenton with Black River and Birdseye	1304
6	148	First Magnesian Limestone	1452
7	133	Saccharoidal Sandstone	1585
8	517	Second Magnesian Limestone	2102
9	82	Second Sandstone	2184
10	838	Third Magnesian Limestone	3022
11	98	Third Sandstone	3120
12	384	Fourth Magnesian Limestone	3504
13	54	Potsdam Sandstone	3558
14	285½	Mostly all Granite, the lower 40 ft. being certainly Granite; the upper portion may be Sandstone	3843½

In the above section, the thickness of the several Geological Formations is made up from Mr. Atkinson's descriptive sections and an examination of specimens from the borings. It may therefore be considered only an approximation, for in a deep well, where all material is brought up in a comminuted state, there may be errors; but from the data it as correct as we can make it.

Two well-marked formations are recognized, viz., the red calcareous beds at the upper portion of the Chouteau Group, and the Saccharoidal Sandstone. They have formed the chief guides in the construction of our section. An important fact is also brought forth in the determination of thickness and extensive range of this Sandstone, so useful for glass making, etc.

For comparison, I give the following Tabular Statement of the thickness of the same Geological Formations in different counties of Missouri:

COMPARATIVE VIEW OF GEOLOGICAL FORMATIONS IN MISSOURI.

FORMATIONS.	F. B. Meek		B. F. Shumard.								G. C. Broadhead.				W. B. Potter.		
	MORGAN COUNTY.	MILLER COUNTY.	CRAWFORD COUNTY.	PULASKI COUNTY.	LACLEDE COUNTY.	PHELPS COUNTY.	WRIGHT COUNTY.	OZARK COUNTY.	JEFFERSON COUNTY.	FRANKLIN COUNTY.	WARREN COUNTY.	OSAGE COUNTY.	MARIES COUNTY.	ST. CHARLES COUNTY.	LINCOLN COUNTY.	REPORT OF PROF. SWALLOW.	WELL AT INSANE ASYLUM.
Lower Carboniferous	10	20	....	....	....	....	....	....	60	....	132	....	....	266	370	1145	670
*Chouteau Group	35	....	....	....	....	....	70	50	51	....	37	....	....	40	100	205	93
Lower Devonian	....	....	....	....	....	....	....	....	....	....	40	....	....	14	36	125	....
Upper Silurian	....	....	....	....	....	....	....	....	....	....	15	....	....	....	....	220	....
Hudson River	....	....	....	....	....	....	....	....	80	....	....	....	....	....	65	120	....
Trenton	....	....	....	....	....	....	....	....	†	....	114	....	....	} 168	230	360	} 421
Black River and Birdseye	....	....	....	....	....	....	....	....	100	....	55	....	....		30	†	
First Magnesian	20	....	....	....	....	....	....	....	130	....	84	....	....	94	50	190	148
Saccharoidal Sandstone	40	30	120	....	†	30	†	80	80	175	130	25	35	135	65	125	133
Second Magnesian	175	150	†	†	140	150	250	275	....	300	210	240	240	60	35	230	517
Second Sandstone	40	70	†	100	70	150	130	184	....	140	....	30	55	....	....	70	82
Third Magnesian	300	300	300	600	300	180	....	†	....	300	....	180	200	....	....	350	838
Third Sandstone	30	6	....	....	....	....	....	....	....	....	....	....	....	....	....	50	98
Fourth Magnesian	153	27	....	....	....	....	....	....	....	....	....	....	....	....	....	300	384
Potsdam Sandstone	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	54+

† Where this sign (†) occurs after the name of a formation, it shows that the formation was observed in the county designated, but that its thickness was not ascertained. The numbers express the vertical thickness in feet.

* In this Table, I have marked the formation immediately at the base of the Subcarboniferous the "Chouteau Group." This term I will hereafter use to designate the group to which Prof. Swallow and Prof. Hall, in their reports on Western Geology, applied the term Chemung. The proper position of this group has been a matter of dispute among geologists for the last ten years; some placing it among the Devonian, the majority among the Subcarboniferous. The Illinois and Iowa geologists apply to it the term Kinderhook Group. As it does not seem to be so well developed at Kinderhook, Illinois, as in some places in Missouri, and as Prof. Swallow had applied the term Chouteau Limestone to its principal member because well developed at Chouteau Springs, Missouri, and also as the term Chouteau is well known and of record in Missouri, I shall hereafter call it the Chouteau Group, and make it include the Chouteau Limestone, Vermicular Sandstone and Shales, and the Lithographic Limestone.

ABSTRACT OF THE RECORDS.

The borings indicate	63	ft. of	Clay,
	6	"	Coal,
	360	"	Shale,
	2725	"	Limestone.
	435	"	Sandstone.

When the borings began, the water in the well stood at 40 ft. below the surface; at 134 ft. an 8 or 10 inch opening was struck, and the water sank in the well to a depth of 128 ft. Salt water was obtained at 1220 ft. At 1225 and 1262 ft. from the surface a strong petroleum smell was recognized. Sulphur water was reached at 2140 ft. At 2256 the water in the sand-pump indicated three per cent. of Salt: at 2957, four and a half per cent.; at 3293, two per cent.; at 3367, less than two per cent.; at 3384 ft. three per cent.; and below 3545, seven to eight per cent.

TEMPERATURE.

Experiments with a Fahrenheit registering thermometer indicated the following:

At the	depth of	3127	ft. the	thermometer indicated	106°.
"	"	3129	"	"	107°.
"	"	3264	"	"	106°.
"	"	3376	"	"	106°.
"	"	3473	"	"	105°.
"	"	3533	"	"	105°.
"	"	3604	"	"	105°.
"	"	3641	"	"	104½°.
"	"	3728	"	"	105½°.
"	"	3800	"	"	105°.
"	"	3837	"	"	105°.

It is to be regretted that no tests of temperature were made above these indicated depths.

In boring to the depth of 833 ft. the drill was often observed to be highly magnetized, but after passing that depth no further influence was observed.

TUBING.

A cast iron tube of 11½ inches was first put down, reaching from the top to the limestone in the bottom of the well. The tube was then lined with wooden tubing, reducing the diameter to 4½ inches. A 4½-inch drill was then put down, and boring commenced March 31, 1866, continuing night and day for 3 yrs. 5 mos. and 10 days, every day except Sunday, until August 9, 1869, when work was stopped at a depth of 3843 feet 6 inches. From the 9th of July, 1866, to the 28th of January, 1867, was occupied in enlarging the bore. It was enlarged to 11½ inches to a depth of 1131 ft., and a short iron tube put down. The bore below was enlarged to 6 and afterwards to 10 inches, to 953 ft. depth. A sheet-iron tube, 79 ft. long, was then put down, resting on an offset at the bottom of the 10-inch bore. The 4-inch bore was then enlarged to 6 inches to a depth of 1022 ft., and a 5-inch wrought iron tube, weighing over 6 tons, put down, reaching from the top to the offset at the bottom of the 6-inch bore. The 4½-inch bore was continued downwards to the depth of 3843 feet 6 inches without need of further tubing.

Two wooden plugs with iron screws at the end were driven in, one at the 1022-ft. offset, the other at the 953-ft. offset, in order to separate the fresh from the salt water. If these were withdrawn, the well would be clear from the top to the bottom. The 5-inch tube, reaching to 1022 ft., has been withdrawn, and a pump put down to 400 ft. This pump was worked a few days, the water found to be a little salty and the supply limited.

DIFFICULTIES CONTENDED WITH.

On the 16th of April the jars broke in the well, and all broken parts were taken out the same day from a depth of 227 feet. About this time soft clay fell from the upper portion of the bore, when reaming to 6 inches was begun. On the 23d of the same month, 53 ft. of 5-inch tubing was put in and boring resumed. On the 19th of June, the jars broke at a depth of 841 ft., and four days were occupied in getting them and their broken parts out. On the 14th of November, 1867, the rope attached to the sand-pump parted, leaving the pump and most of the rope in the well, but it was taken out in five days. On the 14th of May, 1867, at the depth of 1876 ft., the jars broke, and two and a half days were consumed in taking out the broken parts and making repairs. At 2140 ft. a hard flinty opening was struck which caused the drill to deviate from a direct course, and it was with difficulty that the place was passed. On September 6th, at 2354 ft., the drill-screw gave way and left the drill in the well; it was removed in ten hours. The hardest flint rock was met with at 2513 ft. On November 14th, 1867, the poles parted at 900 ft. from the surface, also near the top, allowing twenty-seven poles to pass down alongside the lower poles. Twenty-seven new poles had to be made, which, together with taking out the broken poles, retarded the work six days. August 10, 1868, at 3240 ft., the iron of the lower pole broke in the well; in twenty-eight hours the broken parts were taken out. On the 11th of August the pump rope parted. This was the greatest difficulty met with, and ten days were consumed in making repairs.

The poles parted often during the work, causing detentions of a few hours, but the loss of time from all causes was less than ten per cent. for 3 years and 5 months. At the beginning of the boring the drill would fall on the bottom 48 to 50 times per minute, at the depth of 3,000 ft. 28 to to 30 times, and at 3843 ft. 20 to 25 times.

It is of great interest to compare this Artesian well with the one at Belcher's Sugar Refinery, in the upper part of the city, about 300 ft. from the banks of the Mississippi, and about 6 miles E.N.E. from the Asylum well. An account of this well by Dr. Litton was published in the Academy's Transactions, vol. i. p. 80. It is, according to Dr. Litton's statement, 420 feet above the sea, and therefore about 180 feet lower than the well at the Asylum, which is nearly on a level with the Compton Hill Reservoir, and 600 feet above the Gulf of Mexico.

The Asylum Well indicates Red Limestone at 790 ft.; the Belcher at 650+180=830 ft. From the red marly beds to the White Sandstone there is no material difference in distance in the two wells.

Salt water was obtained in the Asylum Well at 1040 ft. and in Belcher's at 610+180=790, and at 849+180=1029 ft.

The two wells we see possess some common characteristics, but the lower strata in Belcher's Well do not seem to have been recorded with sufficient care.

Occurrence of Bitumen in Missouri.

By G. C. Broadhead.

GEOGRAPHICAL DISTRIBUTION.

In the western part of Ray county limited quantities of Bitumen are seen oozing from between thin layers of Sandstone. In Lafayette, 12 miles southeast of Lexington, the Sandstones are very much saturated with it. It is occasionally found in the southern part of Cass and at several places in Bates. South of the Marais des Cygnes, near the line of Bates and Vernon, we find the Sandstone of the same geological age as that of Lafayette county very thoroughly saturated. In Vernon it is more generally diffused, and in Barton exists in nearly all the rocks. In Jasper it occurs occasionally in the northern and western portions of the county, and particularly abounds at Minersville and Joplin. In this county it was not found any farther east than Sarcoxie.

I have not observed the occurrence of Bitumen in paying quantities in any of the counties above named. It is reported to be abundant at several places in Kansas, chiefly in the vicinity of Paoli From my own observations, the quantity of Bitumen seems to increase in going southwardly, and is more generally diffused.

GEOLOGICAL OCCURRENCE.

The Sandstones of Ray and Jackson which carry the Bitumen belong to the Middle Coal Measures, and the first observed occurrence is about 70 feet below the top of these Measures. This was at the Saunders Well, in Ray county. The rock here has a strong bituminous odor, is dark or of a black color, with occasional drops of viscid black tar issuing from between the layers. When this is mingled with water, a beautiful iridescence is apparent on the surface.

The Bituminous Sandstone at Parkerville, Bates county, is geologically of the same age as that of Ray county, but only contains a small per cent. of bitumen. On Mulberry creek, in Bates county, it was observed accompanying a Limestone of the Middle Coal Measures. It was here detected only by the peculiar odor of the rock, which was also very hard and tough, and of a dark-bluish ash color.

Between the Marmaton and Marais des Cygnes rivers, in the southeastern part of Bates county, the "Micaceous Sandstone" of the Lower Coal Measures is very bituminous. On Mr. Newton's farm I observed viscid masses of bitumen, of the consistency of tar, flowing slowly from between the layers of the Black Sandstone. In the southern part of Vernon and in Barton there are several tar springs always flowing from Sandstone of the Lower Coal Measures. In some of the wells of the western part of Vernon the water is strongly impregnated, and at one of them I noticed a thick coat of tar on the rope. In drinking from a small spring in the northwest part of Vernon county, flowing from shales limestone, I detected a bituminous taste.

A few miles southeast of Butler, Bates county, is a bed of Gray Limestone whose outward appearance presents no indication of containing bitumen, but when broken we find the place once occupied by fossils replaced by bitumen.

The Blue Limestone, so abundant in the western part of Vernon and near Ft. Scott, and sometimes known as Ft. Scott Marble, is highly bituminous, and very hard and tough.

Many of the Sandstones of Vernon and nearly all those of Barton county are impregnated with bitumen. It does not seem very abundant in beds of clay shales; but when dark shales contain black concretions, the latter are generally very bituminous. It is a noticeable fact that the more bitumen in the rock, the harder it is. The Coals of Southwest Missouri are, nearly all. very highly bituminous. Some of those of Bates and Vernon, all those of Barton, those of Jasper, and some of the Cedar county Coals, on fresh fracture emit a strong bituminous odor.

The bituminous rocks above named are all of the age of the Coal Measures, and include the Middle and Lower Measures. and, if their various vertical thicknesses were added up, would amount to not less than 600 feet.

But the bitumen is not entirely confined to the Coal Measures. In the eastern part of Barton, and in Jasper, the Lower Carboniferous limestones are often quite bituminous; in fact, all the dark-looking limestones of that part of the State are bituminous. At Minersville, Joplin, and other mining localities, the limestones, especially the dolomitic, are much saturated with bitumen, and masses of tar are often found intimately associated with the gangue of the lead.

BORINGS.

These occurrences of Bitumen have given rise in some places to considerable outlay in search of richer deposits, and some deep wells have been sunk. Two wells in Ray county are over 800 ft. deep. The Saunders well, 802 ft., commenced with oil near the surface, but records do not indicate an increase downwards. Over 500 ft. of this boring seems to have been in Coal Measures. The McCausland well, in Lafayette county, was sunk about as deep as the Saunders well. That near Parkerville, Bates county, was bored to a little over 500 ft. Borings at foot of bluffs at Kansas City report a flow of bitumen to the surface from a depth of 180 ft. If so, its fountain-head must be in the same sandstone in which it was found at Saunders well in Ray county. This sandstone is No. 69 of General Sec. of Middle Coal Measures. (Mo. Geo. Rep. 1872, Part II. p. 82.)

The above are the main facts that have come under my observation. The origin of the bitumen remains to be solved. I think it most probable that the chief source of these bituminous deposits is in the Coal Measure sandstones, from whence they have escaped and entered the limestones.

Although, as above stated, Bitumen seems so generally diffused in Southwest Missouri, I do not believe it exists in quantity sufficient, at any one place, to prove remunerative.

Results of Investigations of Indian Mounds.

By Jas. R. Gage, M.E.

In March, 1873, I investigated several "mounds" in Washington and Issaquena counties in the State of Mississippi. Throughout the valley of the Mississippi a very large number of the mounds exist, and are especially numerous in the river counties. I have frequently observed these mounds in Bolivar, Coahoma, Issaquena, and Washington, but my examinations have been confined to a very few, and the data obtained will not admit of any generalization; I will therefore confine myself to the facts obtained by the investigations.

Davis and Squier have classified the mounds under the following heads:

I. Enclosures	for Defence, Sacred, Miscellaneous.
II. Mounds	of Sacrifice, for Temple-sites, of Sepulture, of Observation.

In my explorations I observed no works which might be strictly denominated enclosures. One very large mound examined in Washington County was about 80 feet in diameter and 40 feet high, in the shape of a truncated cone. The results of the investigation led me to conclude that this had been a mound of *observation*. On opening it no relics were discovered; it was entirely composed of soil of the country (denominated "buckshot land"); it is built on the old bank of the Mississippi river, and crowns a conspicuous point which overlooks the surrounding country;—there are no other mounds in the immediate neighborhood.

The second mound examined contained a large number of flint (properly "chert") arrow-heads and hatchets; this mound was about 2 feet high and some 15 or 20 feet in diameter. No doubt at one time it was higher, but, being situated in the middle of a field which has been under cultivation for forty years, it has been cut down by the plow. In the neighborhood numerous arrowheads lie embedded in the soil and are turned up every spring: no doubt they all existed at one time in the mound and have been plowed out.

About 100 yards distant I opened a third mound, with much more satisfactory and interesting results. This mound, though only 11 feet high, is the most prominent piece of land for miles; it stands in the middle of a cultivated field, and from its top one can see over the open ground for a great distance. This mound in general appearance shows great resemblance to the other mounds in that region, and, though the mounds differ in height and diameter, they are nearly all of a flat truncated-cone shape.

This mound under discussion was 11 feet high and 30 feet in diameter at the base. The soil composing the mound is identical with that of the country: this soil is principally a clay mixed with a little sand. (See "Silt Analysis of Soils of Mississippi," by E. W. Hilgard, in American Journal of Science and Art.) The mound was formerly covered by a heavy growth of timber, but is now nearly bare, only one tree standing, a very large white oak (*Q. alba*, L.), 36 inches in diameter; a few steps distant, and nearly the centre of the top surface of the cone, is the trunk of another oak, 30 inches in diameter.

I commenced investigation by driving an open tunnel, from three different points, on a level with the base towards the centre; after excavating 8 or 10 feet a skull was discovered, but in such a decayed condition that it immediately crumbled to pieces. A few minutes later the workmen in the other two ditches made similar discoveries. We now became more careful, and by digging around the skull we were able to procure it intact by removing a considerable amount of soil.

The skulls were in a very poor state of preservation—the gelatinous matter had been entirely dissolved away, and the earthy material very much resembled a spongy mass saturated with water, being so soft that water could be pressed out by a very slight force; the bony structure was very fragile, but on drying became quite hard and brittle.

The soil contained a great deal of moisture, being perfectly saturated from two feet below the surface to the base of the mound, and, as the soil was usually in that condition, it was very unfavorable to the preservation of the remains. In one of the better preserved specimens I observed a characteristic which Foster points out in his "Prehistoric Races of the United States"— the tendency at the union between the parietal and squamous bones towards a straight line. In nearly all of the specimens, although the skulls were in a very decayed condition, the perfect form remained; the nasal bones stood out prominently, and the large massive jaw-bones were filled with worn but well-preserved teeth; except portions of the upper jaw-bone, none of the facial bones were wanting. From the size of the skulls, I judge the twelve skeletons exhumed were all adults. Many of the other bones of the skeletons were in excellent preservation, as the femurs, tibiæ, and tarsi. As these bones were in a horizontal position and the crania vertical, I have no hesitation in asserting they were seated in a circle, and in a sitting posture faced the centre. From the slight examination given to the skulls during the disinterment, I judged that in brain volume they were not greatly inferior to the Caucasian; but, judging from the narrow forehead and the receding frontal bone, and the development of the posterior lobes, the latter must have been the seat of the greater portion of the brain. The original contents of the crania had been entirely removed and replaced by soil; this soil dried very rapidly, and in contracting caused the skulls to break to pieces. I was very careful in packing these specimens, but in transporting them nearly a thousand miles by river to St. Louis they became very much injured, some of the skulls being completely destroyed and most of them entirely lost.

I noticed that several of the tibiæ were very much flattened, and supposed it must have been unnatural and occasioned by the pressure from the weight of the overlying soil, until I read H. Gillman's report upon "Indian Mounds in Michigan" in the American Journal of Science and Art, January number, 1874, in which he says, "And I here repeat the interesting fact that all the tibiæ unearthed invariably exhibited the compression or flattening characterizing platycnemic men."

Directly in front of the mouth of each skeleton were placed from two to three vessels of pottery, beautifully ornamented with etchings and tracings, and in one or two specimens figure decorations were attempted. If these vessels were filled on their interment, their contents had long been removed and afterwards replaced by soil. If they originally contained food, all traces of the absence of such could be easily accounted for, as the mound was occupied by numerous ant colonies and other insects; or the contents might have been removed, and then replaced with soil by the water which after every rain percolated the mound. Thinking if the vessels had been filled with food, and if birds or fish had been an article of diet, most probably bones would remain, I subjected the contents to analysis, but under a 400 power microscope no trace of organic remains was to be seen.

Baldwin asks, "What but time could have caused these skeletons to dissolve and become as dust, as all the circumstances attending their burial were unusually favorable to their preservation? The earth around them has been invariably found to be wonderfully compact and dry." The condition of the bones cannot always be used as an accurate measurement of time, as here were remains found surrounded by very unfavorable circumstances for their preservation.

Squier and Davis claim to have found a skull belonging incontestably to the Mound Builders taken from a mound situated in the Scotia Valley, four miles below Chilicothe; but Foster says (p. 291), "Any comparative anatomist on referring to their plate will instantly recognize it as of the Indian type." Foster says that our knowledge of the Mound Builders' crania is exceedingly scant, as we have found but few specimens which were incontestably of that race. In regard to the bones I disinterred there can be no question: the surrounding circumstances proved them to belong to that race beyond a doubt; the positions of the skeletons, and pottery, and other contents of the mound, clearly prove they could belong to no other race.

The work upon the various vessels made of pottery would indicate that the Mound Builders had attained a high degree of skill in the plastic arts, and this race must have been far in advance of those living in the Stone and even Bronze Age of Europe, as Sir John Lubbock says that "few of the British sepulchral urns belonging to the ante-Roman times have upon them any curve lines. Representations of animals and plants are also wanting. They are even absent from all articles belonging to Bronze Age in Switzerland, and I might also say in Western Europe generally, while ornaments of carved and spiral lines are eminently characteristic of this period. The ornamental ideas of the Stone Age, on the other hand, are confined, so far as we know, to compositions of straight lines, and the idea of a curve line scarcely seems to have occurred to them. The most elegant ornaments on their vases are impressions made by the finger-nail, or by a cord wound around the soft clay."—(*Prehistoric Times*, p. 257.)

The Mound Builders were not content with straight lines: here are over 20 specimens taken from this mound, and you can see how beautifully the surfaces were ornamented with fret-work and various figures; and here is a kettle-like vessel having for one side the profile of a human being. One of the specimens was undoubtedly a water-jug, and being unglazed water could readily permeate the clayey material, and. rapidly evaporating in hot weather, would create a lower temperature than the surrounding air and then impart its temperature to the enclosed water, and by this device furnishing a cool beverage for summer.

Besides the pottery, the mound contained other interesting relics, one of which was an article made of magnesian limestone, round in shape, being two inches in diameter and a quarter of an inch thick, and discoidal on both sides. This is a characteristic implement, and frequently found in sepulchral mounds. Foster quotes a number of speculations indulged in as to the uses of this discoidal stone—among them the suggestion of Schoolcraft, that they were used as quoits. The little notches in the sides of the one I have here would give color to the supposition; and they were evidently made by striking against some hard substance, for in places the stone was worn very smooth, as through much handling.

Another implement was made of a very hard sandstone, almost quartzite; its shape was a flat quadrilateral figure, 6 inches long by 4 wide, and 2 in thickness.

Among the other interesting relics was a pipe, from which it seems the Mound Builders were not unaware of the narcotic properties of tobacco. The pipe was very plain, having not a single line for ornament. During the disinterment a small fracture revealed a fresh surface showing that the pipe was manufactured from fire-clay: it had been burned very hard, and from its appearance I judged it had seen a great deal of service.

In this mound I discovered no metalic remains, though I was informed by a gentleman who had opened several that he had found implements of copper and plates of mica, with fragments of obsidian. These facts would indicate that they enjoyed commercial advantages to a very high degree, as I am acquainted with no point where obsidian could have been procured nearer than Mexico—the mica most probably from North Carolina, it being the nearest point where that mineral occurs. As the Mound Builders must have been ignorant of the art of smelting, this copper must have been procured in a native state from the mines of Lake Superior, and that they did work these mines seems no longer a question of doubt. Professor Pumpelly, our late State Geologist, informed me he had seen marks of mining there of great antiquity, which must have been the work of the Mound Builders.

We should not be too hasty in drawing our conclusions, as relics sometimes found under circumstances which would indicate their Mound Builder origin, are afterwards proved to belong to another race. Prof. G. C. Forshey, in "Ancient Monuments," says: "Mounds! mounds without number * * * . The first of these groups is some fifty miles above Vicksburg, on the west bank of the Mississippi, two miles back, on the estate of Dr. Keene Richards, called Transylvania. The temple, which is the central figure of twelve mounds, looms up grandly from the level of the alluvial plain. Arrow-heads and pottery have always been abundantly found on these mounds. *One of them is used as a cemetery for the colored population of the plantation.*" (The italics are mine.) I wish to draw attention to the fact that too great care cannot be exercised in these investigations, as the negroes are usually buried in coffins of light wood, which in that damp soil decay in a few years; and as they are usually interred with their necklaces of beads and other trinkets, these relics found in the mounds might lead to great confusion in assigning to them their proper origin. It is not an unusual case in the South to use the mounds as cemeteries for the negroes. I have seen several used for that purpose.

I have been in communication with Mr. Anderson, of Centreville, Ohio, who examined a large number of mounds throughout the Mississippi Valley to Mexico, and who visited us on the plantation in Mississippi several years ago, and during his stay examined a number of mounds in the immediate vicinity of my explorations, and I will conclude my remarks by reading a few extracts from his letter:

"A desire to send you photographic representations of the articles found in my hurried explorations of the Issaquena Mounds, is I hope sufficient apology for the delay in answering your favor of the 21st ult.

"The result of the examinations were to me a great and agreeable surprise. I knew not what to expect beyond a few pieces of mica, some broken earthenware, and perhaps a specimen or two of obsidian, and therefore felt unusual pleasure in bringing to light a rich and remarkable collection of vases, urns and bowls of archæological pottery, and varied and various implements of stone, which you will find figured in the accompanying charts. With one exception, the vessels are all of the same material as those usually found in mound excavations, well-worked clay intermixed with broken shells or other calcareous matter. The exception is a little pot-hooked vessel with ears for hook suspension, which is of a darker color and apparently of a firmer material, though much injured when exhumed.

"I will now give, as you request, some account of the labor and discovery. On the 22d of February, 1871, I commenced opening the first mound by trenching on the level from the west. The first bones disturbed were the extremities of three individuals buried standing. The femurs, tibiæ and tarsi were in good preservation, and maintained their vertical positions so perfectly that one of my companions exclaimed, 'These fellows must have been buried in a barrel.' The more earthy bones of the dorsal and cervical vertebræ had entirely disappeared. My surmise was that they were the sentinels or outstanding guards, with heads above ground 'to watch and ward' over their superiors in the centre. We next reached a large deposit of ashes and burnt earth, the residuum of a sacrificial fire so intense that not a bone or even tooth was discoverable, over this large bed of undistinguishable rabble, waiting their delivery.

"Approaching the centre of the mound, and about five feet above the level, we met with a few pieces of pottery, then a whole specimen, and another and another to the number of twenty-five or thirty. I confess now to having felt an almost childish delight at the discovery. I had broken into the domestic sanctum of a venerable Mound Builder! I had resurrected his bones and robbed his ancient pantry! I had scattered his armory and rejoiced! I rejoiced at my folly and my good luck, and why should I not? Messrs. Squier and Davis had said, 'It is much to be regretted that none of these remains have been recovered entire in the course of our investigations.' Now bear in mind that they had opened scores and scores of mounds; and I now learn from Llewellyn Jewett, in his 'Grave Mounds and their Contents' of Great Britain, that it must not be supposed that they, (the urns, &c.) are often found in a perfect state; on the contrary, the urns are usually very much crushed.

"As near central as possible lay the three great men of the nation; around them matters of use and ornament, urns and vases, beads and arrows; adjoining the heads of each, in pairs, a drinking vessel and a food vessel, all once filled, but now alas! skull, urn, and bowl, quite empty, dry, and foodless. Not far off we discovered two skeletons on whose crania the bowls were placed like helmets. I know not whether this was accident or design; I think the latter. I had no authority to 'prophesy on the bones or make them speak,' but I felt persuaded that my new-found friends had once been mighty leaders, perhaps glorious heroes, in their days of action.

"In this little collection you will find some points of agreement and some of difference from the contents of other mounds. The cinerary urn on Chart No. 2 is the exact counterpart of those delineated in the works of Llewellyn Jewett, where, as the little common caricature of the human face on the same plate, was perhaps never seen before. The celts or wedges have also their concord and discrepance. The three larger are of silicified wood: the grain, bark and knot marks strongly resemble sycamore; some are jasper-colored, others gray and yellow. I think I have never before seen instruments with keener edge or brighter polish.

"I send also for your acceptance and consideration the photographs of two *carved* stones: the one is a copy of the disc obtained for me by my friend Dr. Robinson, of Lake Washington, Miss., and which was taken out of an Issaquena mound; the other photograph is of the world-renowned Toltec Calendar. The first one, with its birds, serpents, and pipe border, was the moving cause of my subsequent investigations in Issaquena. The contemplation of this stone excited in me an archæological interest I had never known before. My memory carried me back to the many hours I had spent under the walls of the Cathedral of Mexico trying to unravel the mystery of that old record of Time. I have fancied a resemblance, but I cannot establish a complete agreement between the two tablets Here are the eighteen pipes of the border, corresponding to the eighteen months of the year, but the twenty days of the month and the five intercalaries are not to be found. The thirteen hieroglyphical figures and the four zodiacal signs, which as multiples give the fifty-two years of the Aztec cycle, are also absent on the Mississippi stone.

Yours very truly,

W. MARSHALL ANDERSON."

I hope these remarks may excite such an interest as shall lead to further and immediate active investigations in our midst: there are many unexamined mounds in our vicinity which would well repay exploration. "The noblest study of mankind is man," and the late and rapid advancement in the knowledge of Archæology also shows it to be one of the most interesting. And as we have such a fine field for investigation, in which so few laborers are at work, I hope we may be able to do something to add to the knowledge and advancement of this most important and interesting study.

Descriptions and Natural History of two Insects which brave the Dangers of SARRACENIA VARIOLARIS.

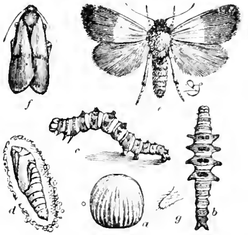
By CHAS. V. RILEY, M.A., Ph.D.

Renewed interest has lately been manifested in the insect-catching attributes of various plants, and especially of Dionæa, Drosera, Nepenthes, Darlingtonia and Sarracenia, and some important additions to our knowledge of the functions of these plants have been made—additions largely due to the exertions of Mr. Darwin, who is understood to be preparing a work on the subject of "Insectivorous Plants." *Sarracenia variolaris*, more particularly, has been the subject of careful and thorough observation and experiment on the part of Dr. J. H. Mellichamp of Bluffton, S. C., through whose kindness and that of Mr. H. W. Ravenel of Aiken, S. C., I have been enabled to study the insects associated with the plant.

The leaf of Sarracenia is, briefly, a trumpet-shaped tube representing the petiole and having a broad ventral wing, with a hood or lid covering more or less completely the mouth. The inside wall is so furnished that most insects entering the tube are prevented from issuing again. From the mouth to about midway to the bottom it consists of a dense, velvety pubescence which is quite slippery, especially as the finger passes over it in a downward direction, and effectually prevents most insects from scaling the tube. From midway downward the surface is beset with retrorse bristles which gradually increase in size till within a short distance of the bottom, where they suddenly cease and the surface is smooth. Similar bristles are also found under the hood. It had long been known that insects were caught in these tubes in large quantities, and were drowned and macerated in a fluid which gathered at the bottom. Dr. Mellichamp has now settled beyond dispute that the fluid—which is a pure secretion, and not the result of dew or rain, as it partly may be in some of the species of Sarracenia with more open lids—has toxic and solvent properties; and that not only is honey secreted in numerous drops around the inside of the mouth, but that there is actually a trail of it, when the leaf is in fullest vigor, running down the margin of the wing to the ground—the whole forming a most effectual lure to honey-loving insects.

The insects which meet their death in this pitcher comprise numerous species, and are of all orders; but, as one might naturally infer, the ubiquitous, honey-loving ant is the principal victim. But, while most insects fall an easy prey to the mechanical and secretory allurements of the plant, there are two species more especially which are proof against those allurements, and which seem to be invariable accompaniments of the tube-like leaf—the one feeding upon it directly, the other sponging upon the captured and macerated insect-remains. Of these two insects, I herewith submit full descriptions.

[*Fig.* 10.]



XANTHOPTERA SEMICROCEA.—*a*, egg, enlarged, the natural size indicated at side; *b*, *c*, larva, back and side views; *d*, chrysalis; *e*, moth, normal form, with wings expanded; *f*, pale variety, with wings closed; *g*, enlarged tubercle of larva.

The first is *Xanthoptera semicrocea* Guen., kindly determined by Mr. A. R. Grote of Buffalo, N. Y., our leading authority on the Noctuidæ. It was many years ago figured, in a yet unpublished plate, by that ardent entomologist, John Abbot, who, toward the close of the last century, did so much to clear up the natural history of North American moths. Guenée's descriptions were made from these drawings, and, as a consequence, are not as complete as one could wish. I am not aware that the insect has ever been definitely referred to by any other authors, and its complete natural history has certainly remained unknown. The egg is laid within the tube, and the young larva covers the smooth surface with a fine gossamer-like web, generally closing up the mouth by webbing the lips together. As it increases in size it frets the leaf within, feeding on the parenchyma and leaving only the epidermis. Its ochre-colored excrement falls in pellets to the bottom of the tube, where it gathers in a compact mass above the putrid remains of the insects which had been captured before the closing of the mouth. The transformations are undergone in a slight cocoon usually constructed just above the mass of excrement. There are at least two broods of the insect each year, the first larvæ appearing during the early part of May, the second toward the end of June.

XANTHOPTERA SEMICROCEA Guen. *Egg*—Globular, slightly flattened at top and bottom; 0.02 inch in diameter. Color, when mature, grayish. With about 35 vertical ribs of a paler color, some of them anastomosing and all becoming fainter toward the crown, which is smooth.

Larva—Average length 0.8 inch. Thickest in the middle of the body, and having but three pairs of prolegs. Color deep crimson, or lake-red, the joints being deeply separated, and their borders, especially posteriorly, being white and strongly contrasting with the red. On each of joints 4, 5, 6 and 7 is a pair of more or less confluent, velvety-black, dorsal patches, and a subdorsal, fleshy tubercle, the foremost a little the longest, the others gradually diminishing in length. The other joints are each ornamented with about a dozen small, dark, conical tubercles, transversely arranged on 2 and 3, from a trapezoid to a square on 8, 9, 10 and 11, and on 12 in an opposite position to those on 9: on the cervical shield there are two rows and on the anal plate they are all brought close together. The red parts are more or less thickly beset with short, fuzzy, dark hairs, which are especially dense on the velvety patches and large tubercles mentioned. Venter from joint 8 to anus pale. Head yellowish-white with a deep brown transverse band around the mouth and the forehead, and an irregular spot of the same color on the top and on the front of each lobe. Thoracic legs dark brown; prolegs dusky.

The newly hatched larva is pale, with the dark bands noticeable principally on joints 4–7, the head uniformly pale-brown, and the tubercles scarcely noticeable and surmounted by one or more stiff hairs. In the second stage the tubercles become more prominent, but those on joints 4–7 are not relatively so much larger than the others. In the third stage the characters of the mature larva are assumed, except that the colors do not contrast so greatly, the short hairs are not so dense, and the head is often unicolored.

Many specimens examined, taken on both *S. variolaris* and *S. flava*.

Chrysalis—Uncharacteristic; varying from yellowish-brown to mahogany-brown in color; the head produced into a slight cone in front between the eyes, and the tip of the abdomen armed, in perfect specimens, with two straight converging thorns, and several smaller curled hooks.

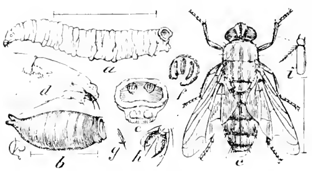
Imago—Average expanse 0.8 inch. Colors, glossy straw-yellow and black. Primaries with the basal half straw-yellow, varying from pale chrome to ochre; the terminal half brown-black with a gray and violet reflection; the two colors sharply separated across the wing at about a right angle from costa. Secondaries same as terminal half of primaries, but usually somewhat paler, especially toward base. Under surfaces uniformly purplish-gray, inclining to yellow basally, and with a somewhat darker median shade usually discernible on primaries. Head black, with palpi beneath and antennæ yellow. Thorax of the same two colors, sharply separated across the shoulders. Legs yellowish, the tarsi with minute spines, the spurs often with a spinous tip. Abdomen yellowish at base, otherwise concolorous with secondaries.

The species is very variable, the dividing line of the two colors, on primaries, being usually across the middle, but in some specimens much nearer the base of the wing. A striking variety (two specimens) is of a uniform straw-yellow, with the faintest dusky shade across the middle and subterminal portions of primaries; while several have the dark parts more or less suffused with yellow.

Twenty-five specimens examined, ♂, ♀, mostly reared from the larva. The scales are very slightly attached, and it is difficult to get good specimens except by rearing them.

The second insect which is always found connected with Sarracenia is a Dipter, belonging to the genus Sarcophaga. The mother-fly drops her living larvæ within the tube to the number of upward of a dozen, and these easily find their way to the bottom, where they feed on the softer parts of the macerated insects which have accumulated there. As a rule, but one of the Sarcophaga larvæ matures, the others having fallen victims to its gluttony and superior strength. When full fed, or rather when it has appropriated all the nourishment at hand, this maggot works through the tube (by this time weakened and decayed at base) and burrows in the ground, where it undergoes its transformations, and whence in a week or more, according to the season, the fly emerges. The species may be recognized from the following description:

[*Fig.* 11.]



SARCOPHAGA SARRACEINÆ.—*a*, larva; *b*, pupa; *c*, fly, the hair-lines showing average natural lengths; *d*, enlarged head and first joint of larva, showing curved hooks, lower lip (*g*), and prothoracic spiracle; *e*, end of body of same, showing stigmata (*f*) and prolegs and vent; *h*, tarsal claws of fly with projecting pads; *i*, antenna of same. All enlarged.

SARCOPHAGA SARRACENIÆ, n. sp. *Larva*—0.30–0.85 inch long. Body composed of but 11 visible joints exclusive of the head; microscopically and transversely shagreened; transversely wrinkled, the hind wrinkle on each joint more particularly prominent laterally. Head extremely small, or ¼ as large as joint 1; showing a division into two maxillary lobes at the tip, and a larger labial lobe, beneath, with a small bunch of setous fibres issuing from it; the black retractile jaws, of the ordinary form, issuing between these lobes, and the antennæ showing in two small rufous projections above the maxillary lobes: sparsely armed anteriorly with minute conical, sharp-pointed spines, decurved in front, directed backward beneath. Prothoracic spiracle pale rufous, retractile, sponge-like, studded with numerous lobules, divided at the end into a variable number of branches (6 being usually apparent, never more than 8), which in their turn ramify into lobules. Anal stigmatic cavity quite deep; the fleshy prominences on the carina surrounding it, sub-obsolete; the stigmata but slightly excavated below, the border brown, enclosing three brown openings, the lower ends of which reach to a circular clear space in the corneous and pale rufous peritreme. Anal prolegs quite small, with the longitudinal anal slit between, and a corneous plate in front of them.

Puparium — 0.25–0.50 inch long; neither smooth nor highly polished, and varying from yellowish-brown to deep brown-black in color. Insections more or less distinctly traceable. Head and prothoracic joint retracted; the prothoracic spiracles, protruding and forming two small ears, about as long as joint 2; the mass of lobules hardened and rufous. Joints 2 and 3 constricted and flattened; 4 suddenly bulging. End of body squarely docked by spiracular cavity, the rim of which forms quite a ridge.

Imago — Length of body 0.23–0.56 inch. Head pale golden-yellow, especially when viewed from above, with a dark brown or bronze sheen, especially below: eyes ferruginous, in life; duller and bronze-colored in death: stripe between the eyes and all appendages jet-black, though showing, in fresh specimens, shades of brown or yellowish-brown, especially at inner base of antennæ and on maxipalps. Thorax pale ash-gray, with three prominent, dark, longitudinal, dorsal vittæ, and two which are shorter, on each side; the two intervening pale dorsal spaces showing also a narrow darker line along their middle: wings slightly fuliginous; tegulæ sordid white: legs black, with the front thighs grayish beneath; cushions large and pale yellowish. Abdomen of the same gray—inclining, in some specimens, to pale golden-yellow, especially behind—checkered with black, the pattern varying with each change of light, but 3 longitudinal lines tolerably distinct from above, the side ones approaching or joining the medial one on the anterior part of each joint, and the whole looking checkered as the light falls on the sides: anus always, and frequently the hind margin of preceding or 4th abdominal joint, pale reddish-brown, the color deepening and becoming less noticeable in the dead specimen; the globular and highly polished ♂ genital organ of a brighter and deeper reddish-brown.

Described from numerous specimens reared from *Sarracenia variolaris* and *S. flava*.

REMARKS.—Though there is such great variation in size—depending, no doubt, on the amount of nourishment obtainable by the larva—there is not much in coloration. The species agrees tolerably well with the descriptions of *carnaria* except in having a red anus, and should perhaps be considered only a variety of this last. Whether it be any of Walker's or Desvoidy's species mentioned in Osten Sacken's catalogue, I have no means of positively knowing, but I have carefully read over the descriptions of Meigen, Macquart and Wiedemann without feeling warranted in referring it to any of them. Several of the brief descriptions of these authors might answer for it, barring the red anus; for a number of them consist of two or three lines, without measurements; and, for aught the student can see to the contrary, several of them apply to one and the same species. A name, a slight modification of the descriptive language, without altering the description, and behold a new species! Such is the impression which Macquart's work, more especially, in this genus, leaves on the mind. The Muscidæ are proverbially difficult to study on account of the many close resemblances which the different species present. In such difficult genera as Sarcophaga science is best served by full descriptions of the different stages, coupled, if possible, with the habits of the species; and my own object is to so characterize the present species that future students cannot fail to recognize it—the name under which it goes being of minor importance.

The larva differs from Packard's description of that of *carnaria* in the character of the prothoracic spiracle, in lacking the 12 blunt spines around the anal spiracular region, and in having the clear space in the peritreme of the anal spiracles, by which it seems to agree more with his description of Calliphora, and to indicate that this feature cannot be looked upon as of generic value, as Dr. Packard suggests it may be.*

Descriptions of two new Moths.

By Chas. V. Riley.

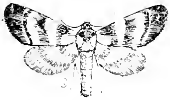
Genus **Xanthoptera** Guenée.

Xanthoptera Ridingsii, n. sp. (Fig. 12 ♂).—Colors pale, bright, glossy straw-yellow and brown-black. Primaries yellow with a dark band across the base, reaching close to the thorax on the costal half, only ⅓ as wide and outwardly obliquing on the inner half; a second band across the middle as wide as the costal part of the basal one, slightly arching with the posterior border; a third much broader occupying the posterior third of wing, with a narrow line more or less distinctly separated from its arched

* *On the Transformation of the common House-fly, with Notes on allied Forms*, by A. S. Packard, Jr., M.D. The author of this interesting essay, which received the Walker prize and appears in the Proc. Bost. Soc. Nat. Hist., vol. xvi. 1874, does not seem to have been familiar with Samuelson's little work on *The Earth-worm and the House-fly*, or with some others cited in Hagen's *Bibliotheca*, as he refers to only three authors (DeGeer, Bouché, and Keller) who have treated of the habits of *Musca domestica*. His own paper is, however, replete with original observations, and from a comparison of the larvæ of Musca, Calliphora, and Sarcophaga, he mentions the number of principal divisions of the prothoracic spiracle, and the absence or presence of the clear space in the peritreme of the anal stigmata as of generic value. Thus in Musca the main divisions in the prothoracic spiracle are said to number 6–8, in Calliphora 9 and in Sarcophaga 11; while, aside from these differences, the only other structural difference between the last two genera is said to be in the absence of the clear space in the peritreme of the anal stigmata in Sarcophaga and its occurrence in Calliphora. My own studies of *Sarcophaga sarraceniæ* would seem to lessen the importance of these characters as generic guides.

inner margin, especially near the costal and inner borders. Secondaries grayish-brown, becoming paler basally, with two faint transverse, median dusky bands. Under surfaces gray-brown, yellowish toward base, the dark bands of upper surfaces, except the basal one on primaries, faintly indicated. Body yellowish, the head and prothorax bushy and deep brown-black, the color not abruptly separated across the shoulders, but tapering on to the mesothorax; the pronotum, palpi above, front femora and tibiæ above, and the other tibiæ toward their tips, dusky. The abdomen also sometimes dusky above toward tip. Expanse 0.8–1.05 inch.

[*Fig.* 12.]



XANTHOPTERA RIDINGSII.

Five specimens, 2 ♂'s 3 ♀'s, examined; 3 in the collection of the American Entomological Society, 2 in my own. The dark bands vary in thickness, and the second or median one may be a little within or without the middle of the wing, regular or irregular on its posterior margin, while the yellow space between it and the broad posterior band may be obsolete (2 specimens) or subobsolete (1 specimen).

Larval habits unknown.

The specimens were collected in Alabama by Mr. J. S. Ridings, to whom I take pleasure in dedicating the species. In colors it closely approaches *semicrocea*, of which it has been considered a variety. It is however a brighter, more graceful species, the primaries being somewhat narrower, with the posterior border more oblique; and while *semicrocea* varies greatly, in none of the specimens that I have examined is there the slightest approach to the basal dark band in the primaries, or to several of the other characters indicated.

Genus **Cerura** Shrank.

CERURA MULTISCRIPTA, n. sp. (Fig. 13 ♀.)—Color white with brown-black and black markings. Primaries white, slightly silvery, crossed with 8 irregularly undulate and angulate, narrow, black lines, as follows: 1, basal, obsolete on costal and inner borders, and preceded by a black spot close to thorax; 2 reaching to both borders, but broken; 3, 4 and 5 proximate, and irregularly undulating almost straight across the basal fourth of wing. 3 and 4 thickened and confluent toward costa and generally forming a circular spot between subcostal and median veins: 6, 7 and 8 obliquing more toward apex, lunulate and more widely separated between veins 2–3–4, more approximate and retreating toward base between veins 1–2 and 4–6, and generally so close along vein 2 as to coalesce: broader, more intense, irregular marks occupy the spaces toward apex and anal angle, left by the retreating of line 8, thus leaving a regularly defined terminal space. Veins more or less dusted with black, and conspicuously marked in terminal space. A distinct row of terminal spots between the veins.

The median space between lines 5–6 is about as wide as the terminal, and has a small discal ring and a costal spot. Fringes white. Under surface fuliginous, with the borders white, the costal and terminal marks mostly repeated, and with two duskier shades across subterminal space. Secondaries fuliginous, with terminal black spots between the veins; lunule, and two more or less distinct transverse bands, dusky: fringes white: under surface paler, with the dusky bands more strongly relieved. Head beneath, front femora and tibiæ inside, two spots on middle and hind tibiæ, tarsi, pectinations of antennæ, a mark (obsolete in one specimen) between eyes and bases of wings, across the shoulders, around the tegulæ and at base of thorax; a spot on each tegula and two in middle of thorax, and a transverse band on anterior edge of each joint superiorly—brown-back.

Alar expanse 1.25–1.50 inches. Length of body 0.60–0.75 inch.

Described from three ♀'s, one bred by myself, one by Miss M. E. Murtfeldt of Kirkwood, Mo., and one by J. R. Muhleman of Woodburn, Ills.—all from Willow-feeding larvæ. In each case the larvæ were supposed to belong to *borealis*, and no critical descriptions were taken. The variation is not great: in one specimen the wings are noticeably shorter and more rounded than in that chosen for my figure, and the marks on primaries are less clearly defined: the bands on secondaries are also scarcely indicated, or only by faint spots on the veins, while the costal marks on primaries inferiorly coalesce so as to form but 3 broad marks.

[*Fig.* 13.]

CERURA MULTISCRIPTA.

The eggs of Cerura are hemispherical, i.e. very flat on the attached side, and while the larvæ of *multiscripta* and *borealis* so closely resemble each other, their eggs are easily distinguished: those of the former being pale yellowish-green, and those of the latter jet-black.

The species approaches nearer to the European *bicuspis* than to the N. A. *borealis*. I am unacquainted with the *scitiscripta* Walker, of Grote & Robinson's "List": but as Mr. Grote has seen *multiscripta* and pronounced it new, I have no hesitancy in describing it.

Catalogue of Earthquakes for the Years 1872-73.

Prepared by RICHARD HAYES.

Date.	*Location.*	*Characteristics.*	*Authority.*
1872.			
January 4	Sheffield, Eng.	Slight	Telegram
5	Pana, Sandw. Isl.	Heavy. Volcano Kila Kua active.	*Nature* v 5:30
6	Khabooshan	Severe. Destroyed the town, killing about 4,000 persons	" v. 6:39
9 8 P.M.	New Hampshire and Quebec	Somewhat heavy; no damage	Daily press
10	Arequipa, Peru	Several shocks	"
14 & 15	Darjeeling, Asia	" "	*Nature* 5:412
16	Valparaiso	Three shocks	" 5:412
23	Guayaquil		" 5:412
27	Zambales, Luzon	Many strong shocks, E. to W.	" 6:180
28 3 P.M.	Malaga	Undulatory, N. to S.	" 5:511
28	Shamaka, Russia	City destroyed; shocks very protracted	" 5:349
29 7 P.M.	Manilla	Three slight shocks, E. to W.	" 5:422
31	Patua, Bengal	Severe shock.	" 5:412
—	Broossa, Asia M.	Frequent during the month	" 5:412
Feb. 6 5 A.M.	Wenona, Mich.	Three shocks from N. N E.	Professor Rockwood
6	Herzogovina		*Nature* v. 6:34
7	"		" 6:34
7	Camarines, Luzon	Two shocks	Daily press
8	Herzogovina		*Nature* 6:34
8 5:30 A.M.	Cairo, Ills., and Memphis, Tenn.	Continued 20 sec N.W. to S.E. No damage	Daily press
12	Lisbon	Slight	"
13	Herzogovina		*Nature* 6:34
16	Arequipa, Peru	Severe	Daily press
25	Herzogovina.		*Nature* 6:34
27	"		" 6:34
March 2	"		" 6:34
6 evening	Berlin, Dresden, Chemnitz, Baden, Bach, Weimar, Rudolstadt	Not violent but continuous at intervals for about one hour	Daily press
6 (or 5) 9 A.M.	Manilla	Weak	*Nature* 6:186
22	"	Several strong shocks	" 6:186
26	Luzon	" " "	" 6:186
26	Inyo Co., Cal.	This earthquake extended over nearly 7 degrees of latitude, including the whole of California, and eastward as far as Virginia City, Nevada. The shock was most violent and destructive in the county of Inyo, east of the Sierra Nevada. The village of Lone Pine, containing about 500 inhabitants, was greatly damaged, over 50 adobe buildings being ruined, and in their fall killing 27 persons and seriously wounding 34 others. These fallen houses seemed to have been pushed N.E. Prof. J. D. Whitney says: "The almost universal testimony of the residents of that portion of the valley was to the effect that the shocks came from that portion of the Sierra Nevada between Owens Lake and Independence. To the south of the lake the vibrations were felt as approaching from the N.W. At Lone Pine they were referred to the W., and as we moved up the valley the direction was assigned more to the S. of W." He also says: "Midway in the valley, commencing about 30 miles N. of Lone Pine and extending for 10 miles, is a region of volcanic cones and lava-flows of recent geological date, but now all quiet."— Shocks	

Date.	*Location.*	*Characteristics.*	*Authority.*
1872.		were of almost daily occurrence till the 17th of May, when one occurred lasting 30 seconds.	
Mar. 26	Mexico	Supposed to be synchronous with the one in California. Felt through several of the Mexican States.	
26	Paducah, Ky.	Slight shock	Daily press
27	Salt Lake	" "	"
27	Oaxaca	Destroyed many churches and dwellings	"
April 3 8 A.M.	Antioch, Syria	Severe shock, lasting 40 seconds, destroying a large portion of the ancient city, and burying hundreds of the inhabitants, the number of killed being estimated at more than 1,000	"
9	Vesuvius	Eruption	"
14 & 15	Acra, Africa	Several violent shocks	"
15	Java	Violent e uption of volcano, destroying many lives and much property	"
17, 18, 19	Iceland	Severe; 20 houses destroyed	"
20	Memphis, Tenn.	Slight	"
20	Japan	Several severe schocks	"
June 4	Ashland, Virginia	Slight	"
8	Valparaiso	"	"
17	Georgia, U. S.	Sharp	"
20	Copiapo	Slight	"
July 8 10:15 P.M.	Missouri, western counties	"	"
17 5:25 A.M.	Long Island, New York	"	"
12 7 P.M.	Chopee, Khandeesh, Amalner, Durrangaon, Dhulia, Jalgaon	Slight, lasting about one minute	*Nature* 6:378
15	Tripatore, India.	Slight	" 6:378
27	Valparaiso	Three shocks	" 6:462
August 6	Colima, Mexico	Slight	Daily press
8	Scotland	Strongest since 1839	*Nature* 6:378
13	Sandwich Islands	Shocks near Mauna Loa	Professor Rockwood
Sept. 7	Italy	Slight shocks near Vesuvius	"
14	Inyo Co., Cal.	Several shocks	"
15	Yokahama, Japan	Severe	Daily press
21	Shanghai, China	Sharp	"
28	Lima, Peru	Slight	"
October 2	San Franc'co, Cal.	"	"
9 10 A.M.	Iowa and Dakota	Severe	"
12	California	Two shocks	"
18	New South Wales	Severe	Rockwood
Nov. 12	California and Nevada	Sharp	"
13 4:10 P.M.	Derby, England.	Slight	*Nature* v. 7:68
18	New Hampshire	Severe	Daily press
Dec. 10 4:30 P.M.	Helena, Montana	Slight	"
11 7 A.M.	" "	"	"
14 9:30 P.M.	Portland, Oregon.	"	"
15	Lehore, India	Severe; over 200 persons killed by falling houses	"
15 (?)	Puget Sound	Severe	"
17 4:2 A.M.	Bogota	Smart shock	"
24	Dumfries, Scotl'd	Severe	*Nature* v. 8:5
26	Arequipa, Peru	"	Rockwood
28	San Salvador	San Vicente destroyed	Daily press
28	Goalpara, India	Slight	"
31	Suchin, India	Severe	*Nature* 7:289
31	Kingston, Jam.	Slight	Rockwood

Date.	Location.	Characteristics.	Authority.
1873.			
January 1 7:55 A.M.	Lehore, India	Severe	*Nature* 7:280
1	Guayaquil	Slight	" 7:311
3	Goalpara, India	"	" 7:311
3 7 P.M.	Vienna	Two shocks, N.W. to S.E.	" 7:330
4 11:40 P.M.	Ohio	Three shocks	Daily press
7 4 P.M.	Sullanpore, India	Sharp	*Nature* 7:311
11 5 A.M.	Brunswick, Me.	Slight	Daily press
13 10:30 A.M.	Dardanelles	" S. to N.	*Nature* 7:292
23	Bemlipatan, India	"	" 7:392
31	Rangoon	"	" 8: 12
31	Samos	Succession of shocks till February 4; in all, 104 shocks	" 7:311
Feb. 2	San Francisco	Slight	Rockwood
3	"	"	"
5 (?)	Lehore		Daily press
6 (?)	Athens		"
9	Antioch		*Nature* 7:251
10	Durazzo, Turkey.	Severe	" 7:251
11	Kavalla, "	"	" 7:251
12	Jazat "	"	" 7:251
12	San Vicente	Destroyed	Daily press
12	Peshawar, India	Sharp shock	"
14	Jerusalem	Slight	*Nature* 7:251
17	Mitylene	Two shocks, E. to W.	" 7:292
20	Kura Hissa, Asia	Twenty shocks	" 7:432
22	Eastport, Maine	Slight	Rockwood
March 7 6 A.M.	Rhodes	Strong	"
14 8 P.M.	Janina, Turkey	Slight	*Nature* 8:12
—	San Salvador	Destroyed	Daily press
April 14	Goalpara, India		*Nature* 8: 94
16 9:50 P.M.	Dumfries, Scotl'd	Rumbling shock	" 8: 5
27	Attok	Lasted several seconds	" 8:112
29 2 P.M.	Doncaster, Eng.	Sharp shock	" 8: 12
May 6	San Salvador	Shocks continue	Daily press
June 29 5 A.M.	Northern Italy.	At Filotto a church was destroyed, 38 persons killed; and in four villages near Vattoria, 14 were killed and many injured	"
July 6	Northern Italy	Shocks continue	"
6	Buffalo, N York	Three shocks	"
6	Valparaiso	Much damage	"
13	Rome, Italy	Slight shocks	"
Aug. 23	Guatemala	Several shocks	"
Oct. 10	San Salvador	Slight	"
13	Panama	Shocks felt throughout the Isthmus	"
10	San Francisco	Slight; an eruption of Mt. Rainer	"
Nov. 6	Austin, Nevada	Three shocks	"
7 6:30 P.M.	Unionville, Cal.	Severe	"
9	Asia Minor	Extensive; vapors of sulphur followed the first shock	*Nature* 9:93
22 9 P.M.	Oregon, Nevada, and California	Severe	Daily press
Dec. 18 7:21 A.M.	Bear Lake Valley in Utah	Heavy shock	"

On the Forms and Origin of the Lead and Zinc Deposits of Southwest Missouri.

By Adolf Schmidt, Ph.D.

The geological formation in which the lead and zinc deposits of Southwest Missouri mainly occur is the Keokuk group, belonging to the Lower Carboniferous system. This group consists, in some places, of immense more or less thinly stratified chert beds; in others, of limestones, which are frequently bituminous: in others, of alternate layers of chert and limestone: and finally, in places, of silico-calcite, which is an irregular and often very intimate mixture of concretionary forms of both chert and limestone. All these rocks are more or less fissured and broken in the vicinity of the ore deposits, and the limestones are altered by dolomization and by partial dissolution. These alterations seem to have created the empty spaces in which the ores were principally deposited: for we find the best lead deposits in such districts where the chert beds are the most fissured and broken, where the limestones are the most cavernous and the most extensively metamorphosed into dolomitic limestone and into dolomite rock. The lead and zinc ores form in these rocks, principally, the following five kinds of deposits:

1. "Runs" (so called).
2. "Openings" (so called).
3. Impregnations of fissured chert beds.
4. Irregular deposits in loose accumulations of broken chert.
5. Seams and impregnations in quartzite.

I will give a general description of these various deposits.

1. "Runs" is a designation given by the miners of Joplin to such deposits which extend chiefly in one horizontal direction, while limited to five or six feet only in width and height. They are generally in a thick limestone layer, and have mostly a chert layer as roof and another chert layer as bottom, which chert layers cut off the ore more or less completely. The ores are invariably connected with dolomite, either fresh or rotten, and reach sidewise into the limestone only as far as the latter is dolomitic and crystalline. The outer portions of the run (in its cross section) contain the galena merely disseminated in the crystalline

limestone, while the central portion of the run is much richer, and often shows very thick seams and pockets of galena, as well as a more completely dolomized, and in places leached, rotten, and disintegrated rock, with layers of dolomite crystals. The length or longest horizontal extent of a run varies from twenty to several hundred feet.

It can hardly be doubted that these runs were formerly vertical fissures in a layer of limestone, limited above and below by chert layers: that solutions of bicarbonate of magnesia attacked the limestone on both sides along the fissure, and converted it, to a greater or less extent, into cracky and porous dolomitic limestone, and often completely into dolomite. A diminution of volume in the mass of the rock is always connected with such dolomization, and the pores, cracks and cavities thus produced gave the mineral solutions an opportunity to deposit the ores in them. The occasional occurrence of disseminated ores with well developed crystals entirely inclosed by the dolomitic rock, indicates that the dolomization and the deposition of the ores have taken place, in most localities, simultaneously or nearly so, and that the galena has been deposited in the rock while the latter was in a soft or magmatic condition. The absence of galena in the mass of entirely unaltered limestone forbids to think that the galena had been an accessory constituent of the limestone as formed originally. The galena seams are frequently found disturbed and broken in the runs, and are then always accompanied by loose disintegrated masses of coarsely crystalline dolomite, of a rotten appearance. In such places a leaching process has undoubtedly taken place after the deposition of the ore. Waters containing carbonic acid dissolved the purely calcareous portions of the dolomitic rock, leaving behind the crystallized dolomite, which is less soluble. The downward movements in the rock masses, caused by this leaching process, broke and disturbed the ore seams.

Several runs often occur together, and are then mostly parallel to each other and separated by altered limestone. Two, three, and four runs are also occasionally found one below the other, and separated by mostly broken, yet sometimes solid, layers of chert and of limestone.

2. "Openings" are deposits which in their interior construction, and in the character of the materials which compose them, are

quite similar to the "runs" just described: but they differ in their extent and somewhat in their genesis. Their vertical extent, although often as large as that of the runs, does not as a rule reach from one chert layer to another. The openings have generally a chert layer as roof, but the bottom is often an uneven, wavy surface of limestone, somewhat softened and sandy near the opening, and turning rapidly into an intact, hard limestone a few feet below the bottom of the opening.

Horizontally the openings extend not in one direction principally like the runs, but they form continuous beds extending over small districts of irregular outlines, generally several hundred feet in diameter.

The above description throws a light on the genesis of these deposits, showing that the processes of alteration have not started in vertical fissures, in this case, and proceeded sidewise, but that they were started, in horizontal partings of strata, mostly below a chert layer, and have proceeded downward into the underlying limestone layer to a greater or less distance according to circumstances. The alterations themselves are similar to those that produced the runs, and the deposition of the ores seems to have taken place in the same manner.

Numerous such deposits generally occur together, forming larger ore districts, as e.g. that of Granby, which covers a whole section or square mile, as far as known at present. The single deposits are separated from each other by the rising surfaces of the underlying limestone.

We also find in many places two or three such deposits, one below the other, being separated from each other by alternate layers of limestone and chert.

The zinc ores in these "openings" are not uniformly sulphurets like the lead ores, but they are mostly oxidized ores, either silicates or carbonates, and often occur in wavy layers, several feet in thickness.

3. Impregnations of fissured chert beds with lead and zinc ores frequently occur in the vicinity of the runs and openings above described, as well as sometimes alone. The ores are mostly sulphurets, and fill all the larger and smaller vertical and horizontal fissures in the chert beds. They fill them exclusive of any other substance, and in most instances fill them completely. The limit

between the ore and the chert is sharp, and no ore is found in the mass of the chert itself. The chert is hard and unaltered. The galena is as coarsely crystalline in its structure as the respective widths of the fissures would allow, showing that the ore has crystallized out of a very thin solution, which must have filled the fissures for a very long period without interruption.

4. Irregular deposits of galena, in loose accumulations of broken chert, are very frequent, especially in the Joplin district. The whole lower part of Joplin creek valley is filled with such accumulations to a considerable depth, in places to more than 70 feet. The galena found in these loose chert masses is partly old, partly of more recent formation. The former seems to have been deposited, while the chert beds were simply fissured, but not greatly disturbed from their position. Afterwards, when these beds became gradually more and more broken through the transformation and dissolution of the underlying limestones, the galena seams broke down with the chert beds, and the quantity of ore was increased by the addition of all that ore which may have been originally contained in the limestone strata, now removed by dissolution. The galena in these deposits is therefore in part loose, in part adhering to chert fragments. It frequently shows signs of friction and impressions of sharp-cornered chert fragments. The crystals are often compressed, and loose pieces are rounded off. But besides this galena, which was formed in the original strata, in some localities intact and well developed galena crystals occur deposited on all sides of loose chert fragments. This fact shows that the deposition of this ore has continued during the slow destruction of the strata, and that it has continued after the chert was, as it now is, entirely broken up into loose fragments.

5. Seams and impregnations in quartzite represent the fifth and last form of lead and zinc deposits observed in Southwest Missouri. They occur in some localities near Joplin, but are especially represented in the mines of Oronogo (late Minersville). There we find considerable masses of quartz rock, partly distinctly crystalline and composed of either pyramidal or prismatic crystals, partly very fine-grained or subcrystalline. This rock is mostly of gray or of grayish-brown color. It is often impregnated with bitumen, and emits a bituminous odor when broken. It

frequently contains disseminated crystals of zinc-blende, often so fine and numerous that the rock appears impregnated with this mineral. It contains also irregular cracks and pockets filled with galena, and sufficiently large to be worked with great profit. This quartzite must be of much later origin than the chert and the limestone: for it incloses and cements together numerous chert fragments, with which it often forms a conglomeratic rock, and it also incloses larger masses of softened limestone. In several places the quartzite has evidently been infiltrated into loose sandy beds of thoroughly dolomized and entirely disintegrated limestone. In this case the quartz contains numerous rather irregularly disseminated crystals of dolomite, as well as crystals of blende, and occasionally of galena. Such crystals have often been removed afterwards, leaving the quartzite as a porous mass, full of impressions of dolomite and of blende crystals. The cavities formerly occupied by these crystals are sometimes seen filled or lined with carbonate of lead or with silicate of zinc.

It seems evident from the descriptions just given that all these various deposits are the results of certain chemical and geological actions, weak and slow in themselves, but steady and prolonged over many centuries. With the only exception of the valley bottoms, where the action of running water has produced more decided irregularities, the appearance of the lead-bearing rocks is such as to indicate a very slow and gradual settling through the metamorphic action of magnesian solutions and through the dissolving action of acid waters. The settling and breaking down of the strata must have naturally taken place at intervals in many instances, while the deposition of the ores appears to have been continuous.

The fact that thin seams of ore are sometimes found in unaltered limestone indicates that the deposition of the ores may have begun before the metamorphic action. But there was at that time comparatively but little room for ores to be deposited in, and it was only after the partial dolomization of the limestone beds along certain vertical and horizontal fissures that richer ore deposits could be formed. These were at first "runs" and "openings"; and afterwards, after the chert beds became more fissured through the alteration of the interstratified limestone, more extensive impregnations of such chert beds could be formed. The entire disintegration of these chert beds, which took place locally, produced the irregular deposits in loose chert, and finally local infiltrations of quartz into the broken rock-masses, under continued deposition of ores, created the fifth kind of deposits afore described, which consequently must be considered as the latest. The various processes by which all this has been effected must have taken an enormous amount of time for their completion. The dolomization of limestone is naturally a very slow process; so is also the dissolution of limestone, even then when we assume that the waters circulating in the rocks were formerly much more acidic than they are now. Very slow is also the deposition of quartz, because water is capable of dissolving but very little of it. That the deposition of the ores must have been very slow, and must have ensued from exceedingly thin solutions, is shown by the large size of the crystals. In many places the crystals of galena reach a diameter of three inches and more. The subcarboniferous rocks in which these processes have taken place are very old. Their age must be estimated, according to some remarks of Professor Dana in one of his recent publications, at twenty millions of years at the very least. Thus we see that these processes had ample time to take place, even under the supposition that the solutions which effected them were but little, if any, more saturated with acids or with metallic oxides than many of our present spring waters.

From all what I have said on the character of the lead deposits of Southwest Missouri, it appears that these deposits do not fill large vertical fissures, cutting through thickly stratified or through unstratified rocks: they have in no place the slightest resemblance to true veins. But they are spread through the rocks horizontally, and extend, in varying richness, over the whole southwestern part of the State. The layers of rocks in which the ores are found at present lie only from 40 to 120 feet below the surface of the ground, and are therefore much easier to reach and much cheaper to mine than similar ores which occur in some other countries in the form of veins. If we compare the work and the production of a poor Saxon miner, who, at a depth of two to three thousand feet, drills and blasts on a vein often but one or two feet wide, and mostly composed of much hard gangue and but little ore:—if we compare this with the work and the production of a Missouri miner, who works at a depth of perhaps sixty feet in the average, mostly with a simple pick, in loose materials or in softened rock, then we understand equally the immense advantage of the Missouri deposits over regular vein deposits, and the reason of the wonderfully rapid development of lead-mining in this State. As some of the oldest mining districts in the State are as yet far from being exhausted, and as very large territories containing the same rocks as those old districts have been as yet very insufficiently investigated by mining, a further and larger development may be confidently looked for.

Whether, or not, other lead deposits exist below that level in which the present mining operations are carried on, can only be decided by practical investigation. The character of the deposits, as I have described them, does not indicate that they may continue to a great depth, and in various places an entirely barren limestone has been struck below the ore, and has been penetrated to a depth of sixty and a hundred feet without favorable results. But as it happens sometimes that barren and ore-bearing rock formations alternate, this may prove to be so in Missouri, and the future discovery of deeper galeniferous layers is not absolutely impossible, although there is nothing to indicate them at the present time. However this may be, the production of lead ores to be expected from the development of *those* lead-bearing strata which are *at present* known and mined will certainly be more than sufficient to supply and to satisfy the present generation, and there can be no reasonable fear that *we* shall ever see the end of lead-mining in Missouri.

On the Terebratula Mormonii.

By Jules Marcou.

A friend has called my attention to a memoir just out, entitled "On the Carboniferous Brachiopoda of Itaituba, Rio Tapajos, Brazil," by O. A. Derby (Bull. Cornell Univ. Science, vol. i, No. 2), in which a small Terebratula is described under the name *Eumetria* (Hall) *punctulifera* Shumard, with the following synonimia:

"*Retzia punctulifera* Shumard. 1858—Trans. St. Louis Acad. Sci vol. i. p. 220. Meek, 1872, Final Report of Geol. of Nebr., p. 181, Pl. I. fig. 13; and Pl. V. fig. 8. *Terebratula Mormonii* Marcou, 1858. Geol. of N. Am. p. 51, Pl. VI. fig. 11."

Questions of priority have been settled hitherto by dates and a strict adherence to truth. If these principles are abandoned, the fancy or preference of the writer will form the only ground of decision. It is because such principles are involved in this case, that it is well to bring the matter before naturalists, every one being interested in upholding, with the greatest care and exactness, questions of priority as a vital matter in classification.

Prof. Derby's synonimia is copied verbatim, with the exception of the genus *Retzia* King, being replaced by the genus *Eumetria* Hall, from Mr. F. B. Meek's "Report on the Palæontology of Eastern Nebraska, with some Remarks on the Carboniferous Rocks of that District" (see "Final Rep. of the U. S. Geol. Surv. of Nebraska, by F. V. Hayden"), who says, p. 182, "I am in doubt whether Dr. Shumard's name, *R. punctulifera*, or Prof. Marcou's name, *Terebratula Mormonii*, for this shell, has priority, both having been published in 1858. If Prof. Marcou's name was published earlier in the year than Dr Shumard's, it would of course have to be retained. If the two names, however, were published exactly at the same date, or so near it as to leave the question of priority in doubt, the name *punctulifera* should be retained, as it was proposed along with a much better description, and with a correct knowledge of the affinities of the shell." So Mr. Meek cuts short his doubts first expressed and adjudges the priority to Dr. Shumard. It is just to say that the late Dr. Benj. F. Shumard has never questioned my priority, and that Mr. Meek put forward his claim several years after his death.

My "Geology of North America," which contains *Terebratula Mormonii*, was published in Zurich, Switzerland, in February, 1858; see the date of the letter of dedication to the late Prof. L. Agassiz, p. vi. Dr. Shumard's memoir, entitled "Descriptions of New Fossils from the Coal Measures of Missouri and Kansas, by B. F. Shumard and G. C. Swallow," was read at the meeting of March 8, 1858, of the St. Louis Academy of Science, and referred on motion to the committee on publication, and it did not appear in print until the beginning of June, 1858, as may be seen in the Trans. of the Acad. of Sci. of St. Louis, vol. i. pp. 113 & 309. As regards priority there cannot be any doubt.

Mr. Meek also claims that Shumard's description is "much better, and with a correct knowledge of the affinities of the shell." At the same time, Mr. Meek carefully avoids saying a single word about drawings. Dr. Shumard's descriptions are *without* figures: I give four different views of a very fine specimen, and, I may add, good figures, well drawn by the artist. Besides, I have so well recognized "the affinities of the shell," that I say, "This species resembles much the *Terebratula radialis* Phillips." Mr. Meek repeats my opinion almost verbatim, saying, "Specifically, this form is related to *Retzia radialis* Phillips." However, that quotation is inexact, for Phillips does not call it *Retzia* but *Terebratula*; and his description is even shorter than mine, for he describes it in half a line, while I give two full lines. By the way, Dr. Shumard did not recognize the affinities with Phillips's species. Of course, Mr. Meek has a perfect right to prefer Dr. Shumard's description and to use the generic name *Retzia*, just as Prof. Derby prefers the generic name *Eumetria*, and Phillips and I the well-known name *Terebratula*. Every one knows that *genera* are not natural sections, but merely convenient groups for the classification of species which do not differ materially; and that no two palæontologists, or zoölogists, agree on *genera*, is a matter of notoriety. I am far from attaching any importance whatever to the almost innumerable *genera* which have been launched during the last twenty years among the *Brachiopoda*.

Mr. Meek has not confined his changing of names to the *Terebratula Mormonii*, and has done the same without explanation for *Orthis Pecosii*, which he calls *O. carbonaria*; *Terebratula Uta*, which for him is *Rhynch. Osagensis*, etc. This putting aside the date of publication, figures of fossils, and descriptions, is to say the least, a very severe attack against the right of priority.

In regard to the "Final Report of the U. S. Geol. Surv. of Nebraska," (Washington, 8vo, 1872,) my name occupies so prominent a place in the criticisms of Mr. Meek that I will say nothing, letting my observations and Prof. Geinitz's descriptions of the fossils stand on their own value. But everybody will be struck with the curious discrepancy between the opinions of Mr. Meek and Mr. Hayden, both of whom agree, in the text, that the Permian (Dyas) does not exist in Nebraska; which does not prevent them, however, from coloring a part of their geological map, accompanying their reports, as having a Permian (Dyas) belt across the State of Nebraska from the Kansas boundary line to the River Platte!

On Climatic Change in Illinois—its Cause.

By Amos Sawyer.

The object I have in view in directing your attention to this subject, is not to defend some pet theory of my own, but in order that older heads than mine may be induced to investigate it, and determine as to the correctness of my views.

The great change which has taken place in our climate has, as a natural consequence, excited our curiosity to try and find out the cause or causes producing this result. I shall, therefore, state the case as witnessed by the writer in this section of Illinois, and attempt to show that the reasons heretofore assigned are not in themselves sufficient to account for the change, but are untenable, or at least not applicable to this part of the country.

During the last twenty years our climate has been slowly but surely changing from wet to dry; and although this change has been beneficial in a sanitary point of view, agriculturally considered, it has, and will hereafter prove to be, a great obstacle to the successful cultivation of our soil. In trying to account for this change, some writers attribute it to the destruction of the forest trees; others, to the cultivation of the soil, which they claim "promotes and hastens evaporation," etc. But the most important agent—one that is yet to produce greater mischief—seems to have escaped their attention: it is the *aqueous*. The chemical and mechanical effects of this agency are constantly at work, and the result is plainly visible in the deepening of the channel of all our small streams.

In the early history of our State, when the wild grass grew rank, and even little ponds had water-basins from three to five feet deep, the process of evaporation was carried on much more slowly than at present, and consequently when the heat became intense during summer there was an immense amount of watery vapor in the atmosphere ready to be condensed in deluging showers upon the slightest change in the temperature.

At the present time all our prairie land is in cultivation, or used as pasture: the ponds and small lakes have become so filled up that they contain less than half the former amount of water: the stock now consumes the reeds and marsh-grass, exposing the water to the direct rays of the sun, thereby promoting evaporation, so that by mid-summer even the muck in their basins has dried to a hard crust, and a change in the temperature during the heated term brings, as a rule, a cool, dry atmosphere instead of rain, as in former years. The large amount of water consumed by our domestic animals, which have increased with the increase of population, must not be overlooked. In this State, at the present time, we have at least three million horses, cattle, and mules, and five million hogs and sheep, and they will consume not less than *seventy million gallons* of water every twenty-four hours—quite a lake of itself.

As I before remarked, it is the *aqueous agent* that is hard at work night and day, summer and winter, overcoming every obstacle placed by nature or man to impede its progress. The work marked out for it to do is no less than the complete drainage of the ponds and lakes of our prairies; and so surely as the world stands, so surely will the task be accomplished in a thorough and workmanlike manner. Every little streamlet has its miniature Niagara Falls: but, unlike their giant relation, they are making *visible* progress every year, and are consequently (strange as the language may seem) more instructive. The "hard-pan," which only yields after repeated blows from the sturdy laborer's pick, and grinds off its steel at the rate of two inches per day, crumbles and gives way under the combined agency of frost and water: the largest trees in the forest yield to the conquering element.

To convey an idea of what I mean, let me give you an account of the progress made during the last quarter of a century by one of these small cataracts, as witnessed by the writer. Spring Branch empties into the Middle Fork of Shoal Creek, near the town of Hillsboro, Montgomery Co., Ills.; it has three large tributaries: the main branch is about four miles long, and its source is a large lake and several small ponds in the same neighborhood. The main stream passes through heavy timber for about three miles, the rest of the distance is prairie, with the usual amount of willows. The original bed of the creek averaged 7 feet wide and 2½ feet deep, but in time of high water it would average 100 feet in width: below the falls it is now 21 feet wide and 9 feet deep, and never overflows its banks; the increased width is therefore 14 ft., and the depth 6½ feet. These falls have travelled over 3,650 yards since 1849, leaving an impassable barrier behind them. It has displaced about 35,680 cubic yards of alluvial soil and clay, 500 cubic yards of gray "hard-pan," and 320 cubic yards of pipe-clay. The above shows an annual average progression of 146 yards, and an annual displacement of 1460 cubic yards, or about *1700 tons*. From 1849 to 1853, or 4 years, it travelled 1650 yards, an average of 412½ yards per year. It required 2 years to work its way through 50 yards of "gray hard-pan"; but like an army long kept at bay, yet finally overcoming the obstacle which for a time prevented its further progress, it rushed on with irresistible impetuosity, and, after causing the downfall of many a mighty monarch of the forest, we find our little Niagara in 1859, or in 4 years, 1500 yards further up stream, showing an advance of 375 yards per year: nearly a fourth of this time, however, was spent in passing 32 yards of pipe-clay. It now passed two of its tributaries, thereby reducing the amount of water nearly one-half: consequently its progress has been less rapid, although the depth remains the same. From 1859 to 1873 it has been working its way through ordinary hard-pan, 450 yards; since January, 1874, it has cut out 50 yards more, the season being very favorable for the work. It now has about 3,000 yards to traverse through the prairie ere it completes its work; yet the task will be comparatively easy, and without a doubt will be accomplished during the next 25 years.

Every little streamlet is bringing its bed down to a level with its parent stream, and the merry rippling of their little cascades greets the ear on every side, and tells you in language not to be misunderstood that they will in time accomplish the work allotted them to perform—the thorough drainage of the land through which they pass: and, when this shall have been accomplished, that it will necessitate some system of irrigation in order to successfully cultivate the soil, I think there can be no doubt; in fact, I think that want is being already felt. Understand me, I do not predict that this country will become a barren waste through lack of rain, but that we will be certain to suffer more and more each year from drouths during the summer months, if we continue to advocate the indiscriminate drainage of our ponds and lakes.

Attention has been directed to the destruction of the forest trees as the main cause, whereas I am convinced it is due to the fact that we have been hard at work for years *bleeding the soil to death*, as it were; for surely water, in one sense, is *soil in motion*. The ponds and lakes are as essential to the vegetable as they are to the animal kingdom: in the first case, it is *indirectly* through the medium of the atmosphere, and is deposited as rain on the earth, where it is absorbed and enters the general circulation; in the other, it is taken directly into the system. These reserve waters are as essential to the agricultural world as bank reserves are to the financial. To compensate for the loss of these natural water-fountains we are obliged to furnish our animals with water from deep springs (wells); but this cannot be done for the vegetable kingdom, hence it suffers. In proof of what I have said, I refer the reader to the more recent results obtained in the Isthmus of Suez, as witnessed by M. Lesseps, the distinguished engineer of the Suez canal, and published as one of the results of that stupendous work. If I remember rightly, he says: "Clouds came up accompanied by thunder and lightning, and rain fell in showers for some distance each side of the canal, where it had never been known to rain before, and greatly to the terror of the natives." Again, in the report made to the French Government by the officers in charge of the artesian wells sunk in the desert, one of the results obtained by these artificial springs was "a free growth of grass, vegetables, trees, and even seeds of plants that had lain dormant in the soil probably for ages, and simply required moisture to awaken them to life and splendor. Even here in these artificial oases we find they are blessed with occasional showers."

In regard to our own arid plains, and the efforts being made by the General and State Governments to overcome this great obstacle to their cultivation, I think too much importance is attached to the supposed influence of trees, although I admit they they are valuable, and really necessary as wind-breaks, fuel, etc.; but by forming a series of artificial ponds and lakes, at short intervals, an immediate change for the better would be noticed in seasonable showers during the summer months: to which may be added the important consideration that this plan is cheaper, and assuredly much more effective than any other that has been suggested. Two men with a plow, road-scraper, and a span of horses or mules, could make two good ponds per week, or at least twenty-four during the season; consequently a fair trial of this plan would cost but little, and might prove beneficial to the whole country.

The change in the climate of Illinois cannot certainly be attributed to the destruction of forest trees, at least in the middle and northern part of the State, for they have increased since the time when, with every annual burning of the prairie, their front lines were scorched and beaten back — the ground, in time, becoming prairie, and assisting in the wholesale destruction of the life it had nourished from its bosom. Now the timber is encroaching on the prairie. and to-day the area of woodland is greater than it was twenty years ago, for in almost every fence-corner in the prairie you will find a vigorous young tree growing; the owners of the land have planted shade and fruit trees; a beautiful line of dark-green marks the useful osage-orange hedge that incloses, divides, and subdivides its owner's land. where, a few years ago, not a tree was to be seen within the field of human vision; and the monotony while crossing these plains was unbroken, save when the graceful deer came bounding across your path, or the sneaking wolf, at some safe distance from his enemy, viewed your passage across his domain. It was a weary, unpleasant, dreaded journey; and no mariner ever strained his weary, anxious eyes to discover the beacon-light which assured him that his reckoning was correct, than the pilot of a "prairie schooner" watched the dull, leaden horizon recede until the blue outline which marks the advanced guard of the timbered land met his view: and the glad shout of "there's a tree!" is only surpassed by the loud, cheering cry of the sailor, when, after a lengthy voyage, he first discovers land.

Inquiry and personal observation have convinced me that the removal of trees from around a "living spring" of water rather increases the flow than otherwise; in no instance has it diminished. One close to my place fills its little channel just as of old, although every tree, for fully a mile in the direction of its source, has been removed, and the ground is in cultivation. This is one of some half dozen similar cases where I have observed the effect. An old man of 80 told me that on his plantation in North Carolina, there was a marshy spot that kept a small stream running part of the year, but in the summer dried up: he cut the trees from all around this spot and cultivated the ground; when, lo! the muddy water that had formerly, by a hard struggle, pushed its way up to the light of day, burst forth in a large, clear stream, apparently invigorated by the light of God's sun, and has continued to furnish an abundant supply, summer and winter, for the last fifty years, although all the adjoining property is now in cultivation.

In summing up—or, in other words, to succinctly mention the various causes which have, combined, produced this change in our climate—I will mention them in the order of their importance, as I view it:

1. The natural and artificial drainage of our ponds and lakes.

2. The increase of our domestic animals, and consequent increased consumption of water and grass, the pastures being quite bare by the first of July, and the ground as dry as a chip.

The cultivation of the soil is rather an advantage than otherwise, in my opinion; for during the night, in hot weather, it becomes cooler than the surrounding atmosphere, and if the earth is loose the air will penetrate it and part of the moisture it contains be condensed, and, as it is protected from the direct rays of the sun, it will not evaporate as rapidly as the dew on the grass, but is retained to nourish the plants growing in the soil; and you will find the ground moist in a well cultivated field, when that of the pasture is as dry as powder.

If the destruction of the forest trees is one of the causes elsewhere, as I before remarked, it will not, I am certain, apply to Illinois; and I very much doubt if it exerts any influence either way,—believing that in those instances where such was thought to be the case, other and more important causes have been overlooked. It appears to me to be another "trout and bucket of water" affair; evidently, some wise man has risen and propounded the question, and all his brother philosophers have been bending their energies to solve the problem, taking it for granted that it has been correctly stated.

Hillsboro', Ills., March 31, 1874.

Iron Manufacture in Missouri.

A General Review of the Metallurgical Districts and their Resources.

By Adolf Schmidt, Ph.D.

In my treatise on the Iron Ores of Missouri, published in the Geological Reports of the State for 1872, I have divided the State into four great ore regions—the Eastern, the Central, the Western, and the Southern.

I. The Eastern region comprises

1. The ore district along the Missisippi River, in Ste. Genevieve, Perry, and Cape Girardeau Counties.
2. The Iron Mountain district, in St. François and Iron Counties.
3. The South-eastern limonite district, in Madison, Iron (southern portion), Bollinger, Wayne, Stoddard, and Butler Counties.
4. The Franklin County district, in Franklin, the northern part of Washington, and the western part of Jefferson Counties.

II. The Central region comprises

5 (1). The Scotia district, in Crawford County.
6 (2). The Steelville district, in Crawford County.
7 (3). The ore district on the Upper Meramec River and its tributaries, in Crawford and Dent Counties.
8 (4). The Salem district, in Dent and Shannon Counties.
9 (5). The Iron Ridge district, in Crawford County.
10 (6). The St. James district, in Phelps County.
11 (7). The Rolla and Upper Gasconade district, in Phelps and Pulaski Counties.
12 (8). The Middle Gasconade district, in Phelps and Maries Counties.
13 (9). The Lower Gasconade district, in Osage and Gasconade Counties.
14 (10). The Callaway County district, in Callaway and Boone Counties.

III. The Western or Osage region comprises

15 (1). The Lower Osage district, in Cole (eastern part), Osage (western part), and Miller Counties.
16 (2). The Middle Osage district, in Camden, Morgan, and Benton Counties.
17 (3). The Upper Osage district, in St. Clair and Henry Counties.

IV. The Southern region comprises

18 (1). The White River district, in Greene and Christian Counties.
19 (2). The Ozark County district, in Ozark and Douglas Counties.

The divisions as given above will be used in the present essay. Two districts, however, which do not contain any ores themselves, but which have nevertheless become very important manufacturing centres, will have to be added, namely,

V. The manufacturing districts of St. Louis and Grand Tower. The former of these two districts is partially, the latter wholly, situated in the State of Illinois, but both use Missouri iron ores almost exclusively.

It is intended to give in the present essay a brief review of the five industrial regions above mentioned, in regard to their location and extent, to their means of inter-communication, to their resources for the iron manufacture, and, finally, in regard to the actual development of these resources, according to our present stage of information.

I. EASTERN ORE REGION.

Extent.—The Eastern iron Ore Region of Missouri extends over the following counties, in which iron ores are known to exist, namely: Butler, Stoddard, Bollinger, Cape Girardeau, Wayne, Reynolds, Iron, Madison, Perry, Ste. Genevieve, St. François, Washington, Jefferson, and Franklin.

Means of Communication.—The Franklin County district has its commercial outlet over the Atlantic and Pacific railroad, through the stations Moselle, St. Clair, and Stanton. The iron ores of Ste. Genevieve, Perry and Cape Girardeau Counties will have to be shipped from various points on the Mississippi.

All the other districts in the Eastern region are situated along the St. Louis and Iron Mountain Railroad. This road, after leaving St. Louis County, and passing near a few iron ore deposits in Jefferson and Washington Counties, divides into two branches at the station of Bismarck. A few miles further south the western branch reaches the Iron Mountain district with its specular ores, in Southern St. François and Northern Iron Counties, and afterwards runs through the western half of the south-eastern limonite district, through Southern Iron County, through Wayne and Butler Counties, and thence farther south into the State of Arkansas. At Poplar Bluffs, in Butler County, it joins the Cairo, Arkansas and Texas Railroad, which runs eastward to the Mississippi River, and thus forms another outlet for the mining districts of

Butler, Wayne and Stoddard Counties. The eastern branch of the St. Louis and Iron Mountain Railroad intersects the eastern part of these districts, especially the iron fields in Madison and Bollinger Counties, to join the Mississippi at Belmont.

Resources and their Development.—The natural resources of the different districts of the Eastern Ore Region are very different.

1. The district along the Mississippi River, in Ste. Genevieve, Perry, and Cape Girardeau Counties, has been, as yet but little investigated and opened. Some mining has been done in Perry County, a few miles below and opposite Grand Tower, and some of the limonite ores found were shipped to the latter place to be smelted. But no larger and reliable deposits have been discovered in that district, so far as can be judged from present data. It appears that this district is provided with an abundance of fuel, as it contains extensive tracts of fine timber-land, and being also situated in pretty close proximity to the Big Muddy coal fields of Illinois; but the quantity of iron ores, as known at present, would not justify the erection of iron-works. The ores may, however, be mined and shipped on the Mississippi to Grand Tower, South St. Louis, or up the Ohio River. An iron industry might develop itself successfully in this district if it was connected by one or two railroad lines with the Iron Mountain district, which abounds in ores, but lacks fuel. Such a railroad line has been projected, running from Iron Mountain over Farmington to St. Mary's on the Mississippi River, but it has not yet been built. It would undoubtedly contribute largely to the development of both districts.

2. The Iron Mountain district, in Southern St. François and Northern Iron Counties, is probably the richest district in iron ores in the State. The ores are mostly specular, and in part of great purity, and yielding the highest percentages of pig-iron in the furnaces. The mines are developed in a considerable degree. Iron Mountain, Pilot Knob, and Shepherd Mountain especially, have been worked continually for a number of years, and have produced very large quantities of iron ore, which were partly smelted with charcoal in the district, partly exported to South St. Louis and Grand Tower, as well as up the Ohio River into Southern Illinois, Indiana, Ohio, and Pennsylvania. This refers principally to the Iron Mountain ore, which on account of its

richness and hardness is specially adapted for export. The Iron Mountain district contains also considerable areas of either good or fair timber-land, which has been sufficient so far to supply with charcoal four blast-furnaces now existing in this district. One of these furnaces is located at Irondale, two at Iron Mountain, and one at Pilot Knob. The supply of charcoal fuel seems, however, to become more difficult from year to year, and is certainly insufficient to allow any larger development of the iron manufacture in the district. This difficulty could only be overcome by a direct communication by railroad with the Mississippi River, and thereby with extensive well-timbered districts, as well as with the coal fields of Western Illinois. A particular advantage might thereby be gained by the Pilot Knob Company. This company owns deposits of iron ore specially adapted to the manufacture of Bessemer pig, as I have already shown in some previous publications, and owns also deposits of manganesic iron ore adapted to the manufacture of spiegeleisen, required in the Bessemer process. Thus the lack of fuel seems to be the principal impediment to the erection in that vicinity of a Bessemer establishment, which would undoubtedly be one of the most successful and lucrative.

3. The South-eastern Limonite district contains numerous limonite deposits scattered over Madison, Bollinger, Iron, Wayne, Stoddard, and Butler Counties. The ores are mostly well adapted, after being calcined, to produce a good foundry iron. The whole district is pretty richly timbered, and contains several large streams. running from north to south, such as Whitewater, Castor, St. François, and Black Rivers, besides numerous smaller branches. It is also intersected by three railroad lines;—two branches of the Iron Mountain Railroad connect it with the city of St. Louis on the north, and with the States of Arkansas, Tennessee. and Kentucky, on the south; while the Cairo, Arkansas, and Texas Railroad forms the directest route from the western portion of the district to the Mississippi. As over one hundred deposits of iron ore have been pointed out in this district—partly in the Geol. Reports for 1872, by myself, and partly in the Geol. Reports for 1874, by Mr. P. N. Moore—it can hardly be doubted that this district will be able to feed several blast-furnaces for a considerable number of years. The fuel is abundant and the

markets are of easy access. Some mining was done at a few banks in Madison, Bollinger, and Butler Counties, and the ore was shipped in part to Iron Mountain, Pilot Knob, Irondale, and South St. Louis, to be mixed with specular ores and thus smelted; another part was shipped to the Mississippi and thence boated up the Ohio River into other States. But, on the whole, this district is as yet but little developed.

4. The Franklin County ore district is situated on the Atlantic and Pacific Railroad line, and may be divided into two subdistricts, one of which is found south of the station of Moselle, the other south-east of the station of Sullivan. Both are well timbered. In the Moselle subdistrict limonite ores have been found exclusively. About ten years ago a charcoal furnace was built half a mile south of Moselle station. This furnace is known as the Moselle Iron Works, and is yet in successful blast for the greater part of every year, although for the last few years most of the ores smelted were brought from various deposits of specular ore in the Central Ore Region, and mixed with the Moselle limonites, as the latter do not occur in very large quantity. The Sullivan subdistrict contains some specular ores besides the limonites, and thus forms the transition from the Moselle limonite district into the specular ore region of Central Missouri. A few of the ore-banks only are situated in Franklin County, most of them being across the southern county line in the N.W. corner of Washington and in the N.E. corner of Crawford Counties. At the time when I visited that district in 1872, the mining operations had not proceeded far enough to disclose a well secured supply of ore for a blast-furnace; but I am informed that new discoveries of value have been made there since. A charcoal blast-furnace was also erected in the N.W. corner of Washington County. This furnace, called the Hamilton Iron Works, went first into blast in October, 1873.

II. CENTRAL ORE REGION.

Extent.—The Central Iron Ore Region of Missouri includes the following counties: Crawford, Dent, Shannon (northern half), Phelps, Pulaski, Gasconade, and the eastern parts of Maries and Osage; to which may also be added Callaway County on the north side of the Missouri River. The main portion of this region is limited in the east by a line which nearly coincides with the boundary between Crawford and Washington Counties, and in the west by the dividing ridge between the Gasconade and Osage waters. I hardly need to remark that these divisions are more or less arbitrary, and have been adopted merely for the sake of convenience, and for the greater precision they give to our geological and metallurgical descriptions. These divisions were made, however, with due reference to the existing means of intercommunication, so as to group together as far as possible such districts as have at the present time about the same commercial outlets for their products.

Means of Communication.—The central portion of this important iron region is opened to commerce by the Atlantic and Pacific Railroad, which runs from N.E. to S.W. through the northern parts of Crawford, Phelps, and Pulaski Counties; and by the St. Louis, Salem, and Little Rock Railroad, which branches off from the Atlantic and Pacific at Cuba City and passes through the rich ore districts of Crawford County, terminating at present at Salem in Dent County.

As the Gasconade River is navigable to a limited extent only, the iron districts in Gasconade and Eastern Osage Counties are as yet of difficult access. Their nearest line of communication is now the Missouri Pacific Railroad, which runs from east to west along the southern bank of the Missouri River, or else the Missouri River itself.

Callaway County is intersected from north to south by the railroad from Mexico to Jefferson City.

Resources and their Development.—The largest part of the southern half of the Central iron region in Crawford, Dent, Shannon, and Phelps Counties, is next to the Iron Mountain district the richest in the State, containing very numerous and valuable deposits, some of which rival in size those of Pilot Knob. The ore is here almost everywhere specular, mixed with soft red hematite. This kind of ore reaches westward to the Upper Gasconade into Pulaski and Maries, and even across the dividing ridge into the Osage region in Miller County. All these districts have, besides the ore, an enormous supply of hard timber well adapted for charring, and are irrigated by the Meramec and Gasconade Rivers and their tributaries. Four successful iron works are already established in the most favored parts of this region, three at various places along the Meramec River—namely, the

Scotia Iron Works, 9 miles south of Leasburgh station; the Meramec Iron Works, 7 miles south of the St. James station; and the Midland Furnace, near Steelville;—the fourth works are the Ozark Iron Works, situated at Ozark station, on a branch of the Upper Gasconade River. All these are well selected spots for the iron manufacture. There are, however, many more such spots in this region, and the supply of ore would be sufficient for a considerable number of additional furnaces. At present nearly all the ore from the largest and best deposits is exported to St. Louis, Illinois, Indiana, and Pennsylvania, while at the same time cheap fuel abounds and lies idle in the immediate vicinity of the ore-banks. This is evidently an unnatural and unfavorable condition of affairs, which should be remedied by the erection of more furnaces, so that more labor and population will be drawn into these districts, and that the State may enjoy the full benefit of its own resources.

As to the northern portion of the Central Iron Region, composed of Gasconade County and the eastern half of Maries and Osage Counties, it may be said that fuel and water abound, and that especially in Osage County a considerable number of limonite deposits are known to exist. In several localities some practical work has been done. But no general geological investigation has as yet been made which alone could furnish the data necessary to judge of the industrial importance of the district as a whole. Many of the deposits seem to be too remote from the railroads—the Missouri Pacific as well as the Atlantic and Pacific—to make their transportation to any of the existing blast-furnace works profitable at the present time. If, however, private reports may be relied on, there must be ore enough in these districts to supply a few charcoal furnaces.

Somewhat less rich in timber, because more cultivated, is the Callaway district, whose ore-banks present a favorable appearance, but are not sufficiently opened to be judged in regard to their metallurgical value.

III. WESTERN ORE REGION.

Extent.—The Western Iron Region of Missouri extends principally along the Osage River, over the counties of St. Clair, Henry, Benton, Morgan, Camden, Miller, Cole, and over the western portions of Maries and Osage Counties. The dividing ridge between the Osage and Gasconade waters may be taken as the eastern limit of this region, which limit separates it from the Central Ore Region, just described.

Means of Communication.—The principal medium of communication of this Western Iron Region is at present the Osage River, which is navigable from its mouth, near Osage City, to Warsaw (Benton County), during the larger half of every year. Freight steamers are now running regularly between Osage City and Linn Creek (Camden County), and are soon expected to extend their trips as far as Warsaw. The southern parts of Camden and Miller Counties are also accessible from the Atlantic and Pacific Railroads, while the most northern parts of Cole and Osage Counties are in contact with the Missouri Pacific Railroad and with the Missouri River.

A narrow-guage railroad has, besides, been planned for some time, and is partially built, running from Jefferson City over Russelville to Versailles (Morgan County), and thence to Warsaw (Benton County). The idea of completing this railroad was lately taken up once more by a company at Jefferson City, and it may be hoped the plan will soon be carried out practically. This would open not only the lead districts of Cole and Morgan, but also the iron fields of Benton, Henry, and St. Clair Counties, and make them of easier access than heretofore. The nearest railroad to the last named districts is at present the Missouri, Kansas and Texas R.R.

Resources and their Development.—In the Lower Osage region, between Tuscumbia and Osage City, by far the greater part of the iron ore seems to lie south of the Osage River. A few banks are, however, known north of it in Cole and Northern Miller Counties. The western half of Osage County, situated along the Osage River, is, as far as known at present, less rich in iron ore than the eastern half, situated along the Gasconade River. The richest known iron district on the Lower Osage is in Southern Miller County, including a strip of Maries County along its western boundary. About forty deposits are known at present in this district. The ores are both limonites and specular, the former occurring more frequently within a few miles of the river, while the specular ores are found in greater abundance in the south-eastern corner of Miller County and in the adjacent portion of Maries County. Several of these deposits have been opened by practical work, and show considerable quantities of iron ore. (The location of the various banks is shown on my map of the Lead Region of Central Missouri, published with the Geol. Reports of the State for 1874.) Good hard timber is plentiful over the whole district, and is especially fine and large in the Osage bottoms. Favorable furnace-sites also exist on the Osage, as well as in some well-watered portions of the highlands.

The remarks just made in regard to timber and furnace-sites may be applied with equal propriety to the Middle Osage district between Tuscumbia and Warsaw, and to the Upper Osage district above Warsaw. In both these districts numerous larger and smaller deposits, principally of limonite, are scattered over the country within about ten miles on both sides of the Osage River. Camden County contains, besides the limonites, some deposits of specular ore; and the Upper Osage district contains, besides the limonites, limited beds of red hematite. A few only of these various deposits have been opened by practical work: but a look at the ore-bank map, published with the Missouri Geol. Report for 1872, will show that the number of deposits is so large as to warrant a good supply of ore for at least a few charcoal furnaces. The furnaces should, however, be built on the bank of the river, so that they may draw their supplies from any part of the whole district without great expense, and also that they may have a greater facility for shipping their products. Linn Creek, Warsaw, as well as numerous spots between these two towns on the river, would be well suited for the purpose. One furnace, called the Osage Iron Works, was built in 1872 on Boulinger Creek, 12 miles north-west of the town of Linn Creek, in Camden County. Although unfortunately located at some distance from the river, and in a part of the country where ores are not very abundant, this furnace was in successful operation until the late financial crisis.

The construction of the railroad above mentioned, from Jefferson City to Warsaw, will give this latter place considerable advantages for the manufacture and shipment of pig-iron.

IV. SOUTHERN ORE REGION.

Several deposits of limonite ore have been reported by B. F. Shumard in Ozark and Douglas Counties, on the North Fork of White River, and several others are known in Christian and

Greene Counties. But a thorough investigation of these districts with special reference to iron ores has not yet been made; no reliable judgment can therefore be formed regarding their industrial importance. The name of Southern Iron Ore Region of Missouri has been given to these districts because some iron ore deposits are known to exist there, and because the similarity of the geological formation with that of other iron districts gives hope that more of such deposits may yet be found, and, finally, because these deposits are too remote from all the other districts to be grouped with any of them.

V. THE MANUFACTURING DISTRICTS OF ST. LOUIS AND GRAND TOWER.

St. Louis, including South St. Louis (formerly called Carondelet) and East St. Louis (situated on the eastern bank of the Mississippi in Illinois), has become a very important centre for iron manufacture within the last eight or ten years, although neither iron ore nor coal fit for iron-smelting is found anywhere in this vicinity. This has been mainly effected through the facilities of communication with the Missouri ore deposits on the one side, and with the excellent industrial coal of Illinois on the other. The fact that these facilities are increasing every year opens promising prospects for a yet grander development of the St. Louis iron industry in the future. Since the completion of the great bridge across the Mississippi, St. Louis and East St. Lou's may be considered as one large industrial complex. This complex is at present connected with the South-eastern ore region through the Iron Mountain Railroad, with the Central Missouri ore region through the Atlantic and Pacific Railroad, and with the Western ore region through the Osage and Missouri Rivers. It is also connected in Illinois with the bituminous coal of Belleville by the St. Louis and Cairo Short-line, and with the Big Muddy field, with its excellent industrial coal, by three routes, namely, the St. Louis and Cairo Short-line, the Cairo and St. Louis narrow-guage road, and by the Mississippi River in conjunction with the Grand Tower and Carbondale Railroad.

Excellent coke can be and is obtained at fair rates from beyond Pittsburg, Pa., partly by the several railroad routes, but mainly by river, the boats being tugged down the Ohio to its mouth and then up the Mississippi. Limestone suitable for fluxing iron ores in the blast-furnace is abundant in the vicinity of St. Louis, as it is also in almost all parts of the State south of the Missouri river.

St. Louis district, as above defined, contains at present the following larger establishments for the manufacture of pig-iron, or of wrought-iron:

Vulcan Iron Works, at South St. Louis, with three blast-furnaces and one large puddling and rolling mill.
Jupiter Iron Works, at South St. Louis, with one large blast-furnace.
South St. Louis Iron Works, at South St. Louis, with two blast-furnaces.
Missouri Furnace Works, at South St. Louis, with two blast-furnaces.
Helmbacher Forge, at South St. Louis, with a puddling and rolling mill
Laclede Rolling Mill, in the northern suburbs of St. Louis.
Meier Rolling Mill, at East St. Louis, Ills.
Bessemer Iron Works, at Bessemer, Ills., opposite South St. Louis, with two blast-furnaces.

There are, besides the above, several important forges and mills producing wrought-iron for the manufacture of various specialties. such as McDonald's Steam Forge, at South St. Louis; the Harrison Wire Works, in Western St. Louis; and the St. Louis Nut and Bolt Works, at East St. Louis, Ills.

The manufacture of coke from Illinois coal has been started in East St. Louis. This branch of industry is well worth the attention and support of both the pig-iron manufacturers and the owners of Illinois coal mines; of the former, because it makes them less dependent on the supply from distant Pennsylvania, and may therefore become of very high importance to them in certain easily imaginable emergencies. The erection of large and efficient coke-works would be also advantageous to the owners of coal mines in Illinois, because coke-works can use up all the fine coal and pay a fair price for it, while without them the price of slack-coal will naturally decrease in proportion to the production of coal in general, and will finally, in places, become entirely unsalable. As it has been practically proved at the coke-works of East St. Louis, and of Grand Tower, that the Big Muddy coal, as well as the coal from an extensive district north and east of the Big Muddy field, is able to produce a good furnace-coke, a well arranged and well conducted coking establishment must necessarily become a successful enterprise, provided that reasonable terms can be obtained from the railroads for the transport of coal-slack and of coke. The most available place for the erection of coke-works is undoubtedly near each mine, because no freight has then to be paid on the large percentage of dirt which the slack often contains, nor on the volatile substances which are separated from the coal in coking. Often, however, the production of slack at a coal mine is not large enough to feed a separate coking establishment: therefore, coke-works may also be established in such places where they can with facility draw their raw material from a number of mines. Such works should generally be located as near as possible to the furnaces that use the coke, and for such establishments East St. Louis is undoubtedly a favorable locality.

I will add a few remarks on the Grand Tower district of Illinois. This district receives the ores for the manufacture of pig-iron almost exclusively from Missouri, especially from the Iron Mountain district (Iron Mountain and Pilot Knob) and from Central Missouri. The ores are shipped over the Iron Mountain Railroad to a point on the Mississippi River south of the city of St. Louis, and are thence taken by boat to Grand Tower. The latter place is situated in Jackson County, Ills., immediately on the river, and is connected by the Grand Tower and Carbondale Railroad with the extensive beds of excellent coal, which have been opened and worked for some time, at several points along the Big Muddy Creek and north of it, and which are known to extend considerably towards the north and east. The coal is of such a quality that it may be used in the blast-furnace raw, while at the same time it is well adapted for coking, and makes a pretty good furnace-coke.

There are at present two iron works at Grand Tower, namely, the Grand Tower Iron Works, consisting of two blast-furnaces and one coking establishment; and the Big Muddy Iron Works, consisting of one blast-furnace. Both are situated close to the Mississippi River, and are in immediate connection with the railroad-net of Illinois through the Grand Tower and Carbondale line, which latter intersects the Big Muddy coal-field.

CONCLUSION.

From the general review just given it may be seen that the iron industry of Missouri, although not unimportant at present, is capable of considerable further development. Let us hope that a time favorable for this will soon come.

Remarks on CANKER-WORMS *and Description of a new genus of Phalænidæ.*

BY CHAS. V. RILEY.

[Read Oct. 18, 1875.]

From the time when Wm. Dandridge Peck published (in 1795) his essay on the Canker-worm, which received a prize from the Massachusetts Society for Promoting Agriculture, up to the year 1873, all writers on the subject spoke of the THE Canker-worm under the impression that there was but one species. Nevertheless two very distinct species have been confounded under this name. The first intimation we have of there being two species is where Harris—after describing at length, as THE Canker-worm Moth, not the species first called the Canker-worm by Peck, but the larger species (*pometaria*) here treated of—uses the following language: "Specimens of a rather smaller size are sometimes found, resembling the figure and description given by Prof. Peck, in which the whitish bands and spots are wanting, and there are three interrupted, dusky lines across the fore-wings, with an oblique, blackish dash near the tip. Perhaps they constitute a different species from that of *the true Canker-worm moth.* Should this be the case, *the latter* may be called *Anisopteryx pometaria.*"* The portions of this passage which I have italicized are well calculated to mislead, for the term "true Canker-worm Moth," should only apply, in justice, to that described as such by Prof. Peck, and not, as Harris here applies it, to the other species. Indeed, most subsequent writers, including Fitch, Packard, Mann, and myself,† were misled by the language, and took it for granted that the name *pometaria* was proposed for the smaller form—a mistake first clearly pointed out by Mr. H. K. Morrison, of Cambridge.‡

So long as the male moths only were carelessly compared, there was always a question as to whether the differences were varietal or specific—1st, because the general resemblance is strong; 2nd, because each species varies considerably both in size and ornamentation; 3rd, because the wing-scales, especially

* *Insects Injurious to Vegetation*, 3rd ed. p. 462.
† *Vide* Fitch, Rep. III. § 38; Packard's *Guide*, 3rd ed. p. 324; Mann, Proc. Bost Soc. Nat. Hist., xv. p 382.
‡ Proc. Bost. Soc. Nat. Hist., vol. xvi. p. 204.

of one species, easily rub off, and perfect specimens, captured at large, are uncommon. More careful comparisons made in 1873 by Mr. Mann (*loc. cit.*) between both sexes, established the specific differences of the two; and further comparisons, by myself,* of the preparatory states, showed these differences to be still more remarkable than had been supposed. During the present year I have been able to make still more careful comparisons, which show the two insects to be so very distinct that they must be separated generically. These differences are set forth in the following comparative columns. They show that *pometaria* alone can be retained in the genus *Anisopteryx*, and for *vernata* I have, therefore, erected a new genus, *Paleacrita*.

PALEACRITA VERNATA.	ANISOPTERYX POMETARIA.
Egg.	
Elliptic-ovoid, the shell of delicate texture and quite yielding; generally appearing shagreened or irregularly impressed; nacreous, and laid in irregular masses in secreted places. (Fig. 14. *b.*)	Squarely docked at top, with a central puncture and a brown circle near the border; of firm texture, and laid side by side in regular rows and compact batches, and generally exposed. (Fig. 18, *a. b, c.*)
Larva.	
No prolegs on joint 8. (Fig. 14. *a.*)	With a pair of short but distinct prolegs on joint 8. (Fig. 18, *f.*)
Head distinctly mottled and spotted, the top pale, and two pale transverse lines in front.	Head very indistinctly spotted, and dark on top.
Body with eight superior, narrow, pale, longitudinal lines barely discernible, the two lowermost much farther apart than the others.	Only six superior, broad, and very distinct pale lines, those each side equidistant.
Dorsum pale, with median black spots; subdorsal region dark; stigmatal region quite pale.	Dorsum dark, without ornament; subdorsal region pale; stigmatal region dark.
Piliferous spots quite visible and large on joint 11, where the pale lines generally enlarge into white spots immediately in front of them.	Piliferous spots subobsolete.
When newly hatched *dark* olive-green or brown, with black shiny head and cervical shield.	When newly hatched *pale* olive-green, with very pale head and cervical shield.

* 7th Mo. Ent. Rep., pp. 80–88.

Chrysalis.

VERNATA.

Formed in a simple earthen cell, the earth compressed, and lined with very few silken threads so as to form a fragile cocoon, which easily breaks to pieces.

MALE — Sparsely and shallowly pitted. Pale grayish brown, with a greenish tint on the wing-sheaths, which extend to the posterior edge of the 5th abdominal joint: abdomen with the spine at tip generally simple, and only occasionally slightly bifurcate.

FEMALE — With wing-sheaths, but, compared with those of the male, thinner and extending only to posterior edge of the 4th abdominal joint: much more robust and more arched dorsally, with the mesothoracic joint shorter, and much reduced in size. Pitted like the male. (Fig. 17.)

POMETARIA.

Formed in a perfect cocoon of fine, densely spun silk of a buff color, interwoven on the outside with particles of earth; never breaking open except by force or purpose.

MALE — Not pitted. Darker brown than *vernata*; the wing-sheaths, as in *vernata*, reaching to the 6th abdominal joint; the anus more blunt and with the spine more dorsal, decurved, and always bifurcate, the prongs spreading and often long and fine. (Fig. 21, *a*.)

FEMALE—Differs from the male in the same way as *vernata*, but is relatively stouter and more arched dorsally: a broad, dusky, dorsal stripe often visible toward the time of issuing—all the more remarkable that there is no such stripe on the imago, whereas in *vernata*, where the imago has such a stripe, it is not indicated in the chrysalis. (Fig. 21, *b*.)

Imago.

VERNATA.

MALE—*Palpi* very short, but distinctly 2-jointed.

Antennæ with not quite 40 joints, the longest more than twice as long as wide, each with *two pairs* of hair fascicles, springing from very slight, lateral elevations, the longest hair about thrice the diameter of joint. Looking from above, with ordinary lens-power, these hairs give the appearance of fine, ciliate pectinations. (Fig. 15, *c*.)

Abdomen with the first seven joints bearing each two transverse dorsal rows of stiff, reddish spines, pointing posteriorly.

POMETARIA.

MALE—*Palpi* rudimentary with joints indistinguishable.

Antennæ with over 50 joints, the longest not twice as long as wide, each with *one pair* of fascicles of slightly curled hairs, the longest about thrice as long as the diameter of the joint, and all springing from a prominent, dark hump which occupies the basal half of the joint beneath, and gives a somewhat serrate appearance from the side. The same appearance of ciliate pectinations looking from above. (Fig. 19, *c*, *d*.)

Abdomen without spines and often with a moderate anal brush

VERNATA.	POMETARIA.
Wings delicate, silky, semi-transparent, transversely striate, the scales short and very loosely attached.	*Wings* less transparent, more glossy, not striate, the scales on an average longer and more firmly attached.
Front-wings with costal and subcostal veins well united, with the discal cross-vein partially open, and but *two* short costal branches, the superior veins straight.* (Fig. 15, *a*.)	*Front-wings* with costal and subcostal less closely united, with the discal cross-vein well closed, and with *three* costal branches. All the veins 7–11 are more distinctly separated and the superiors more curved, veins 9 and 10 forming an open areolet near the disc: the apex more produced. (Fig. 19, *a*.)
Upper surface brownish-gray.	Upper surface also brownish-gray, but somewhat darker, with a purplish reflection.
Crossed by three jagged, dark lines, sometimes obsolete except on the submedian and median veins, and on the costa where they are always distinct and divide the wing into four subequal parts. No white costal spot. (Fig. 16, *a*.)	Crossed by two less jagged, whitish bands, the outermost suddenly bending inwards near costa, where it forms a pale, quadrate spot, relieved by a darker shading of the wing around it: the bands sometimes so obsolete as to leave only this pale spot; but more often relieved on the sides toward each other by a dark shade, most persistent on the veins. (Fig. 20, *a*.)
A pale, jagged, subterminal band, corresponding in some degree to the outermost band in *pometaria*, but running out to apex, where it is always sharply relieved posteriorly by a dark mark, and often the whole length by dusky shadings.	No such band.
Hind-wings with the costal vein bifurcating at, or but little beyond, the discal, and with the independent or vein 5 faint.	*Hind-wings* with the costal vein bifurcating considerably beyond the discal, which is strongly elbowed; vein 5 quite strong. (Fig. 19, *b*.)
Color pale-ash or very light gray, with a dusky discal dot.	Grayish-brown, with a faint blackish discal dot.

* A microscopic examination shows the venation in *vernata* to be on the same plan as that in *pometaria*. The difference is that in *vernata* the costal vein is feeble and generally obsolete at its termination, and all the veins 7–12 are more closely united with the costal than in *pometaria*.

VERNATA.	POMETARIA.
No white band, and rarely any marginal dots.	In most specimens a curved white band runs across the wing, and the veins inside this band and on hind border are generally dotted.
Under surface with a more or less distinct dusky spot on each wing, the front wing having in addition a dusky line along median vein and spot on costa toward apex. No pale bands.	*Under surface* with a dusky discal spot on each wing, and with the outer pale band on upper surface of front-wings as well as that of the hind-wings showing distinctly, the former relieved by a dusky spot inside at costa.
FEMALE—*Antennæ* generally with but few more than 30 joints, the longest about thrice as long as wide, faintly constricted in middle, and pubescent. (Fig. 16, *c.*)	FEMALE—*Antennæ* with over 50 joints, the longest hardly longer than broad; uniform in diameter; without pubescence. (Fig. 20, *c.*)
Body and legs pubescent, clothed with whitish and brown, or black, dentate scales or hairs; general coloration not uniform. Crest of prothorax and mesothorax black. A black stripe along the middle of the back of the abdomen, often interrupted on the second to seventh joints, with a whitish patch each side of its front end. (Fig. 16, *b.*)	*Body and legs* smooth, clothed with glistening brown and white truncate scales intermixed, giving it an appearance of uniform shiny dark ash-gray: somewhat paler beneath. (Fig. 20, *b*, *d.*)
Abdomen tapering rather acutely behind, and with an exsertile, two-jointed, conspicuous ovipositor.—(Fig. 16, *e.*)	*Abdomen* tapering rather bluntly behind, without exsertile ovipositor.
Two rows of spines on back of the first seven joints more prominent than in the male, and often giving the dorsum a reddish aspect. (Fig. 16, *d.*)	No spines on abdomen.
Of a rather smaller size than *pometaria*, the wings of the male expanding from 0.86–1.30 inches, and the female measuring 0.20–0.35 inch in length.	The wings of the male expand from 1.05–1.35 inches; and the female measures 0.25–0.40 inch.

From the above detailed descriptions of the two species it is evident that, as already remarked, *pometaria* alone can be referred to the genus *Anisopteryx*, and this doubtfully. It agrees with the European species of the genus in the principal pterogostic characters, obsolete tongue, and rudimentary palpi; and is, indeed, the analogue of the well known *æscularia*. Yet in the antennal characters of the male, and especially in the basal hump on each joint, it agrees more nearly with the typical species of the genus *Hybernia* as characterized by Guenée. Again, so far as we now know, it differs from *Anisopteryx* in the additional pair of prolegs in the larva, and in the more distinct areolet in the front-wing. I can find no detailed account of the early states of any of the European species of the genus, though in none of the descriptions of the larva at my command is any mention made of additional prolegs. Mr. Geo. T. Porrit, who particularly describes the larva of *A. æscularia*,* makes no mention of this structural feature, and Guenée particularly says: "Il ne faut pas chercher des charactères pour les *Anisopteryx* dans les premiers états, car les chenilles ne diffèrent ni pour la forme, ni pour les couleurs, ni pour les mœurs, de celles des *Hybernia* du première groupe." Should future observations prove this statement correct, then the characters that belong to *pometaria* may come to be considered of generic value. For the present I deem it best to refer it to *Anisopteryx*, as more careful study will probably show that in the characters of egg, larva, and chrysalis, the European species of the genus agree with it, and that some of the structural features of the adolescent states have been overlooked in Europe, as they so long were in this country.

Paleacrita, nov. gen., approaches much nearer *Hybernia*, from which it is, however, readily distinguished by the double pair of hair fascicles to each ♂ antennal joint; the pubescent hairs that cover the female; the two-jointed, horny, exsertile ovipositor; but, more especially, by the dorsal abdominal spines in both sexes—all characters unmentioned in existing diagnoses of the genus.

One peculiar feature which I noticed in *pometaria* is that the larva molts but twice. Yellowish-white when first hatched, with the black eyelets showing distinctly on the pale head, it soon deepens to pale olive-green, and the three whitish lines each side show soon after birth. It develops very rapidly, often entering

* *Ent. Month. Mag.* (London) ix. 272.

the ground within three weeks from hatching. The chrysalis is not formed till about a month afterwards, whereas *vernata* takes on this form two or three days after entering the ground.

The practical lessons to be drawn from the differences here pointed out between these two Canker-worms have been set forth in the report already cited. *Paleacrita vernata* rises from the ground mostly in early Spring, for which reason I have popularly designated it as the Spring Canker-worm. The principal efforts to prevent the female from ascending the tree should, therefore, be made at that season. The cocoon being fragile is easily broken by any disturbance of the land, and, as the chrysalis is more liable to perish when the cell is broken, fall-plowing of the soil under trees that have been attacked by the worms is to be recommended. The eggs being secreted, for the most part, under loose bark, the scraping of trees in early spring, or any system of keeping them smooth, will act as a preventive of injury. *Anisopteryx pometaria*, which I have called the Fall Canker-worm, rises, for the most part, in the Fall, and should be attacked most persistently at this season. Its cocoon being tougher, and its eggs attached to smooth as well as rough trees, scraping and plowing will effect little in preventing its injuries.

Both species attack fruit and shade trees; but while *vernata* is common and very injurious in the apple orchards of the Western States, *pometaria* is rare there, and most common on the elms of New England.

These two insects, so long confounded, forcibly illustrate the practical importance of minute discriminations in Economic Entomology.

EXPLANATION OF FIGURES.

Fig. 14. *Paleacrita vernata*:—*a*, full grown larva; *b*, egg, enlarged, the natural size shown in the small mass at side; *c*, an enlarged joint, side view; *d*, do., back view, showing the markings.

Fig. 15. *P. vernata*:—*a*, *b*, venation of front and hind wings; *c*, joint of male antenna, from above, greatly enlarged.

Fig. 16. *P. vernata*:—*a*, male moth; *b*, female do.—natural size: *c*, joints of her antennæ; *d*, joint of her abdomen, showing spines; *e*, her ovipositor—enlarged.

Fig. 17. *P. vernata*:—Female chrysalis, the hair-line showing natural length.

Fig. 18. *Anisopteryx pometaria*:—*a*, *b*, egg, side and top views; *c*, joint of larva, side view, showing markings—enlarged; *e*, batch of eggs; *f*, full-grown larva—nat. size.

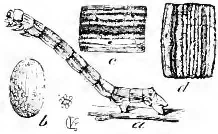
Fig. 19. *A. pometaria*:—*a*, *b*, venation of front and hind wings—nat. size; *c*, joint of male antenna, from the side; *d*, same from beneath—greatly enlarged.

Fig. 20. *A. pometaria*:—*a*, male moth; *b*, female do., natural size; *c*, joints of her antennæ; *d*, joint of her abdomen, enlarged.

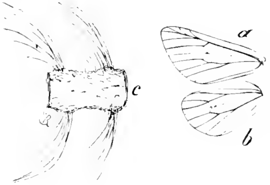
Fig. 21. *A. pometaria*:—*a*, male chrysalis; *b*, female do., the hair-lines showing natural lengths.

SPRING CANKER-WORM (*Paleacrita vernata*).

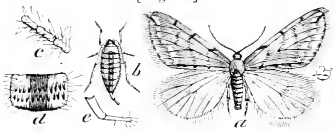
[Fig. 14.]



[Fig. 15.]



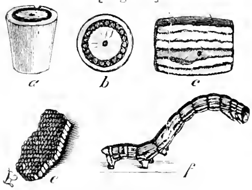
[Fig. 16.]



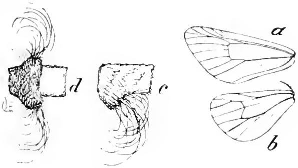
[Fig. 17.]

FALL CANKER-WORM (*Anisopteryx pometaria*).

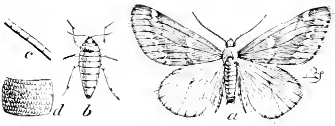
[Fig. 18.]



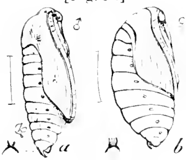
[Fig. 19.]



[Fig. 20.]



[Fig. 21.]



Notes on the Natural History of the Grape PHYLLOXERA (Phylloxera vastatrix, *Planchon*).

By CHAS. V. RILEY.

[Read Oct. 18, 1875.]

It is well known to those who have followed the habits of *Phylloxera vastatrix*, as these have been discovered and recorded, that one of the most important points in the life-history of this insect that has hitherto remained unsettled, is the nidus which the winged female chooses for the consignment of the few eggs she lays. In 1871 I ventured the supposition that these eggs were deposited in the down of the leaf-buds,† but subsequent observation led me to believe that "the more tomentose portions of the vine, such as the bud, or the base of a leaf-stem, furnish the most appropriate and desirable *nidi*" for these winged mothers, and that the eggs were also laid in minute crevices on the surface of the ground, especially around the base of the vine‡—all these conclusions being based on observations made on the insects in confinement. The question is an important one practically, as the hope was entertained that, by knowing just where to look for these eggs, we might be able to check the rapid spread of the Phylloxera disease, since it is through them alone that the disease can be started in new localities distant from infested regions. Feeling, from past experience, that it was extremely difficult to solve the problem in the open vineyard, and that experiments with the insect confined in tubes were more or less unsatisfactory, I built, early in September, a tight house of heavy Swiss muslin, six feet high and four feet square, over a Clinton vine. The house was built so as not to permit even so small an insect as the winged Phylloxera to get in or out, and the vine was trimmed so that but few branches and leaves remained to be examined. Into this enclosure I brought an abundance of infested roots, and for the past five or six weeks I have been getting the winged females confined where I could watch their ways. In addition, I prepared large, wide-mouthed glass jars, by half filling with moist earth. Into the earth was then stuck a vial of water holding a tender grape-sprig with young leaves. The leaves were

† Fourth Mo. Ent. Rep., p. 65. ‡ Seventh Mo. Ent. Rep., p. 98.

thus easily kept fresh and growing for a fortnight and upward. From day to day, as the winged females were obtained from other vessels prepared for the purpose with infested roots, they were introduced into these jars containing living leaves.

The results of these endeavors to supply the winged mothers as nearly as possible with the natural conditions have been satisfactory, and they prove that, as was surmised, the eggs are laid in crevices of the ground around the base of the vine, but still more often on the leaves, attached generally by one end amid the natural pubescence or rather down of the under surface; and while heretofore all efforts to artificially hatch the progeny from these eggs have for the most part failed, I have this year succeeded in hatching them without difficulty, and present a tube with living individuals and also mounted specimens for the inspection of members. I have also succeeded in getting both sexes of the American Oak Phylloxera and in thus completing the natural history of both species.

Though this true sexual form of *vastatrix*, from the winged and agamous female, has never before been carefully observed and described, it was nevertheless anticipated by Balbiani in his studies of the European Oak Phylloxera (*Phylloxera quercus* Fonsc.) and by myself in my studies of the American Oak species (*P. Rileyi*).* Balbiani had also obtained what is evidently the same form from eggs deposited by wingless, hypogean mothers late in the season and after the winged mothers cease to fly.†

The winged females carry in the abdomen from three to five and sometimes as many as eight eggs. These eggs are of two sizes—the smaller, which produce males, about ¾ the size of the larger, which produce females. As the whole organization of these aërial mothers—with the stout proboscis and ample wings—indicates, freedom and nourishment are needed to bring the eggs to perfection and cause their proper oviposition. In confinement in small vessels, where these requisites are not easily furnished, the eggs are generally voided, with the death of the parent, on the sides of such vessels; and those freely laid are with the greatest difficulty brought to the hatching point. Only in two instances did I succeed in doing this last year. These failures in the past

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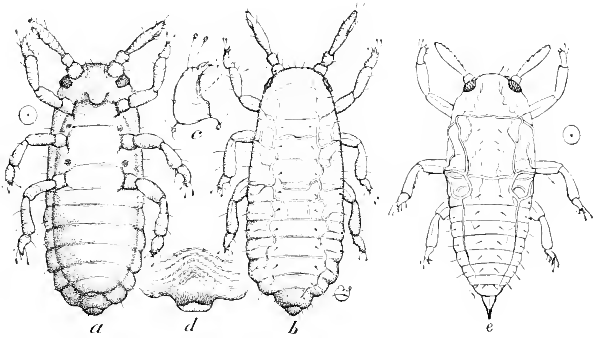
* Seventh Mo. Ent. Rep., p. 119

† *Comptes Rendus de l'Acad. des Sc.*, Paris, Nov. 2, 1874.

find their explanation not so much in the difficulty of supplying the natural conditions, as in lack of experience as to what those conditions were.

Whether owing to the want of down on the Clinton leaf, or to the fact that the minuteness of the eggs makes it about as difficult to find them on a square four feet of earth surface as the proverbial "needle in a haystack," the eggs found on the vine in the afore-mentioned muslin enclosure were very few compared to the number of winged insects which must have come out of the ground. It was also next to impossible to find, and quite impossible to follow, the sexed individuals after hatching. In the prepared jars, where the tomentose leaves of *Labrusca* were kept, I obtained more satisfactory results; for, while a few eggs were laid on the surface of the ground, especially in the space between the earth and the glass, and a few others on the upper side of the leaves, by far the larger number were attached to the under surface, generally by one end and thrust between the natural down of the leaf—evidently showing that this is the natural nidus chosen. The winged mothers die soon after ovipositing, and their shrivelled and decaying bodies adhere to the leaf-down.

[*Fig.* 22.]



SEXED PHYLLOXERÆ: *a*, female *vastatrix*, ventral view, showing egg through transparent skin; *b*, do. dorsal view; *c*, greatly enlarged tarsus; *d*, shrunken anal joints as they appear after oviposition; *e*, male *caryæcaulis*, dorsal view—the dots in circle indicating natural size.

By taking a leaf bearing eggs that are eight or nine days old and enclosing it in a smaller, tightly corked, tube, the sexed individuals hatch freely, and are easily watched. This hatching takes place on about the tenth day after deposition, with our late September temperature. The egg perceptibly enlarges during this time, a fact that might be explained by endosmosis of the leaf-juices were it not known that the same fact holds true of many soft insect eggs that are not attached to succulent leaves or other living vegetation. The red eyes are seen through the delicate egg-shell early in the development of the embryon, and just before hatching the joints of the body are perceptible. The egg-shell is so delicate that in the process of hatching it is usually pushed back in folds, and is left as a little wrinkled, whitish mass: occasionally, however, it more nearly retains its original form.

The sexed individuals are at once distinguished from all the other forms which this interesting species assumes by the obsolete mouth-parts, the sexual organs, and the more highly developed nervous system: otherwise, in size, in smoothness, and in obsoleteness of the basal joint of tarsus, they most closely resemble the newly hatched larva.

The female (Fig. 22, *a*, *b*) measures 0.40 mm. and is about one-third as broad. The body widens slightly behind, and the two narrow anal joints of the abdomen swell out prominently from the others. A mere swelling between the two anterior coxæ represents the mouth-parts. The antennæ more nearly resemble those of the wingless, agamous ♀ than of the winged one, having but one rather small plate near the end of the third joint, which third joint is generally constricted at base so as to give it a somewhat more pedunculate appearance than in the other forms: this does not always appear, however, as in some of my mounted specimens the diameter of the joint from base to tip is nearly uniform. The minute, black, dorsal hair-like points, as also the dusky subventral warts each side of sternum just outside the coxæ, are visible as in the agamous ♀, but not the six pale medio-sternal tubercles between the legs. The legs have the tibiæ rather heavy terminally, and the tarsi show no distinct basal joint: they otherwise precisely resemble those of the agamous ♀, and are, together with the antennæ, similarly more dusky than the body. In most of my mounted and transparent specimens (9 examined), two irregularly contorted nervous chords with numerous finer ramifications are distinctly visible, one each side, crossing and joining on the prothorax and metathorax.

The male differs in no respect from the female except in the bulbous penis tapering to a point; in broadening, if anything, before rather than behind; and in being about ¼ smaller. Barring the somewhat shorter black points, he is the counterpart of the same sex in a larger species (*caryæcaulis*) which I have already illustrated and the figure of which I here introduce (Fig. 22, *e*).

The single egg which the true female carries develops rapidly after she is born, and on the second day already occupies nearly the whole body, as shown at Fig. 22, *a*. It is delivered the third or fourth day, and this generally happens independent of impregnation.

This impregnated egg, which I have so far obtained only in my small tubes, is smooth like the other eggs of the species, but more elongated or ellipsoidal, and but very slightly broadest behind. It measures 0.32 mm. and is nearly three times as long as broad. Bright yellow when laid, it soon acquires a deeper, yellowish-green color. The posterior end is generally thickened or roughened by what is probably a mucous secretion that serves to attach it.

Where this egg is naturally laid I have not yet ascertained, but in all probability it is carried into or near the ground by the impregnated parent. The young hatching from it is the normal agamous female; for, though I have not yet hatched this impregnated egg of *vastatrix*, I have succeeded in doing so with that of *Rileyi*, and Balbiani long since did so with that of *quercus*. I am led to think that, once impregnated, the female carries her egg into the ground, because in 1873 I found females whose abdomens, instead of being filled with numerous small eggs, were distended with a single large one;* and though I was puzzled to interpret the fact at the time, I have no doubt now that I then had under my eyes the true, impregnated female here described, and that I overlooked the obsolete mouth.

The habits of these sexed individuals, as I have been able to observe in both the Grape and the American Oak species, are similar to those recorded by Balbiani of the European Oak species. The male is quite ardent, more active than the female and somewhat longer-lived.

The complete natural history of the Grape Phylloxera, as set forth in my 7th Report, may now be considered established. A full biological view of the species exhibits to us no less than five different kinds of eggs: 1st, the regularly ovoid egg, 0.25 mm. long and half that in diameter, of the normal, agamic and apterous female, as it is found upon the roots; 2d, the similar, but some-

* One fact, which is not now interpretable, but may have a significance in future, I feel constrained to record in this connection. It is that, in examining *vastatrix*, I have occasionally met with degraded ♀'s (underground mothers) in which the abdomen, instead of containing numerous small ova, was well-nigh filled with a single much larger egg. Every observed fact leads to others yet unknown and unsuspected; and the full history of Phylloxera has yet to be written!—*6th Rep.*, p. 87.

what smaller egg of the gall-inhabiting mother; 3rd, the ♀ egg from the winged mother, rather more ellipsoidal, and 0.40 mm. long when mature: 4th, the ♂ egg from same, ¼ less in length and rather stouter; 5th, the impregnated egg, just described, 0.32 mm. long and still more ellipsoidal. We have also the singular spectacle of an egg from the winged mother increasing from 0.34 mm. (its size when laid) to 0.40 mm. (its size just before hatching); giving birth to a perfect insect 0.40 mm. long, and this in turn, without any nourishment, laying an egg 0.32 mm. long. A being is thus born, and, without food whatsoever, lays an egg very nearly as large as that from which she came.

From the observations here recorded I would draw the following conclusions:

1. We can no longer entertain the hope of any practical good from the knowledge of the nidus chosen by the winged mothers, as the destruction either of these or of their eggs—scattered as they are on the leaves all through a vineyard—is out of the question. The objects are too small to be practically searched for, and it is virtually impossible to prevent the spread of the disease in this stage. We might almost as well try to prevent mildew by the destruction of the invisible floating spores that must at times pervade the atmosphere of a vineyard. The hope entertained by Lichtenstein that the winged mothers would congregate and be attracted to some particular plant must, I think, be abandoned.

2. The only preference shown in this respect would seem to be for those leaves that are most downy or tomentose; and from this view of the case we get another probable reason why the varieties of Labrusca which are characterized by an abundant downiness on the under surface of the leaves suffer most from the insect.

3. Having already had the young from the impregnated egg of *Rileyi* hatch in about a fortnight after it was laid—having shown in previous writings that this species winters in the larva state, and not in the impregnated egg as does the European *quercus;* and, remembering, further, that *vastatrix* resembles *Rileyi* in wintering as larva, it is safe to conclude that the impregnated egg of *vastatrix* will also hatch the same season that it is laid, and that we cannot apply to it the term "winter egg" which Balbiani applies to the impregnated egg of *quercus*. It is not unlikely that, since

a few of the winged females issue as late even as the latter part of October, some few also of the later produced impregnated eggs may pass the winter unhatched; if so, they may be considered exceptions to the rule. In the same way, a few of the more common eggs from the agamous ♀ may be exceptionally found on the roots in winter, though as a rule only the hibernal larva is found.

In conclusion, I would state that this year's studies of both *vastatrix* and *Rileyi* confirm me in the opinion, elsewhere maintained (7th Rep., p. 91), that the term "pupa," as applied to the sexed eggs by Lichtenstein, is quite unwarranted, and that the egg-covering—thin and plastic though it be—can in no sense be likened to a cocoon, and still less to a "silken cover."* The fact of its shrivelling up makes it none the less an egg-shell, for this shrivelling process occurs in all eggs with very delicate and plastic covering, and may, indeed, be witnessed in the gall-inhabiting form of *vastatrix*, though no one has thought of questioning the ovarian nature of the eggs found in those galls.

My sincere thanks are due to Miss M. E. Murtfeldt, who has carefully carried on observations for me during my necessary absence. Without her patient watching and persevering efforts, my endeavors must have measurably failed of results.

On a New Form of LECTURE GALVANOMETER.

By FRANCIS E. NIPHER, Professor of Physics in Washington University.

[Read Oct. 18, 1875.]

In the September number of the *American Journal of Science*, Professor George F. Barker has described a lecture galvanometer which possesses marked advantages over any other instrument heretofore described.

Barker's galvanometer is an attachment to the vertical lantern manufactured by Geo. Wale & Co. of Hoboken, N. J., and its construction may be understood from the following brief description:

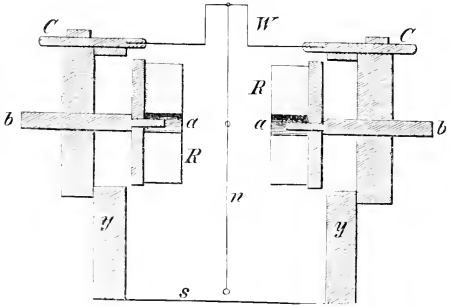
The upper needle of an astatic system plays over the horizontal condensing lens of the lantern, its deflections being shown by

* *Stetteiner Ent. Zeitung*, 1875, p. 358.

a scale photographed on glass immediately below it. From this needle an aluminum wire passes downward through the lens and inclined mirror beneath to the other needle, which is below the lantern. A small coil, surrounding the lower needle, serves to deflect the system of needles, which is supported by a silk fiber. The instrument may be made of any desired delicacy, and is evidently a valuable addition to the apparatus of the public lecturer.

While meditating the construction of one of these instruments, I hit upon another form of the instrument which appears to possess many advantages. A vertical section is shown in Fig. 1. A square box, Y Y, open at the top and bottom, is pierced on opposite sides to admit the wooden rods, *b*. To the inner extremities of these rods are attached coils, R, of covered copper wire, No. 18, wound upon cylinders of wood, *a*. Wooden rods, *c*, clamped so as to move with gentle friction, bear a wire, *w*, from which an astatic system of needles is suspended by means of a fiber of silk. The upper needle is midway between the centers of the two coils. The lower needle plays over a scale, *s*, photographed on glass and graduated to fourths of a degree, beneath which is the horizontal condensing lens of the vertical lantern. The needles are ordinary sewing needles and are each 1.5 inches in length. Each coil is composed of 34.7 meters of wire, the resistance of which is 0.444 ohms. Each coil should have the same number of windings of wire, and the same resistance. This is easily effected by

[*Fig.* 23.]

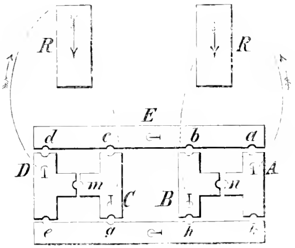


Scale ¼.

care in winding. By sliding the rods *b* in or out, the distance between the coils may be readily varied from 2 cm. to 10 cm., the image of the needle being in all cases perfectly distinct. In this way the instrument is adjusted to currents of any strength. Scales cut in the rods *b* serve to regulate the distances.

On the outside of the box are six plates of brass, whose form and arrangement are shown in Fig. 2. The extremities of the coils are connected with the four plates A, B, C, D. This connection may be made by binding-screws on the inside of the box, in which case the coils may be replaced with ease by others of greater or less resistance. The plates may be put in metallic contact by means of brass plugs inserted at *a*, *b*, *c*, *d*, *e*, *g*, *h*. *k*.

[*Fig.* 24.]



Putting plugs at *h* and *e*, and connecting the poles of a galvanic cup at the binding-screws A and C, the current runs successively through the two coils R, each causing deflection in the same direction. Let R represent the resistance of one coil, then the galvanometer will have a resistance of 2 R. This arrangement is very useful in working with ordinary currents from a constant battery.

If, instead of the former connections, plugs be put at *a*, *d*, *g*, and *h*. the wires from the source of electricity being connected at E and F, then the galvanometer resistance becomes ½ R. This arrangement is of course to be used with circuits of small resistance such as thermo-currents. For this kind of work the instrument is thoroughly adapted.

This instrument can also be used as a differential galvanometer. To do this, put the positive pole of the battery at E. Plug *a* and *c*. Divide the negative wire into two equal branches, which are to be connected at B and D. The circuit being thus closed, the needle evidently remains at zero. Introducing any wire, the resistance of which is to be determined into one branch, the needle is of course deflected. Bring the needle to zero again by introducing known resistances into the other branch, and we at once determine the unknown resistance.* Shunts may be introduced into either of the half circuits. This may be done by introducing coils of a resistance $\frac{1}{9}$ R, or $\frac{1}{99}$ R, between the binding-screws A, B or C, D. The wires may also be wound upon metallic plugs which have been split lengthwise, the parts being insulated, and each being connected with one extremity of the wire. Permanent shunts may be introduced by connecting one extremity with plates A or D, the other being attached to an insulated plate to be put in contact with B or C by means of a solid metallic plug. These shunts are the same as those used in Latimer Clark's differential galvanometer, and the manner of using them in determining resistances is too well known to need further explanation.

The advantages possessed by this instrument are—

1. It is easily adjusted to any vertical lantern, from which it can be removed in a moment if desired.

2. The distance of the deflecting coils from the needle being readily varied, it can be adjusted to currents of various intensity.

3. The resistance of the galvanometer is quickly varied from one-half to twice the resistance of one of the galvanometer coils.

4. The coils may be replaced by others when desired.

5. It can instantly be converted into a differential galvanometer, and used in measuring electrical resistances.

6. It can be constructed in any work-shop, at a very small expense.

St. Louis, Oct. 25, 1875.

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* In determining fractions of an ohm, it is convenient to use a rheocord, made of platinum wire. Using wire weighing 7.37 grams per meter, the resistance of which is 1 ohm to 192.9 cm. of wire (which is 96.45 cm. on the instrument scale), and thousandths of an ohm can be measured direct.

Notes on AGAVE.

By GEORGE ENGELMANN, M.D.

Just as the Yuccas among the Liliaceous plants, of which I have treated in a former paper (vol. 3, p. 17 & 210), the Agaves present among the Amaryllidaceæ a peculiar, gigantic, and sometimes tree-like development, not otherwise found in these families. Like the Yuccas, they are confined to the new world; but, unlike them, which are represented by only about a dozen species, of a more or less uniform and unmistakable character, the Agave type branches out in perhaps a hundred (or 180 or 200, if we dare trust the catalogues of nurserymen) species, of greatly diversified appearance.

The botanical investigation of the Agaves meets with the same difficulties as that of the genus above mentioned in connection with them, the Yuccas, and as the Cacti, or, to use a term more of horticultural than botanical significance, but sanctioned by the authority of no less a name than that of the elder DeCandolle, the *Plantes grasses*. They have, for the most part, been long in cultivation, the individuals being propagated with their individual peculiarities by suckers, and very rarely by seeds. Many of them have never bloomed in Europe, and many that did bloom have not been studied by competent botanists; of a large number, their native country is unknown, and the travelling horticultural collectors have paid more, or only, attention to marketable plants than to botanically-instructive specimens. Moreover, most of these plants are so clumsy and so difficult to properly preserve for the herbarium that travellers have shunned them; so that even the standard herbaria contain mostly only very scanty and incomplete material.

In the old United States only a single representative of the genus was known, the *Agave Virginica*, a rather small and inconspicuous plant, if compared with the extensive development the genus attains in Mexico and further south, in the number of species as well as in the bulk of individuals. But on our southwestern border lands, the same region where the Cacti become a leading feature of the Flora, the botanists of the U. S. and Mexican Boundary Commission, twenty to twenty-five years ago, discovered a greater development of the genus, and Prof. Torrey in his Botany of that Boundary (published in 1859) was able to indicate five other species; his account, however, owing to an insufficiency of material, is meagre and to some extent erroneous. As far as I am informed, nothing has been added to our knowledge of these plants in the sixteen years elapsed since his publication: but in the last few years a quantity of new material has been gathered, and, being placed at my disposal, has enabled me to make a more thorough study of the genus.

The Agaves are American plants, some of which became known to Europeans since the discovery of America, and especially since the conquest of Mexico: the great *Agave Americana* is said to have been already in cultivation in Europe as early as the year 1561: from the similarity of the spinous leaves they were considered forms of the Aloes of the old word, and the name "Aloe" has in popular language stuck to them to this day. Linnæus was the first to distinguish them, and in his Hortus Upsalensis (1748), p. 87, he established the genus *Agave*, and enumerated the characters by which "these American plants" are readily known from the true "Asiatic and African Aloes." He adds that he has "named them *Agave*, because that word indicates something grand and admirable." It is interesting to observe how even at that early date, when botanical geography was not yet born, the geographical domains of these different groups of plants struck the discriminating mind of Linnæus as something remarkable and characteristic.

The Agaveæ were first recognized as a distinct tribe by R. A. Salisbury,* who united in his 12th order of *Sarmentaceæ* Yucca (with a "pericarpium superum") and Agave, Polyanthes and others (with a "pericarpium inferum"), thus recognizing the great resemblance of these plants, which we now place in different but parallel families, just on account of the relation of the ovary to the other parts of the flower.

Other botanists† have appended them to the *Amaryllidaceæ*, but it must be confessed that they have only the inferior‡

* Genera of Plants, ed. 1866, p. 77.

† Endlicher, gen., p. 181; Kunth, Enum. 5, p. 818.

‡ In *Agave* the ovary is truly and entirely inferior, but the closely allied *Polyanthes* shows a partly (about ¼) superior ovary.

ovary in common with the true bulbiferous Amaryllidaceæ, distinguished by a naked scape and an involucral spathe. The numerous horizontally-flattened black seeds, mentioned already by Salisbury as being common to Yucca and Agave, are not found in the true Amaryllis family; nor do these possess the filiform embryo which diagonally traverses the whole length of the albumen. Other interesting differences are found in the valvate æstivation of the Agaveæ and in their commissural* stigmas.

TRUNK.

The majority of the Agaves are acaulescent and monocarpic; the short subterranean trunk continues to grow for years† until vigorous enough to evolve the flowering stem, a continuation of its axis, and dies after bearing fruit. During its growth a wreath of numerous thick, fleshy, white root-fibres is developed every spring from its lower part, while the lowest, oldest part of the trunk dies and rots away. This is the case at least in *Agave Virginica.* A few Agaves have persistent trunks, sometimes of considerable dimensions; these produce flowers repeatedly, just as the caulescent Yuccas do, from axillary branches, after the terminal bud of the main axis has fulfilled its destiny and died. These secondary branches are initiated by a pair of short and clumsy, strongly carinate leaves, which may be considered as representing bud-scales (*Niederblaetter*), as I noticed in vigorous specimens of *A. Boucheana*, Jacobi, and *A. chlorocantha*, Salm, in the Berlin botanic garden, 1869.

In the acaulescent Agaves the subterranean trunk dies entirely, or for the greater part; but in *A. Americana*, and probably in the majority of the species, it first emits from the axils of decaying leaves numerous offshoots, which grow into separate young plants and thus propagate the individual. In *A. Virginica* it produces sessile lateral buds, which grow up, still adhering to the persistent part of the old trunk, a sort of corm, giving to the plant

* Stigmas formed by the *commissures* of the carpels, therefore alternating with these, a comparatively rare case. The common form is the carinal stigma, formed by the tip of the carpel itself or its carina, therefore opposed or rather superimposed to the carpel, while the true Amaryllidaceæ have an imbricate æstivation and carinal stigmas, and so have Yucca and perhaps all Liliaceæ.

† In *A. Americana*, in its home, eight to fifteen or more years; under more unfavorable circumstances, in cultivation in colder countries, much longer, even, it is said, fifty or a hundred years, whence the name *century-plant*.

eventually a cespitose appearance. Polyanthes behaves just in this manner.

The subterranean trunk of most (or all?) Agaves contains, like that of Yuccas and many other plants of these families, a great deal of mucilage,* which, mixed with water, has detergent qualities to a considerable degree; these "roots" and the whole plants thus used are known to the Mexicans by the name of *Amole*. Another use is made of the trunk, when, before flowering, it has developed a large quantity of saccharine matter, for nourishment; and not only the trunk of Mexican Agaves, but also that of the larger Arizona species, is thus eaten, after baking, under the name of *Mezcal*, and is said to be a very savory dish. The name *Maguey* is more commonly used for the plant itself.

LEAVES.

The leaves of the Agaves are sessile with a broad sheathing base, from linear to lanceolate or even ovate, the broader ones contracted above the base, and widened again upwards. They are thick and fleshy, sometimes soft, but usually of a firmer texture, rarely quite tough and hard; in some species (only in the first group) they decay at the end of the season, but in most Agaves they are persistent for years.

The margin of the leaf usually bears hard and dark-colored straight or hooked or variously flexed spiny teeth; sometimes it is denticulate with minute, pale teeth; rarely it dissolves, Yucca-like, into threads; in our *A. parviflora* it combines the teeth on the lower half with the fibres on the upper half of the leaf; very seldom the edge of the leaves is entire; in some species the whole margin of the leaf bearing the spines becomes dry, hard and horny, and is eventually, together with the spines, detached from the leaf (*A. heteracantha*). It is not well-known whether the spines, so much relied on to characterize the different forms, are sufficiently constant; it seems, at least, that an extensively cultivated form of *A. rigida*, of Yucatan, has lost its spines, and produces them only occasionally and very sparsely: in the allied genus *Fourcroya*, leaves with and without marginal spiny teeth are of common occurrence.

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* The suggestion made (p. 21) that the rootstock may contain saponine, has not been verified by chemical analysis.

The point of the leaf forms a soft herbaceous bristle, or usually a hard and pungent spine, of different shapes, round, or compressed sideways, or flattened on the upper surface, or concave, or channelled: and these characters seem to be constant and of specific value.

The tissue of the leaf of most Agaves contains innumerable extremely tough fibres, which, in some of the species with sufficienly long leaves, afford, when freed from the surrounding parenchyma, valuable textile material, usually called *Pita*, in general use in their native countries, and even exported. *A. Americana* furnishes a coarser Pita, *A. rigida*, and its cultivated varieties are the source of the finer Sisal hemp: other species, e.g. *A. heteracantha*, are locally used for the same purposes.

INFLORESCENCE.

The flowering stem or scape shoots up from the centre of a rosette of leaves, continuing the main axis; it bears numerous bractlike leaves (*Hochblaetter*), genera ly triangular from a broad base, often attenuated into a slender tip, smaller as they reach up into the inflorescence. All the vigor of the plant, all the nourishment accumulated in the massive leaves and in the succulent trunk, are used and exhausted in the production of the inflorescence. It is well-known that *A. Americana* is extensively cultivated in Mexico, principally for the immense quantity of saccharine juice prepared in its leaves for this purpose. When the flowering scape shows the first signs of development, the terminal bud and the innermost leaves are removed, when in the basin thus formed the liquid collects and is dipped out; on an average about a gallon a day, for two or three months in succession, from a single plant 150 to 300 gallons in all. From this juice the fermented (*pulque*) and distilled (*mezcal*) liquors are prepared which are so generally used all over Mexico. The juice which is extracted before the plant prepares to bloom is acrid and not copious.

The flowering stems are in the different species from 3 to 20, and, it is said, even 30 feet high, and from a few lines to 3–5 inches in diameter, together with those of the allied Fourcroyas, the tallest flowering stems known.

The flowers are articulated on (usually extremely) short, persistent pedicels, bearing one or two small bracts. The inflorescence itself shows three different forms, and, according to these, the numerous species of this genus naturally are distributed in three different sections.

The first section, *Singuliflorœ*, to which our *A. Virginica* belongs, bears single flowers in a simple, generally slender spike, never crowded as the spikes of the next section are; each flower is borne in the axil of a bract on a short pedicel, which is distinguished by a single lateral bractlet. This bractlet is normally sterile, but in monstrous inflorescences may produce secondary and tertiary flowers, which, however, can always be distinguished from those of the next section by never appearing in pairs.*

The second section, *Geminiflorœ* (gen. *Littœa*, Tagliab., *Bonapartea*, Willd., non Ruiz & Pav.), comprises the species which produce flowers in pairs, crowded into a more or less dense spike. From the axil of each primary bract a short or rarely longer (e.g. *A. Utahensis*) peduncle originates, bearing two opposite lateral bracts (sometimes pushed somewhat towards the main axis), and in their axils the flowers on two short (rarely, e.g. in *A. attenuata*, Hort. Cels. Paris, 1869, longer) secondary pedicels with bractlets of the third order directed owards the primary bract. These bractlets occasionally bear a second pair of flowers with lateral bractlets of the fourth order, directed inward, and in the axils of these occasionally (*A. attenuata* rudimentary flower-buds are seen. An internal perigonal lobe of the flowers of the primary pair is directed backwards and outwards, towards the margin of the primary bract, and an external lobe towards the bractlet. In rare instances the primary peduncle does not ter-

* I have a plant of this species growing, brought from the woods in this vicinity, which produces its irregularly crowded flowering spikes every year in the same manner. The lateral bractlet usually bears a second flower on a similarly bracted pedicel; this second bractlet stands either on the dorsal (towards the principal bract) or on the ventral (towards the main axis) side of the little inflorescence: a third flower, if present, is not coeval nor opposed to the second one, but later and higher up, and usually on the upper or inner side of the second flower; if the antholytic development, which then is often combined with fasciation, proceeds, parts of the primary flower may become more or less detached and again bear incomplete axillary flowers. — It may here be remarked that the flower of the Singuliflorœ is so placed in regard to bract and axis, that an external lobe of the perigon and one carpel are turned towards the bract, and an internal lobe and the commissure of the other two carpels towards the axis. That abnormal stock, however, produces sometimes towards the tip of the spike flowers without a pedicel and without a lateral bractlet; in these one external lobe and one carpel are turned towards the axis.

minate abruptly, as usual, but is continued into a bristle between the flowers (*A. mitis* in H. Bot. Berlin), and may even bear a third, median, flower. if the description of the inflorescence of *A. lophantha* by Jacobi (Ag. p. 202) is to be relied on ; the flowers are there said to be ternate, the pedicel of the middle one being 1 line longer than those of the lateral ones.*

The species of the third section, *Paniculatæ*, are distinguished by a branching inflorescence, a panicle, in which more or less crowded bunches of flowers are borne on the end of secondary or tertiary branches. I have not been able to examine fresh inflorescences or their development, but, judging from dried fragments, the flowers seem originally to appear in pairs, usually with secondary and tertiary flowers unsymmetrically developed from their pedicels, and at last clustered, sometimes 20 or 30 or more together, so that their relative position can not be unravelled.

FLOWERS.

The flowers of the Agaves are thick and fleshy, often of lurid, greenish, yellowish, or brownish colors ; rarely brighter, yellow (*A. deserti*), or orange (*A. Antillarum*). They consist of an inferior ovary, bearing the style, and a not articulated, subpersistent perigon, with the stamens.

The perigonal tube, straight, or often somewhat curved, is either short, campanulate, sometimes quite shallow, or longer, funnel-shaped, or even cylindric, or rather triangular-prismatic. The lobes form two trimerous verticils, each of valvate æstivation, the thicker exterior ones covering the broader thinner margins of the interior ones, leaving only a prominent, tapering middle part free. The lobes are generally oblong or linear-oblong, shorter or longer than the tube, flat or often channelled and including the filament, concave at the obtuse tip, which is sometimes thickened, and usually bears a short, whitish beard ; they are erect or patulous, or sometimes at last reflexed.

The six stamens are more or less adnate to the tube, in some

* Some forms are described so as to leave us in doubt in regard to their inflorescence, e.g. *A. horizontalis*, Jacobi, with a spike consisting of clusters of 3-8 flowers in the axil of each bract; others are said to have 1-3 or 4-5 flowers together. All these probably belong to the Geminifloræ, with a greater normal or, perhaps, monstrous development of flowers. It is to be hoped that in future botanists or amateurs will be more precise in their appreciaciation of these characters.

species free from near its base, in others adnate up to the base of the lobes (an important character which has often been neglected): the outer stamens are usually placed a little higher than the inner ones. In the bud the filaments are always doubled up,* geniculate, and straighten out when the flower opens, and almost always become much longer than the perigon; in a few species they do not exceed the length of the lobes. The filaments are generally attenuated from a broader base and terminate in a thin point, on which they bear the large and conspicuous linear,† nearly quadrangular, somewhat introrse, 4-celled, versatile anther, attached near or a little below the middle; in *A. Virginica* the filaments are thickened upwards, almost clavate. The globose, or elliptic, delicately reticulated pollen-cells have, on an average, a diameter of 0.06 to mostly 0.08 or even 0.11 mm.

The ovary consists of three carpels, opposite the outer perigonal lobes, forming three cells, in each of which two vertical rows of flat, horizontal, anatropous ovules spring from the central placentæ. The stout, somewhat triangular, tubular style rises to the height of the anthers and sometimes above them, but its length is variable and does not seem to be always characteristic. The stigmatic part is thickened, clavate, or somewhat capitate, and is divided into three carinal‡ lobes, which at last open somewhat, or especially in the first section, expand horizontally, and are often emarginate or even obcordate; after expansion they (at least in *A. Virginica*) exude a viscid liquid—whether stigmatic, or only intended to allure insects, has not been ascertained.

The flowers of Agave—I speak particularly of *A. Virginica*, the only one I have been able to observe in its development, but I suspect that the same holds good in all the species—are vespertine or nocturnal and proterandrous. They open late in the afternoon or in the evening, and, while the filaments straighten out and elongate, the anther-cells burst and emit the large pollen grains, and on the following morning are found withering and empty. The style at this period usually does not yet exceed the perigon (in *A. maculosa* it is much shorter), and its lobes are

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* Even the short filaments of *A. maculosa* are thus geniculate. (See p. 301, note.)

† The curved anthers spoken of in some descriptions can only refer to effete and withing ones.

‡ See page 293, note.

firmly closed: but now it begins to elongate and attains its functional maturity 48 hours after the anthers have opened, which by this time have mostly fallen off.*

The Agave flowers are odorous, some of them, like *A. Virginica*, of the sweetest fragrance, resembling tuberose, though not so overpowering: others are more or less fetid. These odors are most fully developed, as is also the case in the tuberose, in the evening and at night, indicating undoubtedly the design of attracting vespertine insects to assist in pollenization. But whether insects aid in this process, or the higher-placed flowers drop their pollen from the just bursting anthers on the opening stigmas of the lower and older ones, has not been ascertained.

The fruit is always an erect, dry, 3-celled capsule, globose or even depressed, or ovate, oblong and sometimes prismatic, obtuse at base or contracted into a sort of a stipe, obtusish at tip or acute or rostrate, opening above, generally about the upper third or half only. The numerous horizontal seeds are flat, black, semi-orbicular or obliquely orbicular with a shining or opaque surface, which, magnified 100 or 150 diameters, shows the epidermal cells flat and scarcely distinct from one another, or with distinct, somewhat elevated cell-walls; or they are slightly depressed, giving the seed a pitted appearance, or rarely elevated and tubercular. The areæ of these cells are very minutely dotted or pitted.

The filiform, cylindric, or slightly compressed embryo is as long as the hard, whitish, semi-transparent, farinaceous and oily albumen. In germination the seed-shell is elevated above the ground on top of the largely developed foliaceous cotyledon, contrary to the behavior of Yucca, where the husk enclosing the small and soon decaying cotyledon remains buried in the ground. (See Notes on Yucca, 3, p. 20.)

Some species bear no fruit, but, in place of the withered flower, or probably in the axil of its bractlet, a bud or bulblet appears, which grows to a considerable size and will eventually sprout and propagate the plant. All the so-called viviparous Agaves

* In figures of Agave flowers we not rarely meet with bursting anthers and a fully elongated style in the same flower; which I suppose is factitious, and not founded on correct observation.

belong here. Some species, *A. Ixtli*, Karw., in the garden of the late Mr. Thuret of Antibes, bears both capsules and bulblets; and so appears to do *A. sobolifera* (*A. vivipara*, Lam.) None of our species possess this peculiarity.

The native country of the Agaves is preëminently Mexico: in the southwestern parts of the United States, mostly in Arizona, 13 species are found; but only one of these extends to the 39° and even 40° N. Lat., while in California the northern limit of the Agaves is about 34°. A few species seem to be natives of the West Indies, and a few more may be peculiar to South America. The Agaves said to come from the East Indies, St. Helena, and other parts of the old world, are propably all forms of *A. Americana* originally brought there from America.

I now proceed to the enumeration of the species of the territory of the United States, and of a few undescribed or imperfectly known foreign Agaves of which I possess sufficient material.

Agave, *Lin.*

Perianthium superum tubulosum vel campanulatum, subregulare, subpersistens, limbo 6-fido, laciniis valvatis. Stamina 6; filamenta tubo plus minus adnata, in alabastro inflexa, demum plerumque longe exserta; antheræ lineares versatiles. Ovarium inferum, triloculare, ovulis anatropis horizontalibus in loculo singulo biseriatis; stylus apice incrassato trilobus. Capsula coriacea, loculicide trivalvis; semina 6-seriata numerosissima, plano-compressa, nigra; embryo axilis, longitudine albuminis cornei.

Plantæ Americanæ, præcipue Mexicanæ, acaules vel caulescentes, sæpius giganteæ; foliis crassis sæpissime aculeato-dentatis spinoso-mucronatis.

I. Singulifloræ.

Flores e bractearum axillis singuli, laxe spicati.

The species of this section have a more herbaceous character than those of the two others; they are stemless, with softer, probably always annual leaves, not contracted above the base, with marginal asperities more than teeth, and a terminal bristle more than a spine. They are the *Herbaceæ* and *Subinermes* of authors, which, however, include some species of the next section. Only about a dozen species are known, three of them within our domain. The spikes are slender, the flowers fragrant, the stigmatic lobes wide-spreading.

1. Agave maculosa, *Hook. Bot. Mag.* 1859, t. 5122: foliis e caudice subterraneo crasso cylindrico lanceolato-linearibus concavis undulatis demum recurvatis glaucis lurido-maculatis cartilagineo-denticulatis; spicæ laxifloræ bracteis lanceolato-subulatis; ovario ovato-lanceolato brevi, lobis lineari-oblongis erecto-patulis tubo gracili subcylindrico sursum parum ampliato plerumque multo brevioribus, staminibus fauci ipsæ insertis lobos vix æquantibus stylum plerumque superantibus, stigmatibus demum patulis obcordatis; capsula oblonga longe cuspidata basi in stipitem contracta.—*A. maculata*, Engelm. in Bot. Mex. Bound. 1859, p. 214, non Regel; *A. Virginica*, Torr. ibid., non al.

Var. β. brevituba: lobis perigonii tubo magis ampliato fere æquilongis, antheris longioribus.

Along the Rio Grande from below El Paso to Matamoros. Wislizenus. 1847; Bigelow. Schott, 1850–52: the variety below El Paso, Wright. No. 1095.—Fl. May and June.—The caudex, somewhat different from the allied species, is a black cylindric stock ½–¾ inches thick and 4–6 inches long, bearing thick white radical fibres at the base. Leaves ½–1 foot long, as many inches wide, concave, flexuous, at length recurved; scape 2–4 feet high, spike 6–12 inches long: fragrant purplish-green flowers, about 2–2½ inches long; ovary 3–4 lines, tube 1 inch and lobes 7–9 lines long, filaments* and anthers as long as lobes. The stigma is remarkable on account of the deep emargination, almost bilobation, which form is only indicated in other Agaves, but is distinct in Polyanthes. The firmer texture of the capsule (1½ inches long, ½ inch thick), and its stipe and beak, further characterize this species. Seed 2–2½ lines wide, thicker than usual in this genus, marked by a flat reticulation.

2. Agave Virginica, *Lin.*: acaulis: foliis late seu oblongo-lanceolatis concavis undulatis flexuosis demum recurvis læte viridibus herbaceo mucronatis margine asperatis; perigonii ovario

* This is one of the few Agaves with stamens so short that they may be called *included*: they occur in all three sections. It is not impossible that superficial investigation has classed several of these American plants with the Asiatic genus *Polyanthes*; but they have —at least this one has—an entirely inferior ovary and filaments doubled up in the bud, both of which characters are wanting in Polyanthes. Kunth (En. 5, p. 48) already suggests this in regard to *Polyanthes Mexicana*, Zucc.

ovato multo longioris tubo angusto sensim ampliato lobis lineari-oblongis erectis bis terve longiore, filamentis inferiori tubi parti adnatis sursum clavatis perigonium vix duplo superantibus, stigmatibus suborbiculatis demum patentibus; capsula tricocca subglobosa retusa breviter stipitata.

Var. β. TIGRINA: robustior; foliis majoribus pulchre purpureo-maculatis; staminibus imo tubo adnatis; capsulis depresso-globosis.

Lusus POLYANTHUS: spica densiflora floribus in glomerulos paucifloros congestis sæpius antholyticis.

On dry hills and in open woods from Maryland and Virginia southward and westward to Missouri and Texas, but not on the western plains or in West Texas, nor on the Rio Grande; the variety in salt-marshes on the coast of South Carolina, Dr. Mellichamp.—Fl. June to August, according to latitude.—This species was first known through Clayton's collection, who described it as "Aloe from Virginia," and makes mention of its fragrant flowers and deciduous leaves; from his specimens and notes it was published by Gronovius in his Flora Virginica, 1739, and through him became known to Linnæus, who in 1751 (Amœn. Acad. 3, p. 22) referred it to his new genus Agave.

Leaves mostly ½–1 foot long, 1½ or 2 inches wide; in a form from Houston, Texas, the leaves are lance-linear and not more than half as wide; marginal teeth extremely small, consisting of single projecting epidermis cells, or larger, $\frac{1}{20}$ to (rarely) ¼ line long, and then consisting of innumerable short cells, not sharp-pointed, but rough, like the small serratures of some Yuccas, only less rigid. Scape altogether 3–5 feet high, of which the spike measures 1 or 1½ feet. Flower, including ovary but excluding stamens—as I always measure Agave flowers—1–1¼ inches long, with the stamens ½ or rarely 1 inch longer; anthers 6–6½ lines long. Capsules 7–9 lines long, a little less wide; seeds 2–3 lines wide, lightly reticulated, with depressed, minutely dotted areas.

Var. *tigrina* is larger and more robust; leaves tapering to a point or abruptly cuspidate, 1–1½ feet long, 2½–3 inches wide, beautifully mottled; the purple color is produced by a clear purple liquid contained in a single layer of small flattened cells between the transparent epidermis cells and the large parenchymatous cells filled with chlorophyll and often with rhaphides;

capsule 8–9 lines wide, less high: seeds over 4 lines wide. This variety has retained its peculiarities in cultivation with me.

Of the sport with crowded, often antholytic flowers, and with a tendency to fasciation, I have before spoken (p. 296, note).

3. AGAVE VARIEGATA, *Jacobi*. *Hamb. Gart. Zeitg.* 21, p. 459; *Agav.* p. 180; *Saunders Refug. Bot.* v. t. 326: acaulis; foliis late lanceolatis undulatis margine asperato denticulatis; perigonii tubo late infundibuliformi ovario oblongo paulo longiore lobos ovato-oblongos patulos demum reflexos longitudine æquante seu eis paulo breviore, filamentis superiori tubi parti adnatis longe exsertis, stylo demum stamina superante; capsula oblonga cuspidata.

On the lower Rio Grande near Mier and Matamoros, Dr. J. Gregg, May, 1847.—Leaves (before me) 9–10 inches long, 1½–2 inches wide; edge similar to that of the last, but teeth often sharper and curved upwards; scape "3–5 feet high"; flowers in Dr. Gregg's specimen about inch apart, in the axil of a broad triangular bract, 4 lines long, upwards smaller. Flowers 1½ inches long; ovary, tube, and lobes, of nearly equal length, 6 lines, or tube a little shorter and lobes a little longer; stamens inserted about ⅔ or ¾ up the tube, not at the base of the lobes, and about 2 inches in length; anthers ½ inch long; style slender, at last often longer than the stamens; only capsule seen 10 lines long and 6 wide; seeds unusually oblique (always?), 2½ lines in longest diameter.

I refer this plant from the Rio Grande with some hesitation to Jacobi's and Saunders' *A. variegata*, the stamens of which are said to be inserted "in the throat," whatever that may mean; the leaves of this plant, which is said to be "probably" from Mexico, and which has repeatedly flowered in Europe, are mottled with lurid blotches, of which in my dried specimen no trace is visible. I have not the means to ascertain whether any of the older names, such as *A. brachystachys*, Cav., or *A. polyanthoides*, Hort., refer to this same plant; the former, however, seems to be a larger plant, with larger "entire" leaves; *A. saponaria*, Lindl., is certainly also similar, but, if the figure in Bot. Reg. 25 t. 55 is to be relied on, is well-distinguished by having a prismatic flowertube. The insertion of stamens in the tube is not mentioned by Lindley, nor is it scarcely ever spoken of in any descriptions, nor indicated in the figures.

II. Geminifloræ.

Flores e bractearum axillis bini oppositi, dense spicati.

The species appertaining to this section. 40 or 50 in the books, 4 of which belong to our F ora, are usually stouter, sometimes with a short trunk, leaves rarely soft and almost herbaceous, but perhaps always perennial, often tough and sometimes the toughest in the whole genus; their margin is most variable, entire, or with small pale cartilaginous teeth, or filamentose, or with stout. horny, brown spines. — Together with the first section they constitute the *Agavæ spicatæ* of some authors; others, who have principally regarded the growth and foliage of cultivated plants, have scattered them in various groups, mixed with the species of the next section.

* Folia margine serrulato-aspera.

4. Agave falcata, *n. sp.*: acaulis; foliis e basi lata linearibus rectis seu plerumque falcatis rigidissimis supra planis concavisve (siccatis) dorso carinatis margine serrulato-asperatis apice in spinam fere triangularem supra planiusculam excurrentibus; scapo et spica bracteis e basi latiore subulato-filiformibus marcidis deciduis stipato; ovario lobisque perigonii ovatis erecto-patulis eo æquilongis tubo multo (ter) brevioribus; staminibus medio tubo vel ultra insertis perigonium fere duplo superantibus: stylo gracili apice trilobo.

Saltillo, Buena Vista, and apparently all over that northern part of Mexico, abundantly collected by Drs. Wislizenus and Gregg in 1846–48; flowering in the latter part of May, and again in July and August, probably at different seasons, as many Mexican plants do, stimulated to development by a few rains or even a single heavy one. — As the plant is common in a region often traversed by collectors, it seems strange that it should not have become known and been brought into cultivation long since; but I can find no description to which I might refer here, unless it be the *A. Californica*, Hort. Kew, of which I find a notice in Jacobi's Agave, App. p. 47; but I strongly suspect that this refers to no Agave at all, but to *Yucca Whipplei*.

Leaves hard and rigid, finely serrulate, 6–15 inches long, sheathing base 1–1½ inches wide, soon contracted to the width of 3–5 or 6 lines, tapering to the point, the sharp brown spine of 6 lines in length, triangular, nearly flat above, with two sharp lateral and one obtuse carinal edge; leaves usually falcate, rarely straight. Scape "3–8 feet high," bearing arid filiform bracts of 2 inches or more in length, smaller in the inflorescence. Flowers crowded on very short knobby pedicels, 12–15 lines long, ovary and lobes each 2½–3, tube 6–7 lines long, and at the throat nearly 3 lines wide; filaments inserted just above the middle of the tube, reaching about 1 inch above the perigon; anthers 7 lines long. Fruit not collected.

** Folia margine filamentosa.

5. AGAVE SCHOTTI: acaulis; foliis e basi lata linearibus rectis seu subfalcatis rigidis supra planis concavisve dorso convexis seu (siccatis) carinatis margine abunde filiferis apice in spinam robustam teretem fuscam excurrentibus; pedicellis brevibus, ovario et lobis perigonii patulo-erectis lineari-oblongis æqualibus tubo anguste infundibiliformi multo brevioribus, staminibus superiori tubi parti adnatis paulo exsertis; stylo robusto staminibus demum æquilongo.—*A. geminiflora?* var. *Sonoræ*, Torrey, Bot. Mex. Bound. 214.

Sierra del Pajarito in Southern Arizona; fl. August; collected only by the late Dr. Arthur Schott, 1855, to whose memory I have dedicated this species in consideration of long years of friendship and of the valuable services to science rendered by him in many arduous exploring expeditions in the arid southwestern wilds, as well as in the primeval tropical forests of the isthmus and on the plains of Yucatan.

According to the discoverer, this as well as the next is one of the *Amole* or soap-plants. Leaves 6–12 inches long, 3–4 lines wide, terminating in a perfectly terete spine 3 lines long; margin splitting into numerous extremely fine whitish fibres. Scape 5–6 feet high; spike rather looser-flowered than in the last; primary and secondary pedicels about 1 line long; flower 1½ inches long, ovary as well as narrow lobes about 5 lines, the gradually widening tube 8 or 9 lines long, and bearing the filaments (8 lines long and reaching scarcely more than 1 line beyond the lobes) 1½ lines below the throat; anthers 5-6 lines long, large for the flower; no fruit seen.*

6. AGAVE PARVIFLORA, *Torrey, Bot. Mex. Bound.* 214: parvula, acaulis: foliis rosulatis terræ adpressis e basi lata vaginante dentata lineari-lanceolatis margine infra bruneo-dentato sursum in filamenta brevia crassa alba soluto, spina terminali rigida supra plana; scapo elatiore, pedicellis brevissimis; floribus geminis seu subquaternis parvis, ovario oblongo perigonio duplo breviore, tubo profunde campanulato lobis oblongis erectis bis longiore, filamentis basi tubi insertis subinclusis; capsula pisiformi subglobosa breviter cuspidata.

On various sierras in the Pimeria Alta in Southern Arizona, in fl. & fr. in July, A. Schott.—The leaves of this prettiest and smallest of all Agaves are, together with the broad, sheathing base, not quite 3 inches long: base 1 inch wide and a little longer; blade 1¾ inches long, 4 lines wide, somewhat contracted above the base; spines 2 lines long, at last gray. On its lower third or half the leaf-margin bears very small, but rigid, sharp teeth, and higher up separates into a few short, stout, white filaments—the only instance of this combination, I believe, in the whole genus. Scape 4-5 feet high. Flowers 6, ovary over 2, tube 2½, and lobes 1¼ lines long, with stamens and style about 4 lines in length and scarcely reaching beyond the lobes of the perigon; anthers 3, capsule 4-5, and seeds 1¾ lines long.

*** Folia margine aculeato-dentata.

7. AGAVE HETERACANTHA, *Zucc. in Act. Leop. Car.* 16, 2. 675; *Kunth, En.* 5, 836: subcaulescens; foliis crassis rigidis lineari-lanceolatis in margine corneo demum soluto aculeos complanatos uncinatos gerentibus, spina terminali valida subterete versus basin leviter exarata; scapo et spica bracteis e basi triangulari subulatis marcidis demum deciduis ornato: floribus in pedicellis brevissimis binis, perigonio ovario oblongo longiore,

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* Dr. Gregg collected near Ocotillo, direction of Tepic, in Western Mexico, leaves of a plant which he says bears a scape 5-6 feet high, and which, like many narrow-leaved Agaves and Yuccas, was called *Palmilla* by the natives; unfortunately no flowers came along, but, as it seems to be an undescribed Agave, it may be designated as A. ANGUSTISSIMA: leaves "2-3 feet long," 2½-3 lines wide, convex on the back, filamentose on the margin, narrowed into a short (2½ lines), stout, triangular, brown spine. It seems allied to *A. filamentosa*, Salm, which, however, has much shorter and wider leaves. The form of the terminal spine precludes its being taken for a Yucca.

lobis lineari-oblongis erecto-patulis tubum campanulatum brevissimum multoties superantibus, filamentis basi loborum insertis perigonio fere duplo longioribus; capsula ovata s. oblonga plus minus cuspidata.—*A. Poselgeri*, Salm, in Bonplandia 7, 92; Jacobi, Agav. p. 40; *A. Lechuguilla*, Torr. Bot. M. B. 213.

On the Rio Grande from El Paso down the river, Wright, 682, 1432, 1907; southward to Parras, Saltillo, and further, Gregg, Wislizenus; Karwinski, Poselger. Fl. in May.—I have ventured to unite the different forms under the oldest (Zuccarini's) name, the more so, as I was able to compare the original specimen in the Munich botanical garden, where I found it in flower in August, 1869. Whether several other garden-forms, described under different names, all characterized by soluble corneous leaf-edges, belong here, or constitute distinct species, can be decided only when their flowers become known. Zuccarini's typical specimen has leaves 18 inches long and 2½ inches wide, with a spine 1½ inches long, the spiny teeth straight or curved up or down, whence the specific name: scape 6 feet high; flowers only 1 inch long (ovary 5, perigon 7, tube over 1½, filaments 15 lines long from base of tube); no fruit was matured, but many bulbilli were sprouting from the top of the scape. Gen. Jacobi (Ag. app. p. 14) describes a specimen which flowered at Brussels with perigon divided to the base, most probably inaccurate, as no Agave is known with such a flower.

Our plant grows in mountainous and rocky localities, is called *Lechuguilla* ("Lecheguilla" in the Mex. Bound. Bot. is a misprint), and its rootstock *Amole;* the leaves furnish excellent but rather coarse fibre, and the rootstock is used as soap and is a "savory food" when roasted; trunk 4–6 inches high; leaves (before me) 10–20 inches long and 1–1½ inches wide, margin and its teeth dark red-brown, at last fading to ash-color and becoming detached from the leaf, but adhering long to the terminal spine; teeth 9–12 or 15 lines apart, below smaller and straight, upward larger (1½–2 or even 3 lines long) and strongly uncinate, not irregular, as in the original specimen; terminal spine 7–9 lines long, slightly grooved on lower third or fourth. Scape 6–10 feet high, its bracts from 2 inches down to ½ inch long, deciduous, so that in the flowering spike little of them is seen. The flowers before me indicate two forms, one with a slender ovary, 7–9 lines long, larger flower (perigon 9–10, tube 1–1½, anthers 6 lines long), and oblong, strongly cuspidate capsule, about 1 inch long and half as wide; the other form has a shorter ovary, 5–7 lines long, smaller flower (perigon 7–8, tube ½–1 line long), and rather shorter anthers, capsule shorter, 8 lines long and 6 wide, with a short abrupt point. Both forms seem to ocur in all the localities mentioned, and certainly belong together. I have been particular in describing them, because we rarely have occasion to study numerous and varying specimens of these plants, but must be generally satisfied with poor fragments, so that it is difficult to ascertain the amount of variation within the species.

8. AGAVE UTAHENSIS, *Engelm. in S. Watson's Bot. 40th Parall.* p. 497: acaulis; foliis crassis glaucis e basi lata attenuatis in spinam validam infra carinatam supra usque ad apicem late exaratam excurrentibus, margine aculeis rectis validis albidis dentato; bracteis scapi elati e basi lata subulatis marcescentibus; floribus (minoribus flavis) pedunculatis binis vel sæpius quaternis, ovario oblongo perianthio subbreviore, tubo late campanulato abbreviato lobis oblongis erectis ter quaterve breviore medio stamina limbum paulo excedentia gerente; capsula oblonga breviter cuspidata.

Southern Utah, about St. George, etc., extending into Arizona, Dr. E. Palmer, J. E. Johnson, F. Bischoff.—Leaves 6–12 inches long, 1–1¾ wide, not contracted above the wider base, very thick and rather hard, strongly marked with the impressions of the margins of the adjoining leaves; terminal spine about 1 inch long, pale or white in the specimens before me, with a darker base and tip, almost triangular in the cross-section; lateral spiny teeth 1½–2 lines long and as wide, white with a darker base. Scape, together with the dense spike of 1–2 feet in length, 5–7 feet high; peduncles and pedicels distinct, in fruit often 3 lines long, ultimate ones shorter. Flowers scarcely 1, perigon about ½ inch long, lobes three times or more the length of the shallow and wide tube, which bears the stamens in the middle, not at the base of the lobes as many short-tubed Agaves do; filaments less than ¾ inch long, about 2 or 3 lines longer than the lobes; anthers 5–6 lines long; capsule 10–14 lines long, 4–5 wide; seeds 1½–2 lines wide, marked with flat punctate areæ.

III. Paniculatæ.

Flores ad apices ramorum inflorescentiæ congesti paniculati.

These are the typical Agaves, of which 20 or more forms are enumerated, with stout, often very large, fleshy leaves, almost always with spiny marginal teeth and strong spiny tips, a stout and high scape bearing a paniculate inflorescence, the branches of which are usually ½–2 feet long or even more, stout, vertically compressed, and naked up to the base of the branchlets or peduncles. Most of them are stemless, some have trunks several feet high, but none grow as large as some Yuccas do. Among them we find the economically and commercially most important Agaves, especially *A. Americana* and *A. rigida*.

* Tubus perianthii lobis multoties brevior.

† *Stamina tubi basi inserta.*

9. Agave Newberryi, *n. sp.:* acaulis; foliis e basi latiore sensim angustatis lanceolato-linearibus rigidis integris apice aculeo fusco semitereti supra canaliculato armatis; scapo gracili, paniculæ angustæ racemiformis ramulis remotis bracteis lanceolatis breviusculis fultis abbreviatis paucifloris; perigonii tubo campanulato brevissimo, lobis oblongis, staminibus infimo tubo adnatis.—*Agave, n. sp.?* Torrey in Bot. Ives Exp. p. 29.

Peacock Spring, Northwestern Arizona, west of the San Francisco Mountains, between them and the Colorado River, over 4,000 feet alt., discovered, when just beginning to bloom, March 31, 1858, by Dr. J. S. Newberry on Lieut. Ives' Expedition, and named for him in commemoration of his services to Botany in this and other western explorations.—This very peculiar plant, of which we unfortunately know so little, is so different from the other paniculate Agaves known to me, that their connection seems to be altogether artificial; but for the present I can not do better than to place it between them and the last section, to which the small stature and the form of the leaves seem to approximate it, though the inflorescence is clearly a contracted, short-branched panicle.

Leaves 7–10 inches long, at base ¾ inch wide, with entire, cartilaginous margins,* terminating in a sharp, semi-terete or almost

* Possibly a horny tooth-bearing edge, such as we find in *A. heteracantha*, may have broken off, but no traces of such remain in the only extant specimen.

triangular, dark colored spine, grooved on the upper side, and about ½ inch long. Scape 8 feet high, flowers in a long, loose raceme or contracted panicle; bracts lanceolate, about ½ inch long; branchlets 1–3 inches apart, 1–2 inches long, bearing 2–5 (not opposed) flowers. The whole flowerbud, just about opening, nearly 1 inch long; prismatic ovary equal to perigon; tube very short, only ⅕ or ⅙ of the lobes; short stamens, which, when fully developed, probably will not be much longer than the perigon, from near the base of the tube; anthers 4½–5 lines long.

†† *Stamina tubi fauci inserta.*

10. AGAVE DESERTI, *n. sp.:* acaulis; foliis crassis glaucis supra basin latissimam aculeato-dentatam leviter contractis ovato-lanceolatis sursum sensim attenuatis in spinam gracilem elongatam compressam ad medium anguste canaliculatam excurrentibus, margine sursum corneo obscuro infra herbaceo aculeis uncinatis flexuosis fuscis armato; scapo graciliore bracteis distantibus foliaceis lanceolato attenuatis dentatis stipato, ramulis paniculæ superioribus erectis, pedicellis fasciculatis longiusculis; floris flavi ovario subprismatico perigonium fere æquante, tubo infundibuliformi brevissimo lobis oblongis erecto-patulis quater s. quinquies breviore, staminibus loborum basi insertis ipsis lobis duplo longioribus; capsula oblongo-prismatica breviter cuspidata.

Eastern base of the Southern California mountains and in the adjoining deserts. Fl. in June, but occasionally, as most of these plants do, at other seasons.—The then Lieut. Emory,* in the adventurous expedition to California in the fall of 1846, was the first to discover this species in Valcitron, southeast of San Felipe. A few years later Dr. Parry found it "on the arid hills and valleys" in the same region, and drew up a full description, but did not collect any specimens. Since then it was lost sight of until within this year, when horticultural collectors again brought it into notice. My specimens were obtained from Mr. G. N. Hitchcock of San Diego and Dr. E. Palmer.

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* In his Notes on a Military Reconnoisance, Washington, 1848, p. 104, he says under date of Nov. 29: "We rode for miles through thickets of the centennial plant and found one in full bloom. The sharp thorns terminating every leaf were a great annoyance to our dismounted and wearied men.... A number of plants were cut by the soldiers and the body of them used as food." A few flowers were saved and are now in the late Dr. Torrey's herbarium.

The plant is one of the smaller of this section; leaves densely clustered around the base of the stalk, ascending and erect, thick, fleshy, deeply concave, very glaucous, 6–12 inches long, ½–2 wide, contracted above the very broad base, which is edged with sharp, straight, pale teeth, wider above the middle and terminated by an unusually long (1–2 inches) and slender, laterally compressed spine marked with a deep narrow groove half-way up; the hard and horny, dark colored edge of this spine extends down to about the middle of the leaf, bearing the crowded, strong, hooked teeth (2–3 lines long); below the middle the teeth-bearing margin is herbaceous. The stalk is, according to Dr. Parry, 4–10 feet high, 1–2 inches thick below. The flattened branches of the panicle, almost horizontal below, longest (2–3 inches) in the middle and nearly erect upwards, divide into not very compact clusters of forked pedicels, 2–3 lines in length, the ultimate ones shorter, bearing a profusion of bright yellow flowers. Prismatic ovary a little shorter than the perigon and scarcely contracted at top; perigon 10–11 lines long, tube only 1½–2 lines long and wide, lobes about 9 lines long and 2½ wide; filaments inserted at base of lobes, about twice their length; anthers as long as lobes; capsule 1¾ inches long, 6–7 lines wide, pointed; seeds 2½ lines in diameter.

11. Agave Parryi, *n. sp.*: acaulis; foliis ascendentibus rectis supra basin dilatatam vix angustatis ovato-lanceolatis versus apicem attenuatis spina valida supra planiuscula medio leviter carinata decurrente terminatis, margine aculeis distantibus minoribus rectis seu paulo deflexis armato; scapo valido bracteis magnis foliaceis triangularibus integris imbricato; paniculæ ramis robustis horizontalibus seu vix ascendentibus apice flores numerosissimos breviter pedicellatos ochroleucos gerentibus, ovario prismatico perigonium fere æquante, tubo brevi infundibuliformi lobis lineari-oblongis erecto-patulis duplo breviore, staminibus summo tubo adnatis longe exsertis, stylo sæpe demum stamina excedente; capsula ovata brevissime cuspidata, seminibus majusculis.—*A. Americana*, β? *latifolia*, Torr. Bot. Mex. Bound. p. 213, pro Emoryi planta; *A. Mescal*, C. Koch, Wochenschr. 1865, p. 94 (ex Jacobi), and *A. crenata*, Jacobi, Agav. p. 229, quoad plantam neo-mexicanam.

Western New Mexico to Northern Arizona, and perhaps eastward to the mountains below El Paso, apparently not south of the Gila River: fl. June and July.— The botanical history of this species is similar to that of most of the larger Agaves, the material for whose definition must be gathered piecemeal and from many different sources. Oct. 19, 1846, a fruiting specimen was collected near the "Copper Mines" by Lieut. Emory, in the California expedition (see p. 310), l. c. p. 59, now preserved in the Torrey herbarium and mentioned in the Mex. Bound. Botany as a short and broad-leaved form of *A. Americana.* In 1865 Dr. E. Coues sent flowerbuds from Fort Whipple, which seem to belong to this species. In January, 1868, Dr. C. C. Parry, then on a railroad surveying expedition, again found it and collected seeds, which I distributed in Europe as *A. Parryi;* the young plants, raised from them, are now advertised in nursery catalogues, but no description has yet been published. Then Mr. F Bischoff, of Lieut. Wheeler's expedition of 1871, brought capsules and seeds home. The first who, collecting foliage, flowers, and fruit, enabled me to connect all these scattered fragments, was Dr. J. T. Rothrock, Surgeon and Naturalist of Lieut. Wheeler's Southwestern Expedition of 1874. He met with the plant in "Rocky Cañon" and as far north as Camp Apache in Northeastern Arizona. Why Koch and Jacobi should have referred the short notes of Torrey to a plant which they found in cultivation in Europe, is unknown to me ; Jacobi's description does in nowise agree with our plant, as the margin of the leaves is nearly straight and not "deeply crenate," etc.

Leaves erectish or the outer ones patulous, 10–12 inches long, 3–3½ inches wide, somewhat concave as all Agave leaves are, rather abruptly acuminate and terminating in a very robust spine, 1 inch long, flattened above, with two sharp lateral angles and a slight ridge in the middle; from this spine a horny, brown margin runs down the leaf-edges for 1 inch or more and to the uppermost teeth. Teeth 6–12 lines apart, comparatively small, only about 1½ lines long, straight, or slightly curved up on upper, and smaller and curved back on lower part of leaf. Scape 8–12 feet high, 1–2 inches thick, bearing numerous large (2 inches wide at base, and twice as long, smaller upwards), triangular, closely adpressed bracts, herbaceous, with scarious brown margins and sharp points. Panicle itself, in well-developed plants, about 3 feet long, and 1 foot in diameter, the stouter branches considerably flattened, $\frac{3}{4}$ inch wide, 6 inches long; ultimate pedicels usually 2–3 lines long. Flowers over 2 inches, the perigon 12–14 lines long, tube 4–4½ lines long and wide, lobe 9–9½ lines long and 2 wide; stamens inserted at the base of the lobes, the inferior a little lower than the exterior ones; filaments 1¾ inches, anthers 10 lines long; style often at last longer than stamens. Capsule wider in proportion to its length than in any other of our species belonging to this section, about 1¾ inches long and half as wide; seeds 4 lines wide, with flat, punctulate, strongly marked reticulation, visible under a strong glass.

12. AGAVE ANTILLARUM, *Descourt. Flor. med. Antill.* 4 *tab.* 284 (1827): subcaulescens; foliis late lanceolato-linearibus elongatis, margine aculeis parvis distantibus rectis recurvisve fuscis armato, spina terminali valida fusca terete basi solum anguste canaliculata; scapo sub-10-pedali; paniculæ ovatæ ramis horizontalibus, pedicellis longiusculis dense fasciculatis; florum (aurantiacorum) ovario perigonio longiore, tubo late infundibiliformi lobis lineari-oblongis erecto-patulis ter quaterve breviore, staminibus basi loborum insertis longe exsertis; capsula ovato-prismatica cuspidata basi in stipitem brevem contracta.

San Domingo, Parry & Wright, U. S. Expl. Exp., Feb. 1871, in flower.—The unusual color of the flower and the native country of the plant make it almost certain that this is Descourtil's plant, and I adopt his, the oldest, name, even if Grisebach's (Flor. West Ind. p. 582) suggestion should prove true, that it might be identical with *A. sobolifera*, Salm, hort. 1834 (*A. vivipara*, Lam., non Lin.) This plant is also reported to come from San Domingo and Jamaica, but to have greenish or yellowish-green flowers (Jacobi, Ag. 122) and to bear capsules as well as bulblets, whence the names; but none of our botanists seem to have observed such proliferation, which in other allied Agaves and in a Fourcroya were duly noticed. The measurements taken by them in San Domingo of a "medium specimen" are: height of leaf-bearing trunk 2 feet, length of leaf 30–36, greatest width 4¼ inches; scape 8–10 feet high, at base 2½ inches thick, length of lower branches of the panicle 9, of middle 12, and upper 3 inches; nearly 100 flowers on the strongest branches.

A single leaf before me is 3 feet long and 3½ inches wide, the terminal spine 9 lines long, a narrow groove occupying only ¼ of its length; marginal teeth 6–12 lines apart, only 1 or at most 1½ lines long, hard and sharp, deep brown. The flowers are reported as having a yellowish-green tube; limb and filaments and the anthers, before opening, are orange. The flowers before me belong to two forms, one with longer (1 inch) pedicels and larger flowers, the other with smaller flowers on shorter (3–5 lines) pedicels. The ovary of the former is 16–18, the tube 4, and the lobes 10–11 lines long; filaments not twice as long as lobes; anthers 11 lines long. The ovary of the smaller flower is 15, tube 2, lobes 7–8 lines long, and the exsert part of the filament longer than the whole perigon; in the former the stamens are inserted a little below the base of the lobes, in the latter at the very base itself. The capsule of the latter is 1½–1¾ inches long and 7–8 lines wide; seeds 3 lines wide.

** Tubus perianthii lobis brevior vel æqualis; stamina medio tubo inserta.

† *Tubus lobis brevior.*

13. Agave Shawii, *n. sp.*: subacaulis; foliis perviridibus erecto-patulis supra basin dilatatam vix denticulatam paulo contractis ovatis acutis spina valida late excavata acuminatis, margine corneo fusco vix solubili aculeis subcontiguis maximis sursum curvatis vel varie flexi sornato; scapo valido bracteis foliaceis triangularibus toto imbricato; ramis paniculæ horizontalibus seu superioribus adscendentibus apice glomerulum florum subsessilium compactum foliaceo-involucratum gerentibus; ovario prismatico perigonio vix breviore, lobis lineari-oblongis suberectis tubo late infundibuliformi medio stamina paulo exserta gerente duplo longioribus, stylo stamina superante sæpius arcuato; capsula prismatica acuta.

On the arid hills which overlook the sandy strand of the Pacific in the southwest corner of California, where the boundary is marked by the initial monument, this fine species, growing together with *Cereus Emoryi*, was discovered by Dr. Parry in 1850, and a full description made; from his memoranda Messrs. Parker and Hitchcock of San Diego re-discovered it a few months ago and supplied me with most instructive photographs and excellent specimens; last summer Dr. Palmer collected it with immature fruit, and in November the above named gentlemen found it in full bloom and sent fresh bunches to St. Louis. This is the short history of a remarkable species, which will flourish, highly esteemed by amateurs as one of the most striking and beautiful Agaves, and commemorate, among all who love horticulture in other climes, the name of Henry Shaw, already so highly esteemed in St. Louis as the founder and donor of the "Missouri Botanical Gardens," grand at present, and promising a future as useful as it will be magnificent.

The trunk of this species is short and globose or more elongated, 8–12 inches long, but all covered with its very regularly (in $\frac{8}{13}$) arranged, broad, deep green leaves, forming masses nearly 2 feet in diameter, set off by the large, bright, red-brown spines. Leaves 8–10 inches long, 3½–4½ wide, with a distinct brown horny margin, which bears the unusually large, very close-set, flat spiny teeth, straight, or mostly curved up or rarely downwards,or flexuous, the largest (near the middle) 6 lines long and half as broad; in old leaves the margin with a few of the spines adhering, is often partially detached, but not as regularly as e.g. in *A. heteracantha*. The stalk, 2–2½ inches thick, 8–12 feet high, is almost entirely covered with large (4–5 inches long by 2 wide) triangular bracts, foliaceous with brown scarious margins and tipped with a spine. The branches of the broad oval panicle are very stout (4–8 or 9 inches long, 1–1¼ thick) flattened above, and bear at the end a most compact cluster of 30–50 flowers surrounded by large foliaceous fleshy bracts, 1–2 inches wide, 2–3 long, which form a sort of involucre; the whole, after the flowers have fallen and only the short truncate closely-packed pedicels are seen, interspersed with subulate bracts, 1–2 inches in length, simulates the receptacle of some large Composita, 2–3 inches in diameter.

Flowers 3–3½ inches long, greenish-yellow; prismatic ovary 1¼–1½, perigon 1¾–2 inches long, tube outside 8–9, inside 6–7 lines long, lobes 12–14 lines long, outer a little longer and 3½, inner shorter, 4 lines wide. Stamens, inserted in the middle of the tube, only about ½ inch longer than perigon; anthers 14 lines long; pollen grains oval, 0.09–0.12 mm. in longest diameter, beautifully marked. Style,* in the numerous specimens before me, curved

* A triangular channel penetrates the style to near its base, where, by salient angles meeting in the centre, the cavity is divided into three tubes, which lead to the ovarian cells, somewhat obstructed, however, about the neck of the ovary by loose cellular tissue.

and ½–¾ inch longer than the filaments, apparently already considerably lengthened when the stamens begin to unfold. Capsules cuspidate but not stipitate, 2½–2¾ inches long, not quite 1 inch in diameter, forming a densely packed radiating cluster, 6 inches in diameter; seeds 4 lines wide.

† † *Tubus lobis vix brevior vel æqualis.*

14. AGAVE RIGIDA, *Mill. Dict. ed.* 8, 1768: caulescens; foliis lanceolato-linearibus glaucescentibus, margine aculeis distantibus rectis parvis fuscis dentato, spina terminali valida terete sæpe torta basi ipsa solum paulo excavata in marginem corneum decurrente; scapo elato foliaceo-bracteato, paniculæ ovatæ capsuligeræ viviparæque ramis horizontalibus ramulosis fasciculos florum laxiores bracteis triangularibus brevibus stipatos gerentibus; ovario perigonio paulo breviore, staminibus medio tubo infundibuliformi lobis paulo breviori vel supra medium insertis longe exsertis stylo demum æquilongis. — *Fourcroya rigida*, Haw. Syn. 74, Kunth en. 5, 843; *A. angustifolia*, Haw. Saxif. 35; *A. Ixtli*, Karw. ap. Salm, Hort. Dyck. 304; Jacobi Ag. 95.

Var. LONGIFOLIA: foliis multo longioribus glaucis, aculeato-dentatis, spina terminali non decurrente.

Var.? SISALANA: foliis multo longioribus viridioribus margine integris seu pauci-dentatis, spina terminali non decurrente.— *Agave Sisalana*, Perrine, vide infra.

The original plant was, according to Miller, brought from Vera Cruz; my specimens, on which the above diagnosis is based, were collected in Yucatan by Dr. Schott. Dr. Perrine forty, and Dr. Schott ten years ago, studied in Yucatan this interesting plant, its different forms and economical uses, and left us accounts of it, the former in Senate Doc. 300, Washington, Mar. 12, 1838; the latter in the Report of the Agricultural Department at Washington for 1869. Both agree that there is a common native species in Yucatan, called *Chelem* by the aboriginal inhabitants; but from time immemorial a number of varieties, all characterized by much longer leaves, and one also by the absence of marginal spines, and differing among themselves in the quantity and quality of their fibre, have been cultivated by the natives of Yucatan, and are a staple product of that country to this day, furnishing the well-known Sisal hemp. The people know them as *Jene-*

quen (Schott) or *Henequen* (Perrine), and distinguish, as Dr. Schott reports, the *Yaxci* (Yashki) as furnishing the best quality and the *Sacci* (Sacqui) with the largest quantity of fibre; *Chucumci*, larger than the last, produces coarser fibre; *Babci* has fine fibre but in smaller quantity; *Citamci*, with small narrow leaves and poor fibre, stands probably nearest to the wild plant. Dr. Perrine mentions another variety, *Istle*, evidently the *Ixtli* of Karwinski, as furnishing a fine fibre called *Pita*. These plants yield a return of leaves when four or five years old, and may last 50 or 60 years under proper management; the flowering scape is cut off as soon as 4 feet high, when, evidently, axillary branches continue the growth of the plant, which is thus kept so long alive by being prevented from flowering.

The trunk of the wild plant of Yucatan — which I refer with little doubt to Miller's old *A. rigida*—is 1-2 feet high, leaves 1½–2 feet long and as many inches wide, contracted above the broader base and widest about the middle; lateral teeth ¾ or even 1 inch apart, mostly straight, from a broad base 1–2 lines long, rather unequal, with smaller ones interspersed, dark brown; terminal spine 1 inch long, 1¾ lines in diameter, straight, or often somewhat twisted, terete, scooped out at base but not channelled, dark red-brown, a dark corneous margin extending down the leaf-edge for several inches and bearing the uppermost teeth. Scape 12–15 feet high; flowers pale yellowish-green, 2¼–2½ inches long, perigon 16, tube 6–7, lobes 9–10 lines long; stamens inserted about the middle of the tube, "blood-red upwards," 1 inch longer than the perigon; anthers 10–10½ lines long; styles at last as long as stamens.

A. Ixtli, which in 1872 flowered in the gardens of the late Mr. Thuret at Antibes, is entirely similar, flowers of the same dimensions, anthers a little larger (11½ lines long); capsules, which grow with the bulbs on the same panicle, oval, over 2 inches long, 1¼ wide, very short stipitate; seeds uncommonly large, 4½ lines high, with a ventral hilum (in many other Agaves I find the hilum more basal, a character which may be of some value). I believe this is the first time that the flowers of the Ixtli have been described; they identify the plant with the old *A. rigida*, or at least the above-described Chelem. *A. Karwinskii*, Zucc. is probably the same thing.

With the name of *longifolia* I designate the variety known as *Sacci* and extensively cultivated in Yucatan: it is principally distinguished by its much longer spiny leaves, 4–5½ feet long, 3–4½ inches wide; flowers very similar to those of the wild plant, but filaments greenish. *A. fourcroides*, Jacobi, Ag. 107, probably belongs here, and *A. elongata*, Jacobi, 108, I would also refer to this form if the description did not expressly mention a channelled terminal spine.

Agave Sisalana is the name that Dr. Perrine gave to the plant known to the natives of Yucatan as *Yaxci*, the most valuable of the fibre-producing Agaves, and which was introduced by him into South Florida some thirty-five or forty years ago, during his efforts to acclimatize commercially valuable tropical plants in that almost tropical portion of our territory, efforts which were aided by Congress by a large grant of land, but which were destroyed, together with his own life, during the subsequent Indian wars. With this Agave, however, he has been successful, as it is now fully naturalized, and is quite abundant at Key West and the adjacent coast. Dr. Parry found it there in full bloom in February, 1871, and gives the following description of it: trunk short, leaves pale green but not glaucous, 4–6 feet long and 4–6 inches wide, generally smooth-edged, but here and there bearing a few unequal, sometimes very stout and sharp teeth; terminal spine stout, often twisted, purplish-black; scape 20 or 25 feet high, panicle 8 feet long and half as wide; one of the largest plants examined had 35 branches in the panicle, the largest (near the middle) 2 feet long, upper and lower ones shorter. The flowers are slightly larger than those described, with a shorter, thicker ovary, stamens inserted a little higher up in the tube. The plants bore no fruit, but produced an abundance of buds, by which they propagate themselves and from which this interesting form has been multiplied in this country and in Europe.

If this plant is, as is most probable, only a cultivated variety of *A. rigida*, it is of the greatest importance for the study and the understanding of the Agaves, indicating, as it does, the extent of variation which they may undergo. It shows that the size of leaf and scape, or color of leaf, are of no great specific value, and also that the presence or absence of spiny teeth on the margin is not an unalterable character, not any more than the cartilaginous margin decurrent from the terminal spine. The presence of a trunk, the proportions of the leaf (in *A. rigida* and all its varieties the length equals 12–14 times the width), probably the form of the terminal spine, the character of the inflorescence, and, above all, the form and proportions of the flower and its parts, remain constant, and perhaps also the proliferous character of the inflorescence of some species.

15. AGAVE PALMERI, *n. sp.*: acaulis; foliis lanceolatis sursum attenuatis in spinam gracilem teretem ultra medium canaliculatam excurrentibus, margine aculeis inæqualibus sæpius recurvis flexuosisve atro fuscis dentato; florum albidorum pedicellis bracteis abbreviatis carnosis fultis; ovario perigonio æquali seu paulo longiore, tubo lobis vix longiore stamina longe-exserta medio vel paulo supra gerente; capsula gracili prismatica brevi-cuspidata in stipitem contracta, seminibus minoribus minute verruculosis.

In the mountains of Southern Arizona Dr. Schott collected the flowers in 1855: in 1869, Dr. E. Palmer, who during ten years has made Arizona and the adjacent regions the field of his explorations, and for whose services to botany in that district this species is named, gathered more complete specimens and seeds; and last year, 1874, Dr. Rothrock, of Lieut. Wheeler's expedition, brought very fine specimens found there at an altitude of 6,300 feet.—Fl. July and August.

This species seems to take in the southern part of Arizona the place of *A. Parryi* of the northern part of that territory, and is used there for the same purpose; it is easily distinguished from it by its longer and narrower leaves, the much less deeply divided perigon, and the slender capsule and small seeds.—Leaves 10–20 inches long, 2–2½ wide, slightly contracted above the base, long pointed; terminal spine 8–14 lines long, deeply channelled to above the middle, decurrent with brown, horny margins about 2 inches; lateral teeth ½–¾ inch apart, 1½–2 lines long, often interspersed with smaller ones, straight, or usually hooked, or often, especially the lower ones, flexuous. Scape 8–12 feet high (bracts not noticed by the collectors); branches of the panicle repeatedly and loosely ramified, ultimate pedicels crowded, about 1 line long. Flowers 1¾–2 inches long; perigon 10–12 lines long, whitish: filaments, anthers, and style, purple; lobes usually a little shorter than the tube, exterior ones strongly cucullate and much thickened at the apex, interior shorter, broader and thinner; nectariferous part of tube, below the insertion of the stamens 2½–3 lines long, a little longer than upper part of tube; exsert part of filaments about the length of perigon, anthers 8 lines long; capsules slender, 18–24 lines long, 7–8 wide; seeds among the smallest of this section 2½ lines in the longest diameter, easily distinguished by the minute tubercles, 0.01 line wide, which, different from other Agave seeds, cover the surface.

16. AGAVE WISLIZENI: acaulis; foliis ovatis supra basin paulo angustatis medio latissimis acutis, spinæ subflexuosæ supra late exaratæ margine acutiusculo decurrente, dentibus rigidis atrofuscis superioribus majoribus distantibus rectis, inferioribus parvis confertis subdeflexis; panicula laxiflora; ovario perigonium et tubo lobos fere æquante, staminibus ultra medium tubo adnatis longe exsertis; capsula gracili prismatica utrumque acuta nec stipitata, areolis seminum planis punctulatis.—*A. scabra*, Salm, Bonpl. 7, 89; Jacobi, Ag. 88.

This interesting species was discovered by Dr. A. Wislizenus on the celebrated march of Doniphan's corps through Northern Mexico, on the Nazas River near San Sebastiano, in the southeast corner of the State of Chihuahua, not far east of Parras, May 10, 1847, in fl. and fr. Living shoots were sent by me to Prince Salm and seeds to different European correspondents, among others to Prof. A. Braun of Freiburg. Two years later Gen. v. Jacobi obtained some of the young plants raised from these seeds in the botanic garden of that university and afterwards communicated them to Prince Salm, who described them (1858) under the inappropriate name *A. scabra*, though, as the General expressly states, they are perfectly smooth on both sides.* As thus the published name is inadmissible, I deem it proper to substitute for it that of the discoverer of this and so many other interesting plants of Northern Mexico.

Jacobi describes his specimens (then 16 years old, and, as he thinks, full grown) as 8 inches high and 15 in diameter, rosulate and somewhat squarrose, with broad, nearly rhombic and almost flat leaves, 5 inches long, 3½ wide, pale grayish-green, teeth distant

* *Agave asperrima*, Jacobi, is one of the few rough ones, and the only hairy one known, I believe, is *A. pubescens*, lately described by Regel. This species, obtained from Mexico and flowered at St. Petersburg, is one of the smaller ones and seems to belong to the first section.

and curved downwards. The leaf of the wild plant, now before me, is 8 inches long and 4 wide, terminal spine very stout, 10–11 lines long, decurrent about the same distance; arrangement of marginal teeth quite peculiar, the uppermost ones the largest, 1½–2½ lines long from a broader base, straight, almost black and very rigid, 6–8 lines apart; teeth below the upper third smaller and closer set, and below the middle only 2–3 lines apart, less than 1 or only ½ line long and strongly curved downwards. Scape 12 feet high, branches of the panicle loosely ramified, branchlets 3–6 inches long, pedicels 1–2 lines long; flowers in small clusters, 3–6 or 8 together, 2½ inches long, perigon half as long, divided to the middle; stamens inserted about ⅔ from the base of tube, exsert about ¾ inch above lobes; anthers 10–10½ lines long. Capsule 18–22 lines long, 7–8 wide, similar to that of last species but not stipitate; seeds 2¾ lines in diameter, cells of the surface, under the microscope, flat, punctulate.

I have a flower and a capsule of Agaves differing from any above described, and thus perhaps indicating two other species; but as the material is too incomplete to characterize them, I only indicate them here for further investigation.

AGAVE SP. "Common on mountain-sides in the Wild Rose Pass on the Limpio," West Texas, Chas. Wright, No. 1906; flowers only, collected June 11, 1851, referred by Torrey in Bot. Bound. 213 to *A. Americana*. Flower not quite 3 inches long, perigon equal to ovary, divided to the middle; stamens inserted about ⅝ up the funnel-shaped tube, reaching 14 lines above the lobes; anthers 10 lines long.—Could it belong to the last described species, which was found 300 miles further south?

AGAVE SP. Dragoon Mountains, Southeastern Arizona, Capt. Chas. Bendire, U. S. A. A capsule and seeds only, with the verbal information that the leaves are about 3 feet long and 4 inches wide, and the scape nearly 20 feet high. The capsule is ovate-prismatic, 2 inches long, 10 lines wide, strongly cuspidate, at base obtuse; seeds 3½ lines in longest diameter, apparently minutely pitted.—It is not probable that this could be a form of *A. Americana*, as that species has, I believe, always a stipitate capsule and larger seeds with flat, punctulate areæ.

ADDITIONAL REMARKS.

The highest trunks of cultivated Agaves which I find noticed are 3–4 feet high and 3–4 inches in diameter; the thickest one was 14 inches through, but less high. I have met with no account of the size they may attain in their native country.

The scape of *A. Americana* is said to measure sometimes 36 feet in height.

The flowers of Agave are always more or less erect and of a coarser, calycine texture, while those of Yucca are pendulous and corolline.

NOTICE TO BOTANISTS.

I wish to direct the attention of botanists, who have the opportunity to observe the development of these plants, to the following questions:

At what hour of the day do the anthers of the different species burst and begin to shed their pollen, when do they become entirely effete, and in what state is then the style? How long afterwards and when does the style of the same flower attain its full development, and when and how much do the stigmatic lobes open or spread, and when does the stigmatic liquid fill the cavity of the style and cover the inside of the lobes?—I have above given an account of these physiological processes in *A. Virginica;* the only reference to them in literature which I can find is made by Jacobi, Ag. 310, where he says of an Agave of the second section, that the full development of the style and the separation and partial spreading of its lobes takes place only after the stamens have faded, which, as far as it goes, fully coincides with my observations. His further remark, that the stamens are not inflexed in the buds of that species (*A. Goeppertiana*), is unquestionably erroneous. Of the floral development of the Agaves of the third section nothing at all seems to be known.

I wish also to direct the attention of observers to the time and nature of the secretion of honey in the lower part of the flower-tube.

The inflorescence of those Agaves of the second section which are said to bear 1 or 3 or 6–8 flowers in a fascicle requires further investigation.—A careful examination of the young (forming) inflorescences of the third section will disclose the true nature of their arrangement.

Another point which claims the attention of observers, is the place and time of the formation of bulblets in the proliferous Agaves.

ERRATA.—P. 293, note, l. 3 from "while" to end of paragraph should be carried and added to the paragraph ending in "stigmas" at l. 8, top of page.

P. 304, l. 4 from bottom, strike out "to."

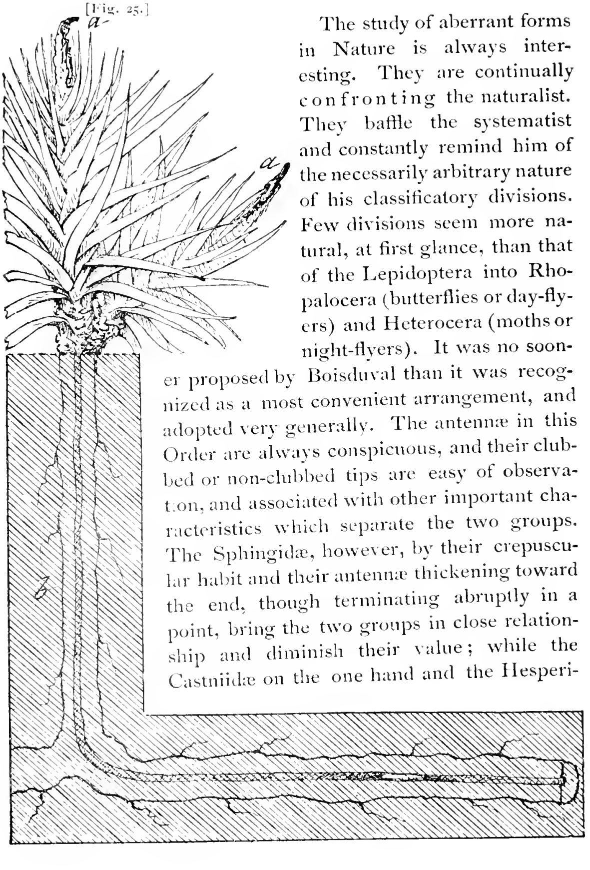
P. 314, l. 21, for "flexi sornato," read "flexis ornato."

Notes on the YUCCA BORER, *Megathymus yuccæ* (Walk.)

BY CHAS. V. RILEY.

> *"He who, by a minute analysis of any animal, enables us to solve any dubious point connected therewith, does more for the elucidation of this much abused natural system than the greatest and most ingenious theorist who has yet taken the subject in hand."*
>
> WESTWOOD.

[Fig. 25.]



The study of aberrant forms in Nature is always interesting. They are continually confronting the naturalist. They baffle the systematist and constantly remind him of the necessarily arbitrary nature of his classificatory divisions. Few divisions seem more natural, at first glance, than that of the Lepidoptera into Rhopalocera (butterflies or day-flyers) and Heterocera (moths or night-flyers). It was no sooner proposed by Boisduval than it was recognized as a most convenient arrangement, and adopted very generally. The antennæ in this Order are always conspicuous, and their clubbed or non-clubbed tips are easy of observation, and associated with other important characteristics which separate the two groups. The Sphingidæ, however, by their crepuscular habit and their antennæ thickening toward the end, though terminating abruptly in a point, bring the two groups in close relationship and diminish their value; while the Castniidæ on the one hand and the Hesperidæ on the other so intimately connect them, that it becomes almost a matter of opinion as to whether the former should be considered butterflies, or the latter moths. *Urania* and other abnormal genera* make the relationship of the two groups still more perplexing. On antennal structure alone—whether we consider the clubbed or non-clubbed tips according to Boisduval, or the rigidity, direction, and length, which Mr. Grote deems of greater importance†—two primary divisions cannot be based. If we take the spring or spine on the hind-wings, which is so characteristic of the Heterocera, we meet with the same difficulty; for a large number of moths do not possess it, while an accepted Hesperian (*Euschemon Rafflesiæ*, Macl.) from New South Wales is furnished with it. Nor is there any one set of characters which will serve as an infallible guide to distinguish moths from butterflies; and the number of moths described as butterflies, and the fact that Kirby considers the position of *Barbicornis*, *Threnodes*, *Pseudopontia*, *Rhipheus*, *Ægiale*, and *Euschemon*, included in his "Synonymic Catalogue of Diurnal Lepidoptera" as doubtful butterflies, gives sufficient proof of the truth of the statement. Between all classificatory divisions, from variety to kingdom, the separating lines we draw get more and more broken in proportion as our knowledge of forms, past and present, increases. Every step in advance toward a true conception of the relations of animals brings the different groups closer together, until at last we perceive an almost continuous chain. Even the older naturalists had an appreciation of this fact. Linnæus's noted dictum, "*Natura saltus non facit*," implies it; and Kirby and Spence justly observe that "it appears to be the opinion of most modern physiologists that the series of affinities in nature is a concatenation or continuous series; and that though an hiatus is here and there observable, this has been caused either by the annihilation of some original group or species * * * or that the objects required to fill it up are still in existence but have not yet been discovered." Modern naturalists find in this more or less gradual blending their strongest argument in favor of community of descent, and speculation as to the origin, or outcome rather, in the near present or remote past, of existing forms, is naturally and

* Westwood (*Intr.* ii. 359) figures *Barbicornis Basalis*, God. as an Erycinid butterfly with tapering and ciliate antennæ.

† Proc. Amer. Assoc. Adv. Sci. xxii., B. 111.

very generally indulged, even by those who a few years back were more inclined to ridicule than accept Darwinian doctrine. Shall we then say that the old divisions must be discarded because not absolute? As well might we argue for the abolition of the four seasons because they differ with the latitude, or because they gradually blend into each other! Entomologists will always speak of moths and butterflies, howsoever arbitrary the groups may come to be looked upon, or however numerous the intermediate gradations.

These thoughts naturally present themselves in considering so osculant a species as the Yucca Borer.

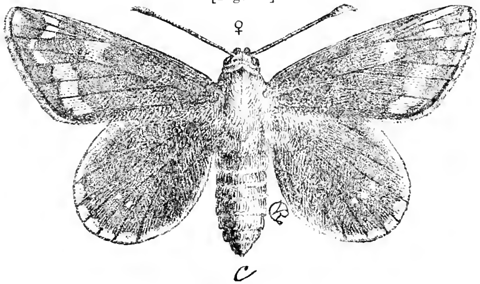
BIOLOGICAL.

The reader of these Transactions is aware that the queenly Yuccas cradle and nourish a very curious and anomalous Lepidopteron—the *Pronuba yuccasella** (*cf.* pp. 55–64 and 178–80). The genus is further interesting, from the entomological side, as giving us the insect under consideration.

* P. C. Zeller (Beitr. zur Kenntniss d. nord-amerikanischen Nachfalter; dritte Abtheil, pp. 134-6, Wien, 1875) shows that his *Tegeticula alba*, described in 1873 from the male only as a Hyponomeutid, is nothing but *Pronuba yuccasella*. He also condenses my account of its habits and offers some remarks which I deem it proper to notice. 1. Of the specific name, he observes in a note, "Vielleicht mit einer kleinen Abänderung in *Yuccæella*, da *Yuccasella* eine gegen die Regeln der lateinischen Wortbildung streitende Ableitung von Yucca ist." The pedantry is perhaps excusable in so venerable and careful an author, though it required little grace to see that I purposely deviated from grammatical usage; for in nomenclature I prefer euphony to strict classical construction where the latter gives us unpronounceable names. 2. "Die Raupe ist ohne Bauchfüsse und Nachschieber(?)" The question raised here is, perhaps, also excusable, since the want of anal prolegs is so anomalous in Lepidopterous larvæ. Nevertheless *Pronuba* in this respect, as in many others, *is* anomalous. The larva has no anal legs, there being not the faintest sign of hooklets; and my description was so detailed that Prof. Zeller might have omitted his query 3. Speaking of the ♀, he remarks: "Das Merkwürdigste an dem Ex. ist der grosse, hellgelbe, wachsähnliche, anscheinend solide, nicht aus Körnchen zusammengesetzte Klumpen, welcher zwischen der Wurzel des Saugrüssels und den Vorderhüften fest angeklebt ist. * * * Die Erklärung welche Riley von der Ansammlung der Fig. 74 richtig dargestellten Pollenmasse gibt will mir nicht genügen, da ich die Maxillartaster nicht für brauchbar zu dem Zweck halte. Der kräftige Saugrüssel scheint mir dazu allein brauchbar; aber wie durch allmäliges Ansammeln des Staubes eine solide, wie zusammen geschmolzene Masse entsteht, bleibt noch genauer zu untersuchen. Meines Erachtens hat Riley bei seiner höchst interessanten Entdeckung noch nicht Alles gesehen, und noch andere Beobachter werden erforderlich sein, um die sonderbaren Vorgänge bei der Fortpflanzung der Motte ganz genügend zu erklären." I remember very well the ♀ specimen which Prof. Zeller had under his eye, and which was received from Mr. A R Grote, to whom I had given it. She had already partly used her ball of pollen before being captured by me, and by repeated rubbing in the stigma and soaking in its nectar the mass had become welded and compacted. A little soaking in pure water would have resolved and separated the grains. A more careful reading of my articles on this insect would also have greatly helped Prof. Zeller's comprehension; for I have shown (6th Mo. Ent. Rep., p. 133) that the pollen is collected

In the home of the Yuccas, and more particularly in the home of the caulescent species, like *Y. aloifolia* and *Y. gloriosa*,* persons who have occasion to dig up the roots, or subterranean trunks, often notice that these are bored and hollowed out along the axis (Fig. 25, *b*), the burrow cylindrical, and lined at its upper end with silk, which is generally intermixed with a white, glistening, soapy powder. These tunnelings are made by our Yucca Borer, which dwells therein; and their presence may generally be detected by masses of excrement observable among the leaves, and by certain chimney-like projections made by the twisting and webbing together of the more tender heart-leaves, or even of the flower-stalk, after they have been partly devoured, into a sort of funnel, from which the excrement is expelled (Fig. 25, *a*, *a*). The tunnelings weaken the trunk and induce rot, so that the plant is not unfrequently prostrated thereby; and as the insect is sufficiently common in the Gulf

[Fig. 26.]



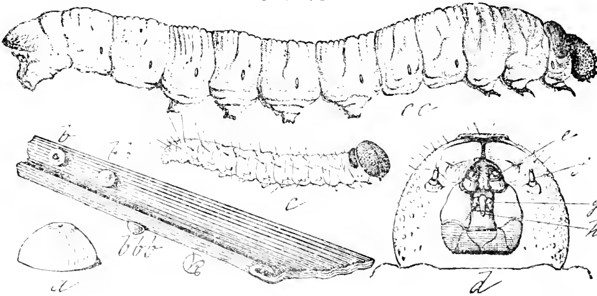
MEGATHYMUS YUCCÆ: Female.

without difficulty, being glutinous, and generally remaining in an entire lump on the contracted and curled anthers, so that a single anther may furnish the required amount. After stating (p. 60 of these Transactions) that my account of the mode of collecting the pollen was founded on repeated observation, and showing that the spinous maxillary tentacles are admirably adapted to the purpose, the opinion that the smooth tongue can alone be employed for the purpose is unworthy so careful a writer as Prof. Zeller; and as for the reflection in the last sentence which I have quoted, I am vain enough to believe that there is no other provocation for it than a certain ill-will on my critic's part. It comes, too, with all the less grace from one who confessedly made hasty and incorrect observations on the position of the species. From one less honored and esteemed, such captious remarks would have received no notice at my hand.

* Though I have positive proof of its working in *aloifolia*, *gloriosa*, and *filamentosa*, its range does not seem to be co-extensive with this last species, as I believe the insect has not yet been reported north of latitude 36°.

States to sometimes be found in every third plant over extended regions, its work renders the Yucca worthless as a hedge plant, for which it has been tried.

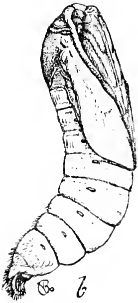
[Fig. 27.]



MEGATHYMUS YUCCÆ: *a*, egg, side view, enlarged; *b*, egg from which the larva has hatched; *bb*, *bbb*, unhatched eggs, nat. size; *c*, newly-hatched larva, enlarged; *cc*, full-grown larva, nat. size; *d*, underside of head of same, enlarged to show the trophi.

In the months of April and May, in South Carolina, but earlier in more southern latitudes, the parent Megathymus may be observed, where the Yuccas abound, passing, with very rapid, darting flight, from plant to plant, remaining but a few seconds at one place, during which she fastens an egg (Fig. 27, *bb*) to some portion of a leaf. She is generally seen at this work in the morning hours. The eggs, which are well-developed when she issues from the pupa, are laid singly, though several are often attached to the same leaf, generally near its tip and on the upper or under side indifferently. In the course of about ten days the young, reddish-brown larva (Fig. 27, *c*) gnaws its way out through the crown of the egg and conceals itself in a web between some of the more tender terminal leaves. Generally it will be found at first near the tip of a leaf where the sides naturally roll up and afford a safe retreat. It then gradually works to the base, feeding the while and rolling and shriveling the blade as it descends. Other blades are often joined, and, in fact, the insect lives among the blades till it is about one-fourth grown, and seldom enters the trunk before that time. How soon, in the larval development, the white, powdery secretion, already spoken of, appears, or how many larval molts occur, has not been ascertained; but the more mature larva is always more or less covered with this powdery matter, which doubtless serves as a protection from the mucilaginous liquid which the tissues of the Yuccas contain and freely exude upon interference or maceration. Pupation does not take place till the subsequent late winter or spring; there being, from all that I can ascertain, but one brood each year. The burrow often extends two or more feet below ground, and during the coldest weather the larva probably remains in a partially dormant state at the bottom. Occasionally two larvæ inhabit the same trunk, in which case their tunnelings are kept separate, side by side. The pupa state (Fig. 28) is generally assumed just below the chimney-like funnel at the top of the burrow, and no other preparation is made for it than partial closing, near head and tail, to insure suspension. This funnel is, in reality, built and extended by the larva, and what little matter besides silk goes to make its exterior has been added and worked in from the outside. In the several larvæ that I have had feeding in breeding-cages, this habit of building up and making tubes, for which remnants of leaves and other extraneous substances are pressed into use, struck me as quite characteristic; and in one instance I have had such a tube extended over nine inches from the tunneled trunk, the moss on which the section of Yucca rested being used in its construction.

[Fig. 28.]

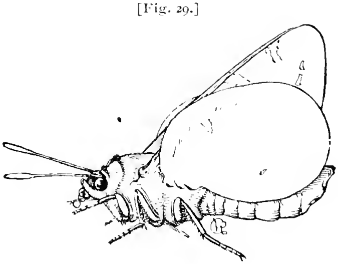


MEGATHYMUS YUCCÆ: Pupa.

In the issuing of the imago the pupa skin is rent on the middle of the notum and across the eyes, and the casings of the legs are never, and those of the antennæ seldom, severed from their solderings in the exuvium.

The imago rests (Fig. 29) with its antennæ slightly diverging and generally directed forwards; with the wings elevated, closely appressed, and with the costa of primaries at an angle of about 45° from the body. Regarding the flight, which is diurnal. Dr. J. H. Melli-

[Fig. 29.]



MEGATHYMUS YUCCÆ: At rest.

champ, of Bluffton, S. C., was impressed with the extremely rapid and darting motions of the insect as it passes from plant to plant; and Mr. E. A. Schwarz, of Detroit, who has had very excellent opportunity of observing the species in Volusia Co., Florida, informs me that, when startled, Megathymus flies directly upward 20 or 30 feet, then horizontally for a long stretch — sometimes out of sight — and descends as directly as it rose. It frequents open places, is very shy, and generally settles near the ground.

BIBLIOGRAPHICAL.

The first notice of this insect that we have any record of is that by Boisduval and LeConte, who figure it under the name of *Eudamus? yuccæ* on Plate 70 of their *Iconographie*.* Though there is no text accompanying the plate, it is evident from the generic reference that the insect is considered Hesperian, and no one could hesitate to so consider it if guided by the figures. In those of the imago the head is unnaturally broad, the body too slender, and the antennæ with the club too slender and too much hooked. The wings in repose are thrown forward as in *Thecla;* the antennæ erect, and the legs too slender. The larva has the large and nutant head, narrow thoracic joints, and green, yellow and white longitudinal stripes so characteristic of Hesperid larvæ. The pupa has much the form and color of *Epargyreus Tityrus* (Fabr.) In short, these figures, in many respects, and those of the larva and pupa more particularly, are so unlike the insect considered in the present paper, that the question might justly be raised as to whether I am dealing with the *Yuccæ* of Boisduval and LeConte, if the figures in the work in question were known to be generally trustworthy. But I have already shown in these pages† how inaccurate and unreliable some of the said figures are; while the food-plant, as indicated by the specific name, and the size, markings and color of the perfect insects in the plate, leave no doubt as to the identity of *Yuccæ* B. & L. and the species here considered. Too much imagination entered into the composition of that plate, and the probability is that after LeConte's figures were received in

* *Hist. Gén. et Icon. des Lépid. de l'Am. Sept.*, 1833.

† Transactions, etc., pp. 193-4.

Europe by Boisduval, the latter by mistake coupled with *Yuccæ* the larva and pupa of some other large Southern Hesperian.¶

The next reference to this insect is by Walker,* in 1856, who is the first to briefly describe it as *Castnia yuccæ*. In 1871, Kirby referred it doubtingly to *Ægiale*, Feld. in Hesperidæ.† In 1872, Scudder made it the type of a new genus (*Megathymus*) in Hesperidæ,‡ without further diagnosis than the incorrect figures in the *Iconographie* alluded to. This reference is followed by Wm. H. Edwards in the Synopsis accompanying the first volume of his work on N. A. Butterflies (1872). Scudder subsequently states that "it is not a butterfly."§ and Mr. A. R. Grote, after an examination of specimens collected in Florida, regards it "as belonging to the Castnians, where it is placed by Walker."‖

It will thus be seen that this insect has sorely perplexed systematists, having been bandied from the butterflies to the moths: and that the balance of opinion withdraws it from the butterflies and places it with the Castnians—a family which, in some respects. combines the characters of the two great Lepidopterous divisions, but is regarded, and justly, as having most affinities with the moths.

I shall endeavor to show that this opinion is not well-founded: that *Megathymus* is a genuine butterfly, and that its greatest affinities are with the Hesperians. Together with one or two

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¶ They belong, however, neither to *Tityrus* nor *Proteus*, with the early stages of which I am familiar. It would seem that Boisduval already had in his possession a more correct figure of the larva of *Yuccæ*: for Mr Scudder has transcribed for me the following memorandum, which is accompanied by a truthful outline of the larva:

"Larva de la grande Hesperia: *Habitat in caulibus et radicibus diversarum specierum Yuccæ, nidum format longum cylindricum e tela sericea fragmentisque foliorum plantæ. Cum tempus metamorphoseos appropinquat pulvere albo larva conspergitur et idem chrysalidem vestat.*"

This memorandum was originally in Boisduval's possession, but has been purchased by the Boston Soc. Nat. Hist, among other original drawings by Abbott, under the supposition that it was one of this naturalist's sketches There is good reason for believing, however, that it was made by the late Major John LeComte, who, as we know from his son (Proc. Am. Assoc. Adv. Sci. xxii. B, 13, note), had nothing to do with the preparation and systematic arrangement of the *Iconographie*. though he made numerous notes and drawings which were retained in Europe by his co-editor.

* List of the specimens of Lep. Ins. in the Coll. of the British Museum, Part VII., p. 1583. No. 43.

† Synonymic Cat. Diurnal Lep., p 608. W F. Kirby: London, 1871

‡ Systematic Revision of some of the Am. Butterflies, etc., p. 62. S. H. Scudder: Salem, 1872.

§ Historical Sketch of Generic Names proposed for Butterflies, p. 213. Salem, 1875.

‖ *Canadian Entomologist*. September, 1875. p. 173.

other species it forms a small, aberrant Tribe; but, in order to more fully discuss its affinities, it is necessary to give an exposition of its characters, as no detailed descriptions have yet been published.

DESCRIPTIVE.

EGG—Subconical, the top flattened or depressed, and with a slight central dimple; the attached base concave; smooth but not polished. Color pale green when laid, inclining to buff-yellow or brown before hatching. Diameter at base 2.5 mm.; height 1.8 mm.; the transverse diameter often varying slightly in two cross directions. Fourteen examined that were naturally deposited and many more in the ♀ abdomen.

LARVA.—Newly-hatched Larva (Fig. 27, *c*): Length 6 mm. Color dark brick-red with pitchy-black head and cervical shield; the abdominal joints showing two principal transverse folds. Six longitudinal rows (2 dorsal on anterior fold, 2 subdorsal, and 2 stigmatal on posterior fold) of black stiff hairs, arising either directly from the skin or from very small tubercles, longest posteriorly where they often exceed in length the diameter of the joint bearing them; some less conspicuous stigmatal and subventral hairs. Head larger than first thoracic joint, rounded, but rather flat in front; cervical shield narrow and in one piece; both minutely punctate. No anal plate. Full-grown Larva (Fig. 27, *cc*)—Average length 2.60 inches; diameter 0.40 inch. Color edematous white. Surface faintly aciculate, and sparsely armed, dorsally, with minute, evenly distributed, short, rufous bristles, springing from the general surface, and not very noticeable with the naked eye: covered more or less copiously with a white, glistening, powdery secretion.* Cylindrical, the abdominal joints with 8 annulets, the first 3 occupying anterior half, the 3rd most prominent and widening laterally, and the other 5 on the hind half of the joint—all best defined dorsally. The thoracic joints somewhat larger than the rest, more deeply and irregularly wrinkled; the substigmatal region with longitudinal folds. *Head* black, perpendicular, and asperous or deeply shagreened; epistoma and labrum brown, small, and usually with a transverse median ridge, the λ-shaped mark white, forking before the suture, and the forks having the shape of U: mandibles stout, subtriangular, non-dentate: antennæ (Fig. 27, *f*) 2-jointed, exclusive of bulbus, the terminal joint twice as long as the basal, sometimes showing a faint constriction, and with an apical nipple and long seta: maxillæ and labium and mentum forming a subquadrate piece, bulging out prominently from beneath, the parts seemingly soldered together and separated only by deep sutures, the maxillary palpi (Fig. 27, *e*) consisting of two broad joints, the second surmounted by two stout nipples, squarely docked at tip, the inner one stoutest and both armed

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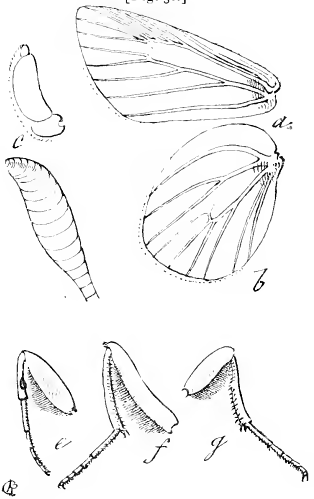
* This secretion is of a waxy nature, analogous if not identical with that secreted by so many Homopterous and some Hymenopterous larvæ. It is soapy to the touch, and dissolves readily in alcohol, leaving however a distinct scum on the surface.

with bristles (the parts not clearly shown in figure): the labium small, trapezoidal, highly polished, with the spinneret (*h*) twice as long as palpi (*g*) which are small, recurved and 2-jointed, exclusive of bulbus: a few stout bristles on labrum, on palpigerous piece of maxilla, on mentum, base of mandibles and around the ocelli, which are not easily distinguished from the more globular of the shagreenations. Cervical shield more glabrous than head, and scarcely darker than the body except around hind border. *Thoracic legs* very short but stout, with the horny parts deep brown, and sparsely armed with bristles. Prolegs well developed, the hooks in double row and forming a distinct purple-brown, transversely oval annulus, but slightly broken at the narrow ends. *Anal shield* rounded behind, coreaceous rather than corneous, and with a slight increase of bristly hairs, especially around border. *Stigmata* large, with a purple-brown, oval annulus.

PUPA—Average length 1.50 inches. Cylindrical; broadest at shoulders, the abdomen large, recurving ventrally toward anus, and terminating in a broad, flattened, posteriorly rounded, transverse, slightly decurving flap, the borders thickened basally and extending ventrally so as to surround the bilobed anus. Eyes prominent, with a transverse carina: wing-sheaths reaching hind part of 4th abdominal joint, ventrally; hind tarsi to about the hind third of these, and the club of antennæ—which forms a prominent bulge but tapers to a point—nearly as far. Surface but slightly polished and faintly corrugate; a few extremely minute bristle-like spines distributed over the abdominal joints, dorsally, and the two or three terminal joints with stiff rufous hairs, increasing posteriorly and thickest on the flap. Chitinous covering delicate, and all the members clearly defined. Prothoracic spiracle showing as an opaque, elliptic-ovoid wart. Color brown-black anteriorly, paler on the abdomen, and more or less densely covered with a white powdery secretion like that which characterizes the full-grown larva.

IMAGO.—Generic Characters—Head small, the width, including eyes, not much more than half that of the mesothorax; the antennal bulbus large, and the inter-antennal space not wider than one of the sockets; covered with rather evenly shorn, dense hairs, and flattened scales not overhanging the eyes. Eyes small and smooth. No ocelli. Labial palpi (Fig. 30, *c*) stout and short, not reaching to top of eyes, 3-jointed, the basal joint broad but short, the middle joint 4 times as long, the terminal joint tuberculous and ¼ as long as the preceding: clothed in short and thick hair-like scales. Tongue filiform, rather more than ½ the antennal length. Antennæ rigid, cylindrical, terminating in an elongate knob (Fig. 30, *d*) which is slightly flattened and slightly tapering and recurved at tip, but without apical spine or tuft: having rather more (♂) or rather less (♀) than half the costal length of primaries. *Thorax* very robust, recalling that of *Xyleutes;* clothed with close-lying hair which becomes longer and looser behind; the patagia rather broad, forming two crescent-shaped, slightly raised layers; the tegulæ closely appressed. Legs (Fig. 30, *e*, *f*, *g*, front, middle and hind) with brushy hairs beneath the femora; the tarsi all studded beneath with minute reddish spines, the hind and middle tibiæ still more strongly spined, and each with a pair of more prominent spine-like, apical spurs, of equal size, and hardly longer than the other spines in ♂ and not longer than the diameter of tibiæ in ♀: the front tibiæ unarmed, the nodule on the inner apical third ovoid and dark: tarsal claws with a very small pulvillus between them: front femora 5.5 mm. long; tibiæ rather more than half as long; tarsi as long as femora: middle femora 7.4 mm. long; tibiæ and tarsi but slightly shorter: hind femora same length as front ones; tibiæ $\frac{1}{5}$ longer. *Wings*, with the scales, small but mostly long, narrow and dense, with long hair at base superiorly and with the general shape and venation (Fig 30. *a*, *b*) of *Hesperia*, the primaries with the apical angle more acute, but less so than in *Thymele;* anal angle not produced but rounded: secondaries narrow and more rounded than in any other Hesperid genus known to me: veins quite stout. *Abdomen* ♀, very stout and heavy, thickening behind, blunt at tip, and truncate below; ♂ more slender and gradually tapering. Specific Characters — Average expanse 2.50 inches; length of body 1.12 inches. General color, above, deep umber-brown, the body more grayish, especially the tegulæ; the longer hairs of mesothorax and base of abdomen inclining to ferruginous: whitish in front and around the neck and back of the eyes. Primaries with a notched ferruginous band on the outer fourth bounded by veins 1 and 4; a narrower mark running from the posterior margin of this between 4 and 6; a paler mark in a line with the first band between 6 and 9, and a ferruginous mark again just within the discal area—the veins traversing these spots showing distinctly black: an apical shade, a costal streak between veins 8 and 9, and alternate marks on the fringes, are pale yellowish; while the basal hairs are ferruginous. Secondaries with a ferruginous border and straw-yellow fringes. In the ♂ the antennal stem is paler, the spots on primaries smaller and paler, and the border on secondaries wider; while in the ♀ the secondaries have

[Fig. 30.]



MEGATHYMUS: *a*, *b*, venation of front and hind wings; *c*, labial palpus, denuded; *d*, club of antenna; *e*, *f*, *g*, front, middle and hind legs.

from two to four ferruginous spots just outside the disc and between the inferior veins.* Beneath, the whole coloration is brighter, the spot between veins 6 and 9 being pure white, the others saffron-yellow. and the posterior portions of all the wings, and a broad costal streak on secondaries, pearly-gray: a spot of the same color is observable on the outer third of secondaries below vein 2, a more distinct and triangular mark on the inner third just below the costal vein; while the orange superior spots in ♀ show dark brown. The antennæ are white with the exception of the club; the palpi and front trochanters whitish-gray, deepening posteriorly. The legs are brown with the tarsi but faintly tinged with gray.

The ten specimens that have come under my observation show considerable variation, aside from that which is sexual, in the depth of color and size of the spots, as well as in the distance between them and the hind border of the wing; but none of them have the spot on primaries, indicated in one of Boisduval's figures, just within the middle of the wing and below vein 2.

AFFINITIES.

Let us now compare the foregoing detailed characters with the Castnians on the one hand and the Hesperians on the other.

Scudder, who has certainly given more attention than perhaps any other author to the Hesperians, divides them into two groups, which he considers of tribal value.† The first to which he applies Latreille's name *Hesperides* is characterized chiefly by the primaries in the ♂ having a costal fold (often inconspicuous, however); by the posterior extremity of the alimentary canal being protected beneath by a corneous sheath, which extends beyond the centrum or body of the upper pair of abdominal appendages, sometimes nearly to the extremity of the appendages; by the club of antennæ being elongate, roundly bent, or with a sinuous lateral curve; by the prevailing color being dark brown with white or translucent angular spots; by the stout body and swift flight; by the eggs being distinctly ribbed vertically; and by the larvæ generally feeding on leguminous plants and living in horizontal nests made with the leaves. The second tribe, to which he gives Hübner's name *Astyci*,‡ the front wings of ♂ have no costal fold; the extremity of the alimentary canal is not protected

* The secondary sexual characters are confounded by Boisduval, as quoted by Morris (Synopsis of Lep. of N. A., p 113), though, as there is no text in the *Iconographie*, the error doubtless originated with Morris in making descriptions from the figures.

† Bulletin Buffalo Soc. Nat. Sci., p. 195.

‡ I think such diversity of ending in terms used for divisions of the same value should be avoided.

by any extruded sheath; "the prevailing tints of the wings are tawny and black, marked also but often feebly with pale, sometimes vitreous, spots"; the antennæ have a stout club, which either tapers rapidly or is devoid of a crook; the hind wings are usually horizontal in rest; the eggs are smooth, usually broader than high; and the larvæ "feed on Gramineæ, and generally construct vertical nests among the blades."

The eggs of the Castnians are, so far as I am aware, unknown and undescribed. In both butterflies and moths they present an infinite variety in form, in sculpture, and in the manner in which they are laid. As a rule, however, those of the larger moths are either ovoid, spherical or flattened, and rarely subconical or sculptured; while those of butterflies are more often conical, and present greater variety in form and sculpture. The eggs of Hesperians are subconical, and those of the Astyci, as we have just seen, in being smooth and broader than high, agree exactly with those of *Yuccæ*.

The larvæ of the Castnians are, according to Boisduval,* endophytous, boring the stems and roots of Orchids and other plants, like the Sesians and Hepialians, and like *Yuccæ*. But they are ornamented with the ordinary horny piliferous spots or warts which characterize Heterocerous larvæ, and have a horny anal plate. Butterfly larvæ, on the contrary, rarely possess these warts, but frequently have the body uniformly beset superiorly with close-shorn bristles as in *Yuccæ*, such bristles generally springing from minute papillæ. The newly hatched larvæ of the two divisions approach each other more nearly in general appearance, as all animals do, the farther we go back to the commencement of individual life; but though the newly-hatched larva of *Yuccæ* bears a general resemblance to the same stage in many endophytous Heterocerous larvæ (e.g. *Xyleutes*, *Cossus*), yet in the stiff hairs springing from the general surface, or from very minute points, instead of from distinct tubercles, it agrees with the Rhopalocera. The legs, both false and true, together with their armature and the trophi, are so extremely variable in both divisions that comparisons can hardly be instituted. The endophytous habit, though very exceptional, is found in butterflies (e.g. *Thecla Isocrates*, Fabr.: see Westwood's Intr., ii.,

* Suites à Buffon; *Sphingides, Sésiides, Castniides*; Paris, 1874.

p. 369). None of the Heterocerous borers, so far as my experience goes, line their burrows continuously with a matting of silk; but use the silk very sparingly, or not at all, till about ready to pupate. The larva of *Yuccæ*, for the most part, lives in a tube of silk, which it builds and extends often several inches beyond the trunk or stem in which it burrows, and from which it often, especially when young, issues to feed. In this, again, it approaches the Hesperians, which are partial concealers, and live, when not feeding, within silken cases or tubes constructed among the leaves of their food-plants.

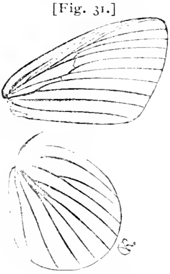
The pupæ of the Castnians, like those of all Heterocerous borers known to me, are, according to authors, armed with rings of minute spines on the hind borders of the abdominal joints—the spines serving a very useful purpose in assisting the pupa out of its cocoon. Heterocerous borers also pupate in a more or less perfect cocoon, made either within or without the burrow; and, in the issuing of the imago, the mesothoracic covering generally collapses, the leg-cases become unsoldered, and those of the antennæ are always separated and often curled back over the head in the exuvium. The Hesperians pupate within the silken cavity occupied as larva, or else in a separate slight cocoon: the pupa is generally attached to a silken tuft by the hooks of the cremaster, and sometimes by a silken girth around the middle of the body besides: it is not unfrequently covered with a slight powdery bloom, and is characterized by the prominence of the prothoracic spiracle*: the exuvium more nearly retains its form, the leg-cases remaining soldered, and even those of the antennæ being rarely separated. In not having a well-formed cocoon, in being covered with bloom, in the characters of the exuvium, in the conspicuity of the prothoracic spiracle, but more particularly in the want of minute spines on the borders of the abdominal joints, *Yuccæ* is again Hesperian and not Castnian. Indeed, except in the broader anal flap, densely surrounded with stiff bristles, in place of an apical bunch of hooks, in the smaller head and larger body, it resembles *Nisoniades* in general form, color, and texture.

The typical Castnians, in the perfect state, have the wings large

* In *Nisoniades Juvenalis* (Fabr.) this spiracle takes the form of a prominent sooty-black horn or tubercle.

with loose and *very large* scales, and the hind-wings *invariably* armed, at costal base, with the *long stout spine*, or spring, which serves to lock the wings in flight by hooking in a sort of socket beneath the primaries, and which is so characteristic of the Heterocera. The venation resembles more nearly that of the Hepialians, and is totally unlike that of the Hesperians. The veins are slender: in the primaries 1*a* and 5 are as stout as the rest; the discal cell is short, connected transversely with 3 and with an areolet above: in the secondaries the cell is nearly obsolete, and the independent or vein 5 of secondaries is as stout as the others. (Comp. Fig. 30 *a*, *b*, with Fig. 31.) The antennæ, though thickened at tip, are generally long and more or less supple, and there are two distinct ocelli between the eyes, behind the antennæ. The Castnians vary much in general appearance, but, whether we deal with the Brazilian *Castnia Linus* (Cram.) with its narrow, elongate, rounded, clear-spotted wings, and its remarkably elongate and swollen basal joint of the middle tarsi; or with *C. Licus* (Cram.) which has broad, angular wings; or with the genera *Ceretes*, *Orthia*, *Gazera*, and *Synemon*—we find the characters above mentioned constant: they are typical of the Family and are Heterocerous characters. *Yuccæ*, on the contrary, has none of these characters; but in the smaller wings, in their venation, in the closeness of the small and narrow scales and hairiness at base, in having no ocelli, and in the unarmed secondaries, entirely agrees with the Hesperians.* I attach much less importance to the antennæ, size of head and body, or even the spurs of tibiæ; because they are all more variable. Thus, while most of the Castnians have the antennal club tipped with a spine or a bunch of bristles, others (e.g. *Castnia Orestes*, Walker, from Surinam) have it of the same shape as in *Yuccæ*, and unarmed, or even more short and blunt (*Synemon*

[Fig. 31.]



Venation of Castnia Phalaris (Fabr.)

* These views were communicated to my friend Mr. Scudder during the first week in December, and were by him brought before the entomological section of the Bost. Soc. Nat. Hist. on the 22nd of the month. On the 26th of the same month I received from Mr. Kirby the copy, published in the Appendix, of Felder's description of *Ægiale Kollari*, and the opinion that its affinities are Hesperian. *Ægiale* is so near *Megathymus* that the similarity of Felder's views and of my own, independently arrived at as they were, is gratifying.

Theresa, Doubl.) Again, in most Hesperians the club tapers, or is curved at tip; but there are all degrees of variation, from the extremely curved club of *Epargyreus Tityrus* (Fabr.) to the straight and blunt club of *Oarisma Poweshiek* (Parker). The small head and subobsolete spurs in *Yuccæ* are abnormal compared with either family; for most of the Castnians have the spurs much as in *Hesperia*, and the head almost as broad as the thorax. In the stiffer, relatively shorter antennæ, with large club; in the spines which stud the tibiæ,* as well as in the stoutness of the thorax and abdomen, *Yuccæ* is again Hesperian rather than Castnian. The Castnians, like the Uranians and many other exceptional moths, resemble the butterflies in being day-flyers; but the position of the wings in repose, which is a more important character, is said by all observers to be similar to that of *Catocala*, *Drasteria*, and other Heterocera, viz., deflexed or incumbent. *Yuccæ*, both in manner of repose, in color, and in pattern, is a staunch Hesperian.

In short, a careful consideration of the characters of our Yucca Borer shows that in all the more important characters it is essentially Hesperian; and that in most of those characters by which it differs from the more typical species of that family—as in the small spurs, in having only the apical ones on the hind tibiæ, in the tibial spines, and difference in size of legs—it is more Rhopalocerous than Heterocerous. The same holds true when we consider the adolescent states. In the small head of both larva and imago, and in the very large abdomen, it is abnormal; but these characters are traceable to the abnormal larval habit, and are very unimportant compared to the pterogostic and other characters cited. I have long since concluded that general larval form and appearance is so dependent on habit and so variable according to habit, that it is less valuable than more minute structural characters, and that for purposes of classification it has even less value than egg-structure, and infinitely less than imaginal characters. All endophytous Lepidopterous larvæ, of whatever family, have certain general resemblances that are a consequence

† In the Castnians that I have been able to examine none of the tibiæ have spines, while those on the tarsi are very minute: the middle tibiæ have a pair of unequal, prominent subapical spurs, and the hind tibiæ have two similarly unequal pairs, the anterior pair from about the terminal fifth.

of similarity of habit; and I give it as my emphatic opinion that *Yuccæ* is a large-bodied Hesperian, which, though approaching the Castnians through *Synemon*, has no real relation with them. In certain marked characters it departs from the Hesperians as at present understood, and the only question which a careful study of the species gives rise to in my mind is—not whether it should be considered a Castnian, but whether it offers characters that necessarily separate it from the Hesperians. Families should, I think, be made as comprehensive as possible and not unduly multiplied; and in considering aberrant forms, the objects of classification are best subserved by retaining them in whatever division can claim the balance of characters. It is better to widen than to restrict in the higher groups. LeConte does better service in bringing Platypsylla among the Coleoptera than does Westwood in creating a new Order—Achreioptera—for it. Phylloxera, in Homoptera, is much more wisely retained in the Aphididæ than made the type of a new Family. Let *Yuccæ*, therefore, be retained in Hesperidæ. By its aberrant characters it may constitute the type of a third tribe, for which I would propose the name *Castnioides*. This Tribe consists at present, in addition to *Megathymus yuccæ*, of two other good species, the one from Mexico, the other from Costa Rica. It is very probable that this number will be greatly increased as we become more familiar with the Lepidopterous fauna of Mexico and Central America, where the Yuccas and Agaves abound; for I have little doubt that the last-named plants will also be found to nourish other species of the Tribe.

ENEMIES.

I have reared from the Yucca Borer eleven Tachnia flies, all belonging to the species which I have designated *anonyma*, and which infests the larvæ of a number of other Lepidoptera.* The fact that *Yuccæ* is attacked by such a parasite is further proof that it is more or less an external feeder, since it is hardly probable that the parent Tachina would enter the burrow, and I know of no genuine endophytes that are similarly attacked.

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* 4th Mo. Ent. Rep., p. 129.

CONCLUSION.

Whether we have in our Yucca Borer a remnant of more ancient and synthetic types from which the Castnians on the one hand and the Hesperians on the other are derived, or whether we have in it a more recent variation from the more typical Hesperians, are questions which, with present knowledge, permit only of a speculative answer. The former hypothesis is, however, the more plausible. The Castnians, while occurring in Mexico, find their greatest development in Central America and Brazil. The few Castnioides known, inhabit the southern part of N. America. During the tertiary period, when the ocean reached over the whole Mexican plateau northward, the fauna of North and South America was much more similar than at the present time. It is not difficult to conceive how a Lepidopterous family that was then common to both divisions of the continent, may since that time have deviated in the two directions indicated, and yet have left some less modified forms in the intermediate country. We are assisted in this conception if we view, with some botanists, the Yuccas as remnants of an ancient flora.

We may learn from the history of this butterfly, as from that of the Hackberry butterflies,* how unsafe it is to describe, and particularly to create genera, from mere drawings. Megathymus, as founded on Boisduval's figures, is very much of a myth. It is so with all genera erected by the mere coining of a name without recognizable definition; and while a Hübner, in making a number of divisions on superficial grounds, may accidentally hit upon relationships which subsequent research proves correct, he certainly does not greatly benefit science by his work. Again, we may learn the necessity for the adoption by entomologists of some rules for guidance in matters that do not come within the scope of present accepted rules. Can names connected solely with published figures be accepted? Shall we write *Yuccæ* Boisduval or *Yuccæ* Walker? Such questions become the more important when two different names are employed. A figure, however good, cannot be considered a definition; and, whilst most entomologists would consider that the species in question

* These Transactions, p. 203; 6th Mo. Ent. Rep., p. 150.

had not virtually been named until described by Walker, others take a different view, and perhaps with reason, since a good figure, so far as recognition of the thing intended is concerned, is infinitely more definite than the majority of the earlier descriptions of species in entomology.

In conclusion, I take pleasure in expressing my obligations to Mr. W. F. Kirby of Dublin, Mr. John A. Ryder of Philadelphia, and Mr. Herman Strecker of Reading, Pa., for kind assistance in my studies of this insect; and more particularly to my esteemed correspondent Dr. J. H. Mellichamp of Bluffton, S. C., for his efforts in furnishing material, and to my friend Mr. S. H. Scudder of Cambridge, Mass., for valuable aid, always freely given.

APPENDIX.

As a matter of convenience and future reference, especially for those living where the Yucca Borer occurs, and allied species are likely to be found, and where scientific libraries are nearly unknown,—I have brought together in this appendix the descriptions of those species that belong to the *Castnioides*. It will be seen that *Ægiale* Felder comes very close to *Megathymus*. The antennæ, however, appear to have the club more falcate; while the legs, in having the tibiæ unarmed and hairy, and the wings, in being broader, more triangular, with the posterior border more convex, would seem to distinguish *Ægiale*. Felder's *Kollari*, as Mr. Kirby informs me, is believed by Mr. Butler to be synonymous with Walker's *Hesperiaris*—a belief founded, no doubt, on comparison of the types, since Walker's description is very insufficient.

Castnia yuccæ.—Nigro-fusca; antennæ capitatæ, non falcatæ; alæ basi subfulvescentes, anticæ fascia subapicali incompleta antice duplicata testacea, posticæ testaceo-marginatæ.

Blackish-brown. Antennæ capitate, not falcate; middle part whitish. Wings with a slight dingy tawny hue at the base. F.w. with a subapical, pale, incomplete, testaceous band, which is forked in front. H.w. with pale testaceous borders. U.s. with hoary borders, and with a triangular white subcostal spot. Length of body, 10–12 lines; of wings, 21–28 lines.

This species connects the *Castniæ* with the *Hesperiæ*. Georgia.—[Walker, List Lep. Het. B. M. vii., p. 1583 (1856). Belongs to *Megathymus*.

Ægiale Felder.

Caput mediocre, porrectum, villosum.

Oculi nudi, prominentes.

Antennæ crassiusculæ, sat longæ, costæ dimidium æquantes, in clavam elongatam subrectam apice mucrone brevissimo terminatam incrassatæ, distincte articulatæ.

Maxillæ spirales longæ, sat angustæ.

Palpi breves, dense squamato-villosi, sursum ascendentes, capitis verticem non æquantes, approximati, articulo primo secundo dimidio breviore, tertio minimo, obtuso pennicillato-setoso.

Thorax valde convexus, ovatus, robustus, dense villosus.

Alæ elongatæ, integerrimæ, basi dense villosæ, venis validis, ciliis latis variegatis, cellulis clausis.

Alæ anticæ trigonæ acutæ, costa subrecta, margine externo convexo, costalis dimidium æquante, interno subrecto, costa breviore, disco paginæ inferioris villo longiore tecto, cellula angusta, vena costali recta, post costæ medium desinente, vena subcostali quinque-ramosa, ramis intervallis æqualibus ante cellulæ extimum ascendentibus, vena discoidali prima ramo ultimo subcostali valde approximata, secunda remota, ad venæ medianæ extimum oriente, vena disco-cellulari incurvata, vena mediana triramosa, ramis intervallis longis inter se distantibus.

Alæ posticæ costa arcuata, antice dilatata, angulo apicali subproducto, anali subtruncato, calcaribus binis præcostalibus validis, cellula præcostali angustissima, vena costali subrecta, post costæ medium desinente, ramis binis subcostalibus intervallo sat longo distantibus, secundo ad cellulæ extimum oriente, vena discocellulari distincta, incurvata, vena discoidali a ramis subcostalibus valde remota, basi arcuata, ramis tribus medianis approximatis rectis, vena submediana et postmediana parum distantibus.

Pedes validi, femoribus tibiisque longe villosis, tibiis inermibus, femore tertia parte brevioribus, tarsis subtus spinulosis, quinque articulatis, articulo primo longissimo tibiam fere æquante, ungulis minutis curvatis.

Abdomen subconicum robustissimum.

Type *Æ. Kollari.*—♀ alæ ciliis albidis, fusco intersectis, supra nigrofuscæ, basi rufo-fulvo villosæ, anticæ fascia discali abbreviata recte læte fulva, intus tridentata (dente infimo usque ad basin protracto) maculæ costali albæ adhærente, strigaque incurvata subapicali, antice alba, postice fulvescente; posticæ macula basali obsoleta fasciaque sinuata submedia læte fulvis. Alæ anticæ subtus nigro-fuscæ, fascia strigaque paginæ superioris, costa limboque apicali cinereis, fusco-atomatis. Alæ posticæ cinereæ, fusco-atomatæ, macula costali nigra, fascia subbasali obsoleta alteraque submedia maculari in loco fasciæ paginæ superioris dilutioribus, nigrocinctis, illa macula cellulari alba nigrocincta notata. Antennæ albæ. Caput postice albido-cinctum. Palpi, thorax et pedes cinereo-villosi. Thorax postice et abdomen basi fulvo-hirsuta, hoc nigricans.

Antennæ and habitus resembling *Castnia:* but the want of the bristle on the h.w., the neuration, and the hairy clothing of the wings, show it to be Rhopalocerous, and to belong specially to the family of the Hesperidæ, in which it forms a new genus, characterized by the structure of the antennæ, the short palpi, the unspurred feet, and by the position of the discoidal and median nervures of front wing, as well as by the robustness of all parts, and may be best placed near *Pamphila*, Westw. Mexico.—[Wien. Ent. Mon. iv., p. 100 (1860).

Castnia Hesperiaris.—Nigricans. alæ ochraceo-fulvæ, nigro-strigatæ et marginatæ, anticæ strigis duabus subcostalibus testaceis; posticæ subtus cinereæ, lineis undulosis nigricantibus.

Blackish, stout. Antennæ clavate, falcate, luteous towards the tips. Abdomen towards the base with somewhat ferruginous hairs. Wings orange-tawny, bordered with black, and with interrupted whitish ciliæ. Front-wings with a trifurcate black streak which proceeds from the costa, and with two irregular, oblique. pale, testaceous subcostal streaks. Hind-wings with slight blackish streaks, underside gray, with several slender, oblique, blackish, undulating bands. Length of the body, 12 lines; of the wings, 30 lines. Mexico.—[Walker, Cat. Het. B. M., p. 1583 (1856). Belongs to *Ægiale.*

Ægiale indecisa.—Alæ supra nigro-fuscæ, area basali fulvescenti-hirta, anticæ macula discoidea; punctis tribus in serie arcuata subcostali, pone cellam; duabus apud medium marginis externi, maculisque tribus in serie obliqua infra ramos medianos ochraceo-albidis: ciliis omnibus albis, fusco-notatis; corpus supra fuscum, metathorace fulvescenti-hirto, oculis albo-cinctis; antennis nigris; alæ anticæ subtus nigræ, apice grisescente; costa fuscescente; maculis superinis albidis; posticæ cinereæ fusco adspersæ; dimidio interno fuscecente; macula discoidea, altera majore interno-mediana, et subtribus fere lunatis discalibus margini subparallelis, nigris: ciliis albis, fusco variis; corpus subtus fuscum, abdomine cinereo-squamoso, antennis albicantibus, exp. al. 2½ in. Costa Rica.

The genus *Ægiale* seems to me to belong rather to the *Castniidæ* than to the *Hesperidæ;* for not only does it differ remarkably from all the genera of the latter family in neuration, but in its small palpi and comparatively narrow head, thickened antennæ, clumsy legs, and apparently flexible abdomen.*—[Butler & Druce, Cist. Ent. i., p. 116 (1872).

ADDENDA.

After the matter on p. 328 was printed, it occurred to me that the method of pupation had not been described with sufficient explicitness. The exposed portion of the blackened, chimney-like funnel has a length of from four to six inches; but the funnel virtually extends from one to three inches below the still green and growing leaves before it reaches the more solid portion of the trunk, where the true burrow may be said to commence. Throughout this entire length the funnel is elastic, with a tendency to con-

* These remarks will appear ill-founded in the light of what Felder wrote and of what I have written.

traction. It is within the hidden base of this elastic funnel, or just above the burrow proper, that the pupa state is generally, if not always, assumed. A more careful study of Yucca tops in which the pupa was naturally formed—i.e. in plants not cut till after pupation—shows me, also, that the partial closing of the burrow near head and tail is due solely to the elasticity of the funnel. No additional silk is used, and nothing that can well be called a cocoon is constructed. Just above the natural contraction that occurs at the junction of the more elastic with the more firm and solid portion of the burrow, the pupa rests—the cast-off larval skin generally helping to close up the lower passage. Here the pupa has perfect freedom of motion, and readily twirls the lower part of the body when disturbed. The natural recurvature of the abdomen, as shown in the figure, presses the bristled, dorsal and terminal portion of the body on the one side, and the ventral, middle portion on the other, against its elastic confines, and holds it securely. A few muscular movements, aided by the leverage and hold which the aforementioned bristles insure, bring the pupa, when the imago is about to issue, toward the top of the funnel, which readily opens under the pressure, since it is closed only by contraction. In the issuing of the imago the pupa remains within the tube.

Having recently (March 13) let several of the butterflies loose in a spacious chamber in order to watch their movements, I can confirm what has been said of the rapidity and strength of their flight. I would further add, that, in resting or walking, as in all their actions, they have the characteristics of the larger-bodied skippers. When the wings are not used in flight, the inferior portion of the secondaries is folded along vein 1 and tucked in under the submedian, as is, I believe, the case with all Hesperians. At rest, the outer portions of primaries are brought more closely together than my Fig. 29 indicates. The favorite position of the insect when at rest is vertical, or even hanging from beneath an oblique object. In walking, the wings open more or less, but the hind ones are not held horizontal. In walking on a flat surface, the fore body is strongly raised on the legs, while the end of the abdomen, especially in the female, generally touches the ground, so that the costæ of primaries are nearly on a plane with the surface. The antennæ are most often on a plane with the body, and strongly diverging.

The Rocky Mountain LOCUST *and the Season of* 1875.

By G. C. BROADHEAD.

The season of 1875 has been rather a peculiar one for Western Missouri, and the attendant phenomena instructive and worthy of close attention.

During the fall of 1874 large numbers of locusts (*Caloptenus spretus* Thomas) appeared in Western Missouri, coming from the northwest, and leaving destruction in their path—depositing their eggs late in the fall. Early in April, 1875, they began to hatch, the hatching continuing for over a month. Having undergone the several molts, the perfect insect appeared with wings early in June. In about two days their wings were strong enough to fly, but, as the different individuals gained their wings at irregular periods, they did not essay very far journeys until about the 15th, but by the 20th all had departed. Leaving no eggs, they passed away, by high flights, in a northwest course.

A large black cricket (*Udeopsylla robusta* Serv.), heretofore unobserved in Western Missouri, was often seen during May and June, but I cannot hear that it was seen after the locusts left. I did not find it to be destructive, but it may be. Its body was nearly ¾ of an inch in diameter and 2 inches long, with long, awkward legs. Color dark brown. It remained chiefly hidden under old lumber, or in mouse or mole burrows, but could sometimes be seen abroad on damp or drizzly days, from which circumstance I suppose its habits to be chiefly nocturnal.

The locusts generally first attacked clover, wheat, timothy, oats, blue-grass, in the following order as to preference and rate of destruction; to wit, all the wheat, all the timothy and clover, and most of the blue-grass, was eaten close to the ground and entirely killed. Most fields of oats were entirely destroyed, but some only partially, so as to produce a poor and stunted crop. In some instances blue-grass was killed; some of mine was, probably over one-half, and the remainder eaten to the ground twice, to rise again and afford good pasturage during the latter half of July, August, and September; but no blue-grass went to seed. The timothy was all killed by the middle of May. The weeds were nearly all destroyed. The various garden vegetables were eaten to the ground as fast as they sprouted above the surface. Corn eaten to the ground would again sprout, some as much as the third time, but was generally killed by that time. Irish potatoes whose sprouts were eaten off close, afterwards bore a crop, but were a little later than those planted just after the locusts left.

Towards the latter part of May vegetation became scarce, and the locusts, being larger and more ravenous, would eat things previously discarded.

Early in the season the leaves had been eaten off the grapevines, currant and gooseberry bushes, strawberries, and most small shrubs, and many shrubs were killed Later in the season the larger bushes and some trees suffered; all the gooseberry and currant bushes were killed. Leaves were now eaten off the apple, pear and peach trees, and the young fruit was also devoured; next the buds were appropriated, and then the pests would commence to eat the bark off the young twigs. In this way many young fruit trees, chiefly apple, were destroyed. The sumach (*Rhus*) and wahoo (*Euonymus*) were denuded of leaves, and often the entire bark from trees 6 feet high was stripped. The locusts would climb forty feet to the tops of coffee trees (*Gymnocladus*) and eat the leaves. At night they would ascend apple trees for rest, and be ready by early morning to climb to the top limbs and eat buds and leaves. For this reason our apple trees, the present year, had either no apples, or very few and small ones, on the upper branches.

Generally retiring before sunset, the insects would climb on fences and trees, and there remain until 8 or 9 o'clock next morning; and if it was cool, damp, or rainy, they would scarcely move from their place of repose during the whole day. On damp days my apple trees would be covered, and I could pass among them with a flat board and brush off many thousands of the insects. After constant occupation of the fences as resting places, we would find them denuded of the softer, rotten exterior, it having been eaten off, so that the fences would have the appearance of being well scraped.

At one time the locusts covered a field of mine as thick as 5 bushels to the acre, and several persons estimated that in the township of 3 by 9 miles they would average 1 to 1½ bushels per acre. They are very tenacious of life. After exceedingly heavy rains, I would go out and find them thickly seated on a low stalk of oats, and it seemed that the rains washed very few into the streams and drowned but few, if any. Bushels of them might be swept into a pile, and straw thrown over them and set on fire; only those at and near the surface would be burned—those in the interior scarcely scorched.

Chickens and hogs would eat the locusts with avidity, and these would eat each other when maimed.

AFTERWARDS.

The fields and woods at the period of departure of the locusts were dry and verdureless as a well-beaten road; in fact, in some places scarcely any vegetation grew during the entire season, unless seeds were planted. Rich creek bottoms were observed bare of all vegetation a month after the "hegira," except the leaves upon the trees, whereas ordinarily these bottom lands present a luxuriant growth. The chief forest trees were not much interfered with.

June 20th, we find growing only the following plants wholly or in part not interfered with, viz.: *Salvia trichostemmoides*, *Vernonia Noveboracensis*, *Apocynum cannabinum*, *Asclepias Cornuti*, *Ipomœa pandurata*. The *Asclepias*, after being cut and withered, would be eaten, and once I detected the locusts nibbling at the growing plant. These were about all the plants vegetating at that time. Others growing up immediately thereafter were purslane (*Portulacca oleracea*), very abundantly, more so than I ever saw it before, and occupying entire fields, and even yards and roadsides and waste ground, places where not ordinarily found. *Phytolacca decandra* (poke-weed) was very abundant, filling small fenced lots; and what seemed curious was, that most plants appeared gregarious, only a single species, but in great numbers, occupying a certain space. The lately introduced, but now abundant, prostrate *Amarantus Blitum* was unmolested; many of its stems were 6 feet long, spreading over perhaps 100 square feet, the entire plant weighing 15 pounds. The common nettle, *Solanum Carolinense*, soon sprang up everywhere; although always common in Eastern Missouri, it has not heretofore abounded here so as to be trouble-some. This year it was abundant, growing on all soils. The black nightshade, *Solanum nigrum*, was not more common than usual. The sand burr, *Solanum rostratrum*, of the plains, heretofore of rare occurrence, was occasionally found growing large and spreading very wide. I would remark that only a few years ago this plant was unknown in Missouri; now it has advanced 75 miles into the State. The cockle burr, *Xanthium strumarium*, was abundant as usual. The *Salvia trichostemmoides* grew over 2 feet high, and often patches of it would average 3 feet. The various species of morning glory put forth their energies, and were great pests in the fields.

The locusts did not seriously interfere with the prairie grasses, not eating them much anywhere, and none at all where there was other more genial food. The seasons being favorable, the grasses grew very luxuriantly, forming fine meadows and pastures.

Up to the 20th of June we find no kitchen vegetables in the country excepting such as were imported, and the many that have been raised are all results of plantings at that time and afterwards. The season was favorable: potatoes were finer, turnips larger and more abundant than ever known. My grape-vines grew 10 to 12 feet, but bore no fruit. Melons were also finer and more abundant. Large quantities of all kinds of seeds were sown and the result was a magnificent yield. The summer apple trees had a few blossoms after the first crop, and late in season found apples of second growth one inch in diameter.

The growth of wild grasses was more luxuriant than I have known for many years. On the 20th of September I observed the following grasses: *Andropogon furcatus*, 6½ feet high; *Spartina cynosuroides*, 6 ft.; *Sorghum nutans*, 6 to 8 ft.; *Panicum sanguinale*, 6 ft.; *P. Crus galli*, 5½ ft.; *P. capillare*, 4½ ft.; *P. virgatam*, 5½ ft.; *P. glaucum*, 5½ ft.; *Eragrostis poœoides*, 3½ ft.; *E. Purshii*, 2 ft.; *Vilfa vaginæflora*, and *Aristida oligostachya*, over 2 ft. Some of these grasses, as *Vilfa*, I do not remember to have seen here before; it abounds in S.E. Missouri on post-oak and white-oak land, and probably may be common on similar soils of Western Missouri. The *Aristida*, although growing abundantly south of this, I have rarely seen here before. The *Eragrostis* I have only heretofore seen in yards and roadsides, recumbent and scarcely to be noticed; but, this season, behold their luxuriance! tall and growing thick, looking like fine meadows ready to be mowed. The *Panicum sanguinale* (crab-grass) grew luxuriant and thick, and in some fields sufficiently so to cut for hay. The *Setaria glauca* (foxtail) also formed meadow-like fields. The *Spartina*, *Sorghum*, and *Andropogon*, grew very tall and formed seed. These prairie grasses I do not remember to have seen in seed for over a half dozen years, nor do I remember them to have grown so tall for as long a time. Two years ago, in Bates County, the grass grew on the prairies only a few feet high; this year it would average 5 to 5½ feet for miles, and presented a beautiful scene. The most common upland species is *Andropogon scoparius*, and is very much valued by people for hay. The reason of the luxuriance of this growth we find in the frequency of moistening rains at the proper season. The presence of strange plants, and the unusual abundance of others, is owing to the absence of most of the previous known common plants. This absence was caused, in the first place, by the dryness of the season of 1874, and by the damage the locusts had done, and the consequent failure to produce or ripen many seeds; in the second place, the locusts, in the spring of 1875, destroyed all the young plants as fast as they appeared above ground and before the time arrived for them to blossom and seed.

Such causes as the above may in time considerably change the flora of the country.

The Meteor of December 27, 1875.

By G. C. Broadhead.

About 9 P.M., Dec. 27, 1875, a brilliant meteor was seen to dart across the northern sky from west to east, being chiefly observed in Northwest Missouri, illuminating the heavens, for a few seconds, brighter than the brightest moonlight, and then bursting into fragments; and after an interval of a few minutes a sound was heard resembling distant thunder.

I find that the explosion was only heard in Northwest Missouri, although the meteor was seen as far north as Nevada and Clinton; also at Lawrence (Kansas), Council Bluffs and Iowa

City (Iowa); at Kirksville and St. Louis (Missouri); at Cincinnati (Ohio), Ripley (Indiana), and Falls City (Nebraska).

Mr. Wm. Kaucher and wife, of Oregon, Holt County, observed it quite accurately, and state that at 9 P.M. it was observed near the constellation Gemini and a little S.E. of those stars, passing near Procyon and beyond, exploding 30° below that star and 20° above the horizon in a southeastern direction. Mrs. K., who first saw it, says that it seemed suddenly to flash into view, lighting up the whole sky, and before reaching Procyon began to leave a train of innumerable rocket-like sparks. The width of the train was probably a half degree, becoming smaller near the nucleus. The duration of the illumination was about three seconds.

Mr. Kaucher further says that about five minutes later an explosion was heard resembling the firing of several pieces of artillery, followed by a long metallic reverberation which lasted for several seconds.

Mr. Kaucher's meteorological observations give—thermometer 28°; barometer 28.966, corrected to freezing point for elevation, and elevation 1100 feet above the sea; force of vapor .090; relative humidity 0.56; no clouds, wind south, night very bright, the sky hazy, becoming more dense afterwards. Rain fell on 29th and 30th.

C. W. Irish, at Iowa City, Iowa, first observed it S. 60°, W. altitude 65°; its size about that of an ordinary shooting star, then gave out a flash that illuminated the whole concave of the heavens.

A. Slingerland, of Kirksville, Adair County, Missouri, observed the meteor at 30° to 40° altitude, and 10° to 15° northwest. It lighted up the sky and passed quickly out of sight to the southwest.

At Rockport, Atchison County, it was seen passing in a southeastwardly course.

At Hiawatha, Kansas, it was seen to pass from northwest to southeast, causing a brilliant illumination of a few seconds' duration. Time, about 9 P.M.

The Rev. Mr. Huntley, observing it near Maryville, Nodaway County, Missouri, says it resembled a calcium light, and three minutes afterwards an explosion was heard.

At Graham, Nodaway County, it was seen passing eastwardly, and a few minutes thereafter a rumbling sound was heard.

The Savannah (Andrew County) *Republican* states that 20 minutes past 9 P.M. it flashed across the sky for a moment with an illumination nearly as bright as day, but only for a moment, then disappeared in the S.S.E., and that it apparently came from the N.N.W. It exploded just above the horizon 5° to 12°, and, three minutes after, a noise was heard resembling the discharge of a battery of cannon. Many saw it at this place and they generally unite in the above statement, and also say that portions were thrown off two or three times.

The St. Louis *Globe-Democrat* says, it seemed to start from the zenith, suddenly changed its course, darted in an eastwardly direction, bursting like a sky-rocket, and several minutes later a low, rumbling sound was heard resembling distant thunder.

Stephen Sale, at corner of Main and Franklin streets, St. Joseph, between 9 and 10 P.M., the night being clear and bright, observed a meteor with a nucleus and long tail immediately over him, passing horizontally from N.W. to S.E., exploding and emitting sparks like a sky-rocket, then disappearing, the train apparently brighter for awhile and then vanishing. The duration of the illumination was about thirty seconds, the light white and bright as noonday. Three minutes thereafter a noise was heard resembling the discharge of heavy guns, followed closely by a succession of rumbling reports sufficiently heavy to jar the windows of houses, and lasting probably ten seconds.

Thomas Crawford and Arthur Kirkpatrick, of St. Joseph, occupying different points of observation, substantiate fully the above account of Mr. Sales, with the following exceptions and additions: — Thomas Crawford says it passed from N.W. to E.S.E., and continued in view three or four seconds; first appearing red, then blue, then white and bright like a lamp, and that the illumination was so intense that one could easily see to pick up a pin from the ground. The nucleus was apparently one-half the size of the moon, followed by a fiery sheet; sparks like coals were emitted, and a rushing sound was heard resembling distant thunder. Arthur Kirkpatrick gives the course about 85° S. of E., and says the nucleus was apparently four times as large as the sun, and occupied 30 seconds in passing, exploding and disappearing like a sky-rocket; and two to three minutes afterwards a sound was heard resembling distant thunder, followed by a deep rumbling lasting about 60 seconds. He further says that the meteor was of too dazzling a brightness to rest the eyes upon.

The Kansas City *Chief* says it passed from N.W. to S.E., leaving a lurid streak in its wake, and making all out-doors brighter than moonlight; two minutes later an explosion was heard resembling the discharge of heavy cannon.

At Pleasant Hill, Cass County, Mr. R. S. Wilson and others observed it about 9 P. M., the sky first being brightly illuminated, and, immediately after, a bright nucleus similar in appearance to a comet, or ball of fire, with a short tail, appeared in the northwest, shooting up like a rocket from the horizon towards the zenith, and descending eastwardly. Less than a minute was occupied in the total passage.

Mr. Jno. W. Stewart, of Clinton, Henry County, says it passed in a northeast direction at an angle of 30° with the horizon, and apparently was twice the diameter of the sun, leaving a long luminous tail, not spread out, and of a bluish or violet color, the ball appearing brighter.

Although the meteor was seen at various points from Nevada, Mo., to Council Bluffs, Iowa, or for three hundred miles north and south, and over as wide a space east and west, yet I do not find that any explosion was heard south of Kansas City, nor any further eastward. From the apparent course, and time of hearing the sound after the flash, it would appear as if it had burst at a distance of 40 to 70 miles from the observers in Northwest Missouri, or a little east from DeKalb County, probably in Daviess or Caldwell County; but observers in that neighborhood do not mention an explosion, nor do they say that its appearance excited much remark.

Archæology of Missouri.

By A. J. CONANT, A.M.

There is, doubtless, now no richer field for archæological research in this great basin of the Mississippi Valley than is to be found in the State of Missouri. The wonderful extent and variety of the ancient works and monuments therein, the relics they disclose, the huge burial mounds filled with the bones of the dead, disposed in orderly array, as though by loving hands, along with vessels of pottery of graceful forms and varied patterns. often, too, skillfully ornamented,—all bear witness to a settled and permanent condition of society and government and obedience to law, and to certain convictions of a future life. Mounds are found almost everywhere throughout the length and breadth of the State.

The largest tumuli and most extensive works are seen upon the river terraces of the Mississippi and its tributary streams. Here were the large towns and populous centres, seats of government, and doubtless, too, where the national solemnities of their worship were celebrated. The truncated, oblong mounds, with a graded way leading to a higher elevation at one end, are so like the pattern of the Teocalli of Mexico, as to compel the conviction that their purpose was the same, and that from these, too, ascended the smoke of the sacrificial altars in the worship of the heavenly bodies. In the centre of the enclosures rise the commanding residence sites of the dwellings of their chiefs, and grouped around them were similar structures of less notable character. It is interesting to note, also, that the dead were not carried to some distant, isolated spot for interment, but in the very heart of the town, where the homes were the thickest, the last resting-place—the burial mound--was erected.

In many places, the streets of the cities may be traced. The sites of the long rows of dwellings, built of such perishable material that no vestige now remains, may be identified by the constant presence of the family hearth, showing by its reddish, baked appearance, to the depth of several inches, the long continued action of fire.

But not in works like these alone are to be found the evidences of an ancient and vast population. Within the State, from Pulaski Co. to Arkansas, in all the little valleys which wind in and out among the flint-crowned hills of the Ozarks, are seen what may be termed garden mounds. These are elevated about two or three feet above the natural surface of the land, and are from fifteen to fifty feet in diameter, varying thus in size according to the amount of richer soil which could be scraped together. Their presence may always be detected in fields of growing grain by its more luxuriant growth and deeper green.

These Ozark mountains have preserved their treasures well, and demand of the archæologist serious examination and careful study. These hills are honeycombed with caves, many of them of unknown extent. Their openings may be seen in the precipitous bluffs along the Gasconade river, in great numbers, on either side, or the majestic arches of their openings span the divides where the smaller hill ranges meet. Do these numerous caves and channels evidence an ancient system of drainage, in operation long before the Gasconade had asserted its "right of way" and scooped for itself a course, and the rocks had melted away before its ceaseless flow?*

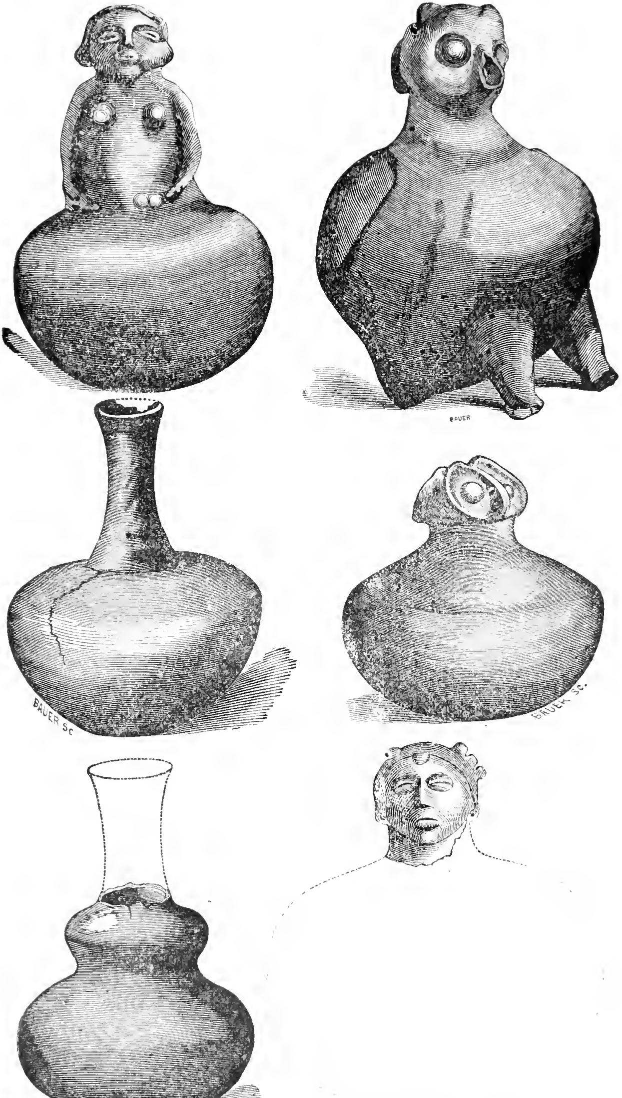
In these caves the ancient dead were buried and the funeral feasts were celebrated. The deep deposit of rich nitrogenous earth in the larger chambers, and the bones of various animals, birds, and mussel shells—the refuse of the funeral feasts,—the alternate layers of ashes and charcoal mingled with earthy matter, containing human bones in different degrees of preservation, tell of oft-repeated visits and recurrence of the funeral rites. Here, too, are found the mounds of stone, the largest on the highest and most inaccessible elevations, and always where the prospect is most delightful and commanding. Sometimes they are ranged in continuous lines from the brow of the precipitous escarpment hundreds of feet in height, along the barren ridges. Sometimes they stand alone on the hillside which overlooks some pleasant valley. Who built them? Did the red man? Possibly. But it was no child's play to climb up the mountain side carrying those great stones, some of which might trouble a strong man to move far from their place, and deposit them together until the heap should cover a space thirty feet in diameter, with an elevation of five or six feet. Of what was deposited there with such labor, nothing

* See Sir Chas. Lyell's remarks upon the Valley of the Meuse, "Antiquity of Man," p. 73.

now remains, as far as is at present known, but a few human teeth and fragments of bone. No one who has seen and studied these ancient remains, thus briefly alluded to, will consider the statement extravagant, that they furnish convincing evidence that Missouri was once inhabited by a population so numerous, that, in comparison, its present occupants are only as the scattered pioneers of a newly settled country. But who they were, what was their origin, what became of them, may perhaps never be known. Still it seems possible, and probable even, that the ancient monuments of Missouri which are yet undisturbed, if examined seriously and thoroughly by those well qualified for the work, may yet disclose some facts, and furnish some records, which will throw light upon these dark questions. Leaving for a future occasion the consideration of many interesting facts concerning the habits and manners of life of these vanished peoples, and such discussions as might properly engage our attention in this connection, the remaining space allotted to this paper will be occupied with the description of the remains of a city situated upon the banks of Bayou St. John, in Southeast Missouri.

This Bayou, as near as could be ascertained, is about seventy-five miles long, finding its outlet into the Mississippi near the town of New Madrid, about eighteen miles from which place the works examined are located. At this point the bayou is one and a half miles wide. The interesting works found here consist of enclosures, large and small mounds in great numbers, as well as countless residence sites of the ancient inhabitants. A description of a single group will give the general characteristics of all in that region. Upon the western bank of this bayou, which (it should be stated) is a dense cypress swamp, the works under consideration are found. From the level of the bayou to the prairie land above, the ascent is by a gradual slope to a vertical height of fifteen feet. Upon this belt of sloping ground, now covered with a heavy growth of timber, the works are most numerous; while from its edge, westward, the level prairie (that is, the alluvial plain of the Mississippi) has been under cultivation for sixty or seventy years. Here, including forty acres of the cultivated field and ten of the sloping timber belt, is an area of about fifty acres, enclosed by earthen walls which may be distinctly traced for several hundred feet, but gradually disappear on the western side, having been nearly obliterated by the long cultivation of the field. Where it is best preserved in the timbered land, its height was found to be from three to five feet, and fifteen feet wide at the base.* In the centre of the western side of the enclosure and close to the wall, as near as could be judged, is a mound of oblong shape, three hundred feet in length at the base, and at its northern end one hundred feet wide, and twenty feet high at the present time. The top of it slopes gradually to the south, and although the plow has passed up and down its sides for sixty years, still on its eastern side may be distinctly seen the evidences of a graded way to its summit, which marks it as a temple mound. Close to its northeastern side, where the mound is widest, is a deep depression in the field, about ten feet in diameter. Mr. Wm. M. Murphy, a farmer who has long resided in the neighborhood, told me that when he first saw it he could not get in and out of it without a ladder, and that it had since been nearly filled up by the tillers of the soil with stumps, logs and earth. It is conjectured to have been a well. The wells of this region are usually sunk to the depth of twenty-five feet. In the centre of the enclosure stands a circular mound seventy-five feet in diameter, and also twenty feet high, which upon examination disclosed nothing but broken pottery. It belongs to that class usually termed residence mounds. The view from its summit towards the west and south commands a prospect several miles in extent; on the north the view is cut off by a heavy growth of timber, and on the east by the cypress swamp. In a direct line with the two mounds thus described, partly upon the edge of the cultivated field and partly upon the declivity which descends towards the swamp, in the midst of a large group of smaller works, stands a large burial mound, about fifteen feet high and one hundred feet in diameter. Its original height could only be conjectured, as it has long been occupied as a residence site by the present inhabitants. The ruins of a log house are still standing upon its summit. It has been the sepulchre of many hundreds, perhaps a thousand individuals. The manner of interment, as far as my own observations extended, was to place the corpse upon the back with the head towards the centre of the mound. The number of articles of pottery

* It will readily be perceived that absolute accuracy of measurement would be impossible, where the ground has been so much disturbed by cultivation. In the dimensions stated above, and those which follow, the figures given above are as close estimates as was possible under the circumstances to make.



LARGE DRINKING VESSELS.

which have been taken from this mound, from time to time, it is impossible to compute. Many of them are now scattered among the cabinets of curiosity collectors, many hundreds I myself have counted, while the ground is strewn with the fragments of those destroyed by careless excavators. Three vessels of this ware were usually found deposited with each individual.* A gourd-shaped jug with a long neck, holding from half a pint to two quarts, was placed close to and by the side of the head; on the other side would be found a smaller jug or drinking vessel, with the mouths of both sorts often moulded into the form of the head of some bird: the owl seems to have been a favorite model. Not infrequently the whole figure of the bird or animal, or of the female form, would be rudely represented. In the latter case, while the maker seemed not to be deficient, to some degree, in the knowledge of anatomy of the human form, and has suggested the spinal column with considerable accuracy, it is always distorted by a curvature from the base of the neck outward, so as to make the figure decidedly humpbacked; the lower limbs are folded under the body and barely suggested, while the sexual distinctions are so strongly marked as to render the object sometimes indecent.

As already noted, the corpse was placed lying upon the back, the arms folded across the breast. In the angle formed by the bend of the arm, and resting upon the arm and the side of the chest, would be found the third article of pottery mentioned. This had usually the shape of an ordinary pan with flaring sides; often, too, like a bowl, and as often again the vessel would be moulded into the shape of a frog, fish, or large clam shell; sometimes a much smaller cup would be found within the larger dish, placed close to one side. In one of these cups was observed a small bone or relic (not yet identified). The vessel resting upon the arm was doubtless filled with food, as some sort of small fruit, completely carbonized, was found in one. I also observed in others fragments of mussel shells, so thoroughly decomposed as

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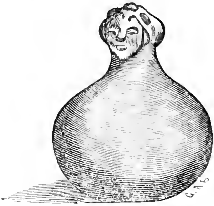
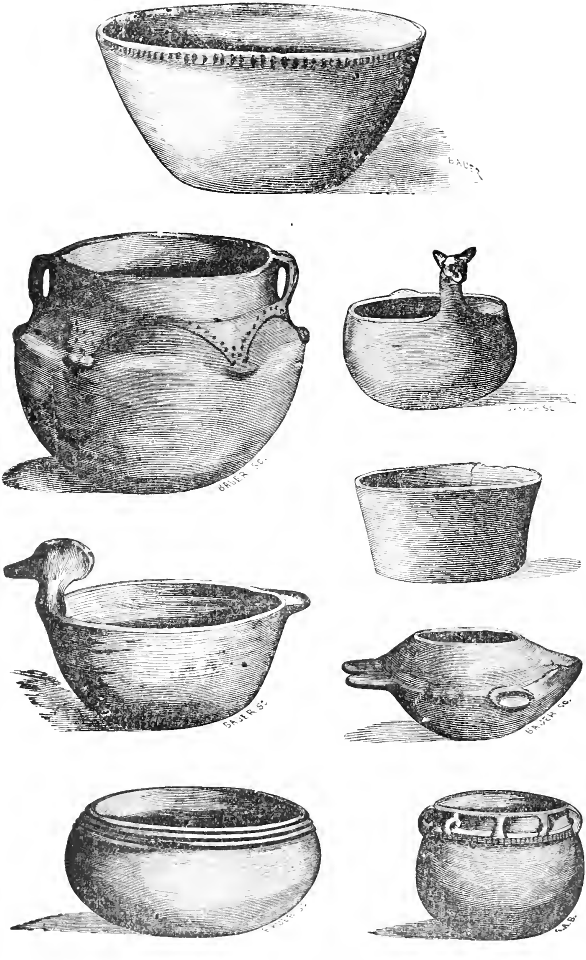
* For the plates here given I am indebted to the kindness of Dr. G C. Swallow, Dean of the Agricultural College of the State University of Missouri. Although they were engraved from pottery taken by him from mounds at New Madrid many years since, no better representations could be made of many of those recently exhumed from the works upon Bayou St. John. As stated in another place, they all seem to have been made of the same material and after the same models.


to be of the consistence of paste. The larger jugs, as well as those of various and fanciful forms, were undoubtedly drinking vessels.

Within the enclosure, from near the edge of the swamp, upon the side of the slope, in close proximity to the burial mound as well and extending quite a distance into the cultivated field, are great numbers of depressions in the soil from one to three feet in depth, and from fifteen to thirty in diameter; sometimes in parallel rows, and usually about thirty feet from centre to centre. In many of these, forest trees of large size are still growing, and others equally large are lying upon the ground in various stages of decay. Upon digging into them, in almost every shovelful of earth were found pieces of broken pottery; many of these fragments indicated vessels of large size which must have had a capacity of from ten to fifteen gallons. Upon joining these fragments together, the mouths or openings were found to vary from three to twelve inches in diameter. They were doubtless stationery receptacles of food or water, as they were so thin that it would hardly seem possible they could be moved, when filled, without breaking. In many of these depressions examined were found large rough masses of burnt clay, of the color of common brick, full of irregular and transverse holes, which seemed to indicate, that, before it was burned, the desired form of a chimney, fire-place, or oven, had been rudely made out, by intertwining sticks, twigs and grass, and the whole plastered inside and out with moist clay, to the thickness of several inches, and then burned until it became red and




SMALL DRINKING VESSELS.



FOOD VESSELS.

hard as the bricks now in use. At the depth of about two feet, at the bottom of all which were examined, what seemed to have been a fire-place was disclosed. The earth was also burned, so as to present the color and hardness of the fragments of brick, to the depth of several inches. Along with the broken pottery were found, quite often, fragments of sandstone of various sizes, the larger pieces with concave surfaces, and all showing that they had been used for polishing or sharpening purposes, especially the smaller pieces, which are covered with small grooves one-eighth of an inch deep across the whole length and width, and at various angles with each other, as though they had long been used for sharpening some small metallic instrument or graver's tool.

One other significant characteristic of these works remains to be noted. All along the shore of the bayou, in front of the enclosed works, small tongues of land have been carried into the water, of varying length and width, averaging perhaps thirty feet in length by ten to fifteen feet in width, and about the same distance apart, resembling, upon a small scale, the wharves of a sea-port town. The cypress trees grow very thickly in all the little bays thus formed, and the irregular, yet methodical, outline of the forest, winding in and out, close to the shore of these tongues of land, is so marked as to compel the conviction that they are of artificial origin: and further, that, when these works were inhabited, what is now a cypress swamp was then the channel of a river. And the idea is no novel or original one, that anciently the Mississippi poured its flood through this long bayou and formed the terraces upon which these works are found.

One mile south of this point, and about three hundred feet from the margin of the swamp, is a peculiar work which is worthy of notice. It may be described as an oval or egg-shaped excavation, one hundred and fifty feet long and in its largest diameter seventy-five feet wide and about six feet deep. It is surrounded by an embankment about eight feet high around its northern curve: on the southern end the wall is not over five feet high, in which is a narrow opening, and extending from it is a curved, elevated way to the swamp, into which the earth taken from the excavation seems to have been deposited, until a circular mound or wharf was raised about twenty feet in diameter and five feet high in the centre. The same opening and elevated way is seen at the northern end, extending to the water. It is doubtless an unfinished work, but its purpose cannot be conjectured.

About eight miles, in a southeasterly direction, from the works upon Bayou St. John, upon what is known as West Lake, is an extensive group of works almost identical with those described above, differing chiefly in this, that they are covered throughout with a heavy growth of timber; and the residence sites are found covering a much larger space, and in prodigious numbers; while in the centre of the group is an open space of several acres which seems to have been made perfectly level, containing no elevations or depressions whatever

In conclusion, it should perhaps be stated that the works described thus at length are only clusters of a continuous line of works extending along the shores for many miles in close connection, and for the most part covered by dense forests, the growth of centuries.

POTTERY.

The pottery of this whole region, including several counties in Southeast Missouri, through all the varieties of form and ornamentation, is so similar, that it would seem as though it might all have been the product of one manufactory. The clay seems first to have been mixed with pounded shells, and the articles then subjected to various degrees of heat. Some of the largest pots were burned till they became red; the medium sizes are usually dark gray; while some of the animal forms are of a yellowish-drab, and seem to have been made of clay of much finer quality, and with a very smooth surface; which surface is also frequently ornamented with stripes of white and red lines, in circles, curves, and spirals—the red circles. enclosing white lines. crossing each other at right angles. In fact, the decorations in many instances are quite artistic, not only in the relation of curves and angles, but in the representation of animal forms as well, which are so true to nature that we may well believe, that, when the human face is attempted, the artist drew from models before him.

CRANIA.

The bones were so thoroughly decayed that very few could be saved, and none in a complete state of preservation. Still, the

Fig. 32—Front and Side View.

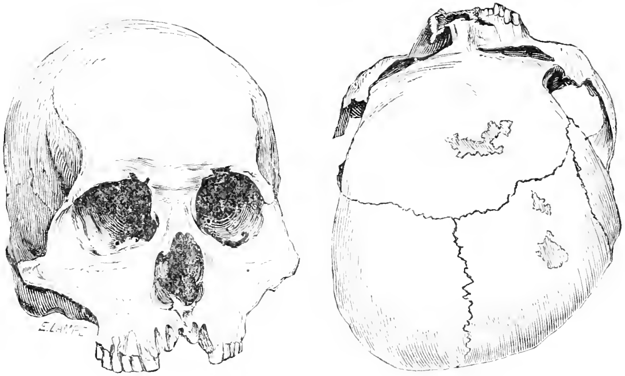


Fig. 33—Front and Vertical View.

Fig. 34.

various stages of decomposition in which they were found showed that a long time must have intervened between the first and last interments.

Fig. 32 shows the normal type, with vertical occiput flattened on the right side; the rest of the skull symmetrical, well-rounded, and high forehead. Fig. 33 shows this artificial flattening to a remarkable degree, and strongly resembles the Peruvian skulls from the Temple of the Sun.* I observed, however, two marked exceptions. In these instances the skulls differed in almost every important particular. Only a fragment of one could be preserved, as they crumbled to dust upon the first exposure to the air. No trace of artificial flattening could be observed. Its longitudinal diameter, as compared with the others, was very great (see fig. 34). The forehead is lower and more retreating than any I have seen from the mounds or caves, while the superciliary ridges are largely developed, altogether suggesting a mental organization but little above the ape. It bears a closer resemblance to the pictures of the Neanderthal skull than any which have come under my observation. When my eyes first rested upon this remarkable skull, I had no doubt that it was an intrusive burial by the Indians, such as I had frequently seen near the surface of other mounds which were unmistakably such, and my suspicion was strengthened by the fact that it was located upon the very outer edge of the mound; but, upon careful examination of its position, I found that it was deposited in the usual manner with the head towards the centre, with the drinking vessels in the usual position, also, beside the head, and corresponding in all particulars of its interment with the rest. From all these circumstances it was impossible to escape the conviction, that, to whatever distinctive race or tribe the individual may have belonged, he was buried by those who erected the mound, and in the same faith.

CHRONOLOGY.

While all generalizations upon the facts here presented, with a view to ascertain the length of time during which these works were occupied, or the period of their abandonment, may seem premature and idle, still there are two considerations suggested thereby which it is hoped may not be entirely out of place or valueless.

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* See Morton's *Crania Americana*, Plates B and C.

First, as to the different degrees of preservation of the skeletons. While all were so decayed that it was possible to secure only three or four skulls—the under jaw seldom or never complete—the bones were usually so far gone as to have no more consistency than the sand which covered them. In many instances, only a faint streak, or whitish line, in the earth, as successive sections were shaved down by the spade, would disclose the form of the head. And, again, the jugs and bowls, or pans, would be found in their relative positions, but no trace of the skeleton whatever! These facts prove, as remarked above, that many years must have intervened between the first and last interments.

Again, the high bank which marks the boundary of the bayou shows the long continued action of flowing water. To those who are acquainted with the habits of this capricious river, the statement that here was once the channel of the Mississippi, will cause no surprise. The town of New Madrid, eighteen miles away, is a moving town, and slowly retiring before its resistless encroachments. In 1804 its site was one mile farther east than now, and upon what is now the eastern shore. The towns and cities of the mound builders were almost always upon the banks of some river. If it be granted that this high terrace upon which they stand was once the bank of the Mississippi, and that they were abandoned when the river left its ancient bed, the question arises, is there any ascertainable uniform rate of recession by which the centuries may be estimated which have passed since that time? Perhaps the question admits of no satisfactory answer. Still, we will venture one speculative estimate. The river has receded (as at New Madrid) about one mile in seventy years. Assuming the mean distance of these works to be now fifteen miles inland, the computation upon these premises would give, in round numbers, one thousand years as the time of their desertion. Another question arises here relating to the length of time required for the cypress swamp to take possession of the deserted channel of the river. Does it follow it up by slow degrees, or appear at one and the same time throughout its length?

One other fact only can be noted in this connection. This whole region has been terribly shaken and disturbed by earthquakes. During the earthquake of 1811 the old town of New Madrid disappeared, the river changed its southward course and for several hours flowed back upon itself. For many miles, long zig-zag fissures and yawning chasms were opened, large tracts of land sank down and lakes and pools of water now fill the openings, over which as we sail, far down in the deep, still water, may be seen the ghostly branches of the sunken forests. Possibly some similar catastrophe suddenly changed the course of the river and caused its bed to become a vast malarious swamp, rendering the whole region sickly and almost uninhabitable as it is to-day. The appearance of these remains would favor the idea that they were suddenly abandoned. The chronological question may be a sealed book which no man can open; and the speculations thus briefly indulged in may possibly—if they have no other value—indicate the direction in which we may look with some signs of promise for those facts which shall shed further light upon the life and times of this mysterious race.

Age of our Porphyries.

By G. C. Broadhead.

In the *American Naturalist* of April, 1875, Prof. T. Sterry Hunt says, "The porphyries of Southeast Missouri seem to be identical with those of Lynn, Saugus, Marblehead, and Newburyport, Mass., which are traced thence along the coast of Maine and New Brunswick, and are well developed about Passamaquoddy Bay, where they occasionally contain small deposits of iron ore." They are also compared with the rocks of the north shore of Lake Superior, and are regarded as Huronian. On the coast of New Brunswick they are intimately associated and interstratified with schistose rocks, supposed to be of Huronian age.

On p. 187 of his *Chemical and Geological Essays*, Dr. Hunt says, "they present great uniformity of type, though in every place subject to variations from a compact jaspery rock to a more or less coarsely granular variety, all of which are often porphyritic from the presence of feldspar crystals, and sometimes include grains or crystals of quartz. In color they are generally some shade of red, varying from flesh-red to purple, pale yellow, greenish, or black. On the coast, these rocks are distinctly stratified, and are closely associated with dioritic, chloritic, and epidotic strata ."

Further on, he says, "stratiform rocks seemingly identical with these quartziferous feldspar porphyries *abound* in MISSOURI, where they are associated with the iron ores of Iron Mountain and Shepard Mountain. The breccia and conglomerate, in which is found the native copper of the Calumet and Hecla and the Boston and Albany mines of the Keweenaw peninsula, on the south shore of Lake Superior, is made up in large part of the ruins of similar orthophyres."

Again, in *Proceedings of Boston Society of Natural History*, April, 1875, Dr. Hunt mentions the feldspar porphyry, or orthophyre, so abundant along the eastern coast of Massachusetts, Maine and New Brunswick, and which passes on the one hand into a jaspery petrosilex, and on the other into a finely granular, almost granitoid, rock.

In its typical and most common form, it is a fine-grained impalpable mixture of orthoclase and quartz, generally of red, brown or purple color, and porphyritic chiefly from presence of feldspar (orthoclase) crystals, and often grains of crystalline quartz. This rock is in contact with the fossiliferous LOWER CAMBRIAN (*Menevian*) strata of Braintree, Mass., and is identical with the porphyries of Southeast Missouri. It is referred to the HURONIAN rocks.

Further on, Prof. Hunt says that "the unchanged fossiliferous strata are seen resting on the Huronian rocks, and include in some cases fragments derived from these rocks. These strata are likewise seen to be older than the Menevian, which at St. John, New Brunswick, includes materials derived therefrom. At Hastings, Ontario, these ancient rocks occupy a position between the Laurentian and the fossiliferous beds of the Trenton."

Prof. T. B. Brooks, in *Am. Jour. of Science* for March, 1876, speaking of the rocks, above referred to, near Lake Superior, regards them as Huronian.

Prof. Pumpelly, in Mo. Geological Report for 1872, speaks of Archæan rocks of S.E. Missouri, but does not say whether he considers them as Huronian or Laurentian ; but he infers that the granite of S.E. Missouri may be older than the porphyry.

Prof. Dana, in his *Manual of Geology*, 1874, speaks of the rocks at Pilot Knob, Mo., as Laurentian.

Our best authorities on the Archæan rocks are Dana and Hunt; they have carefully studied them and are high authorities, yet we know that in many important points of geology they do not agree. Their opinions are greatly to be respected. We honor them for their life-long devotion to science. We could wish that they could visit every place where porphyry or granite is found in Missouri. Prof. Hunt has seen the porphyries at Iron Mountain and Pilot Knob and near by these places. We do not know to what extent nor how far from those places he has seen them.

Prof. Pumpelly studied the porphyries and iron ores very carefully near and at those points, but I scarcely think he has seen sufficient to form a decided opinion of the age of the rocks of the whole region; for, in a note on page 3 of Mo. Geol. Rep. 1872, he states that there are no hornblendic dykes in the porphyry. Now, I know of a dyke of hornblendic rock, 6 feet wide, standing up like a wall and in a porphyry region, 14 miles south of Pilot Knob, on south side of Buck Mountain. Greenstone is frequently found in both Iron and Madison Counties, Mo., associated with porphyry; and, although more often found in loose, tumbled masses, it occurs along a certain course, so as to leave no doubt of its being from dykes protruding through porphyry. In the Geological Report for 1874 (Madison Co. Rep.) several greenstone and dolerite dykes are mentioned, some protruding through granite, others through porphyry.

Not having seen the rocks on the Atlantic coast referred to by Prof. Hunt, I am unable fully to compare ours, but I think it highly probable that our granites and porphyries may be of different age; the granites may be older than the porphyries. Very careful geological study of these districts of Missouri may result in important deductions very useful to science.

In these rocks we have no fossils to guide us, and we can only be guided by their lithological appearance, or mineral contents. Prof. Hunt's description of the eastern porphyries would answer for many of ours. Ours are divided mainly into two classes, one an exceedingly fine-grained jaspery rock, and the other a coarser one, which in texture resembles a granite. The finer grained ones are either black, or with some shade of red; in fact, even the darkest colored will show a reddish tint on a thin edge, if viewed with a magnifying glass. Some of them contain particles of both quartz and feldspar imbedded in a feldspathic paste. Many of the porphyries are banded, and show cleavage planes. Sometimes well marked lines of stratification are seen on a grand scale. Fragments are in my possession that appear to be ripple-marked, but I could not positively so decide unless I were to see the body from whence they were obtained, for this may be due to flexure of strata. Epidote, hornblende, and serpentine occur, and beds and veins of specular iron ore are of frequent occurrence. These veins also occur in the granite of Madison County. Slate (resembling roofing slate) is found at one place in Iron County, although in beds too rough to be useful. Quartz veins occur both in the granite and porphyry. A black magnetic iron sand is often found washed out and lying along the surface in the vicinity of the greenstone dykes.

Our Archæan rocks contain neither gneiss nor limestone: all of our limestones may be referred to more recent age.

Beds of coarse conglomerate are often seen resting on these rocks. These conglomerates are also chiefly made up of rounded fragments of Archæan rocks.

Besides the conglomerates just named, it is not uncommon to find shales or slate entirely composed of porphyritic débris, and resting on unaltered porphyry.

I have examined the porphyries over most of Iron and Madison Counties, also some of those of Wayne, Reynolds and St. François Counties. The granites chiefly occur in the northern portion of this Archæan region. That near Iron Mountain is a coarse red variety, looking well when polished. Near Knob Lick are both the red and the gray. South of Burns Mountain, in Madison County, is a very coarse granite. At the latter place, it touches the porphyry. Along the northern part of Madison County, both granite and porphyry appear, but at no place have I seen these rocks under such circumstances as to say that one was older than the other. One strong evidence in favor of the older age of the granite, is, that the older unaltered magnesian limestones are often found resting on beds of porphyry, or filling valleys between porphyry hills; but I have nowhere seen these limestones reposing on granite. I have seen these unaltered limestones reposing on beds of sandstone. I have also observed the sandstone resting on porphyry, and have also seen beds of sandstone, or conglomerate, resting on porphyry, or on granite.

We feel ourselves inclined to regard the granite as the older, the porphyries as of more recent formation.

Pleasant Hill, Mo., March, 1876.

Addition to Dr. Engelmann's Article on Agave, p. 291–322.

Additions and corrections have accumulated in the interval between printing and publication.

Page 293. The words of the first note, line 3, "while" to the end of the sentence "liliaceæ" should be carried up into the text and added to the first paragraph, line 8, ending with the word "stigmas."

Page 294. It requires further and extensive observations in the field and in the garden to ascertain the limits of variability of the edges of the leaf and its aculeate-toothed margins. Cultivators have already discovered considerable latitude in this respect in plants raised from seeds from the same parent.

Page 302. Var. *tigrina* does not grow *in* salt-marshes, but was found by Dr. Mellichamp, "in one spot only, on a tongue of partly brackish land, extending out into the salt-mud and marsh, under dwarfed live-oaks, Cassine, and saw-palmetto, on the decayed shells, mixed with sand and earth, of what seems to be an old Indian oyster-heap"!

Page 304. *A. falcata.* The lately introduced *A. Hystrix* of the Belgian nurseries may have to be referred to this species; native country and flowers, as usual, unknown.

Page 305. *A. Schottii* (better than *Schotti*, as printed). It is proper to add that *A. geminiflora*, Gawl., the *Bonapartea juncea* of the gardens, is a very different plant, and has nothing to do with *Schottii*, except that both belong to the same section of the genus.

Page 310. *A. deserti.* In characterizing the foliage, I was led into the too common mistake of adopting the individual characters of a single individual as those of the species. Full grown leaves are at least 15–20 inches long, and 2–3 inches wide above the base. The terminal spine is compressed and narrow-grooved only in the young, not fully developed leaf; in the adult it is terete-triangular with a wide and shallow excavation above.—The locality is Vallecito, not "Valcitron."

Page 314. *A. Shawii.* To the liberality of Mr. Henry Shaw we are indebted for the fine photographs of this species which grace this number of our Transactions. They were taken by Mr. J. C. Parker of San Diego, last January. Plate 2 represents a group of these plants on the *mesa* near the coast of the Pacific, which is seen in the distance; one specimen is in full bloom, others flowered in November and are now bearing fruit sparingly. Decaying old plants are seen around, and young ones sprouting. The phyllotactic arrangement of the short broad leaves is beautifully displayed; the bright spiny teeth appear almost white from the effect of reflected light. The scape is conspicuously covered by the broad, triangular, imbricated bracts. The figures are about one-twenty-fourth of the natural size, or half an inch to the foot.

Plate 3 shows, in Fig. 1, a young plant; its leaves are more deeply concave than they are later, and therefore seem to be narrower; the teeth and their impressions on the adjoining leaves are remarkably well developed. One-fourth of natural size.—Fig. 2 is a cluster of flowers, exhibiting a densely compacted mass, unfortunately not distinct enough in its details; but the outlines of the cluster, the enveloping bracts, the very long, mostly vertical, anthers, and the exserted styles, are well rendered. It is two and a half times less than the natural size.

Page 322, line 1. In the Berlin botanic garden an *Agave attenuata* is cultivated which has a trunk 6 feet high; it is said to have grown 4 feet within the last 18 years.

Addition to the Article on YUCCA, p. 17 *of this Vol.*

Page 47. *Y. brevifolia* has sessile, densely-flowered panicles: flowers greenish-white, inconspicuous, and fetid. Fl. in April and May.—It is remarkable that at least in Southeastern Nevada.

north of the great bend of the Colorado River, where Messrs. Johnson and Parry have repeatedly examined numerous plants, no fruit has ever been found.

Page 54. *Y. Whipplei* has now become quite familiar through living specimens and beautiful photographs. From the latter we learn that the scape is imbricately covered with conspicuous, broad, at last patulous or drooping bracts, and that the panicle is densely flowered, narrow, spike-like, almost lanceolate.

About the OAKS *of the United States.*

By Dr. GEORGE ENGELMANN.

We have quite a large number of oaks in the United States, which for more than a hundred years have attracted the attention of botanists, and we thought we knew them pretty well, i.e. we thought we could distinguish, limit, and group the species. That may have been so, to a great extent, in the old States; but when the Rocky Mountains came to be explored, and the regions west of them, new forms were discovered, and often on single specimens, and not rarely on imperfect ones, species were founded and incompletely described, so that now a straight, clear path through such intricacies is difficult to find.

A striking example of the deceptive polymorphism of these western oaks is furnished by the common Rocky Mountain scrub-oak. This interesting species grows on the foot-hills of the eastern slope of the mountains of Colorado, sparingly near Denver, scarcely north of that city, but abundantly southward, about the Pike's Peak region, and thence extends through New Mexico eastward into Texas and westward through Utah and Arizona into Southern California. The centre of distribution perhaps, at all events the classical locality of this species, are the mountains above Cañon City in Southern Colorado.

In the valley and on the mountain slopes about this place the oak thickets abound, 6–8 ft. high, single trees occasionally 4 or 6 inches thick and rising up to 12 or 15 feet, rarely higher. The leaves are 3–4 inches long, broadly obovate, deeply lobed, sometimes pinnatifid, underneath stellate-pubescent; the broad lobes obtuse or retuse, often again 2–3-lobed. They bear middle sized or small oval acorns in more or less knobby hemispherical cups. Scattered copses of these broad-leaved oaks, often of a beautiful brownish-purple in September, accompany us to within a few hundred yards of the top of the cañon, but here the character of these shrubs changes: the bushes are lower, the leaves smaller and in outline narrower, the lobes narrower and mostly undivided, but still obtuse. Now we near the precipice itself; from the ragged, dizzy edge we here and there get a glimpse of the young Arkansas, whose clear green waters toss and foam, twelve or fifteen hundred feet under us, through the inaccessible gorge, rushing towards the plains. The oak bushes accompany us even here, but now they are only 4–6 feet high, with leaves 2 inches long, ovate-lanceolate in outline, no longer lobed, but coarsely dentate, the acute teeth terminating in a sharp point; the acorns are scarcely different from those noticed before. A few steps more and we have reached the brink of the precipice itself: oak bushes here too, but only 3 or 4 feet high, with small (1 inch long), oval, firm, almost cartilaginous, semipersistent, spiny-toothed leaves, here and there with only very few teeth or quite entire; the acorns proportionately smaller, of the same short oval shape, or often elongated from an unusually small, scarcely knobby, and sometimes peduncled cup.

We feel satisfied that we might have abundant material to characterize several distinct species, certainly 4 or 5 well marked forms, and, indeed, they have been considered such. The first is Nuttall's *Quercus Gambelii* (*Q. stellata*, var. *Utahensis*, D.C. Prod.); the second is *Q. alba*, var. *Gunnisoni* of Torrey; the third, with acutish lobes or coarse teeth, is Torrey's old *Q. undulata* of Long's Expedition, the first oak obtained from these mountains, and described about fifty years ago; the fourth, from the edge of the precipice itself, is what has often been mistaken for Torrey's *Q. Emoryi*, or what has been named *Q. pungens*, Liebm., in part; with it occur entire-leaved forms which seem to unite with this as a fifth form the *Q. oblongifolia*, of the same author, and *Q. grisea*, Liebm. As a large and broad-leaved southeastern form somewhat allied to *Q. Gambelii* I consider *Q. Drummondii*, Liebm. In herbarium specimens they all appear distinct enough, but, looking around us, the very abundance of material must shake our confidence in our discrimination: within the compass of a few hundred yards we find not only the forms above distinguished, but numbers of others which are neither the one nor the other, but which are intermediate between them and clearly unite them all as forms of one single extremely polymorphous species.

If one oak behaves thus, why not others? Thrown into a sea of doubt, what can guide us to a correct knowledge?

Though oaks are so common and such well-studied plants, I venture in the following pages to repeat old observations in order to combine with them some which I think are new, and which will help to throw a little more light on the subject.

The TRUNK—its BARK as well as its WOOD—is what we first contemplate, and this at once takes us to one of the principal points I wish to discuss.

That the *trunk* is that of a large, sometimes one of the largest, or of a middle-sized tree, or occasionally that of a shrub, even a very low one, is well known. On the Atlantic slope of the continent most species of oaks make trees and only a few are known as shrubs; I can now recall not more than one species, the live-oak of the south, which occurs in both forms: usually an immense tree, it occasionally bears a rich harvest of fruit as one of the smallest bushes. But it is different on the Pacific slope; there we find many oaks as trees in the lower countries, and as shrubs, usually with smaller foliage and smaller fruit, in the mountains. The lesser number of oaks seem to occur solely in one or in the other of these forms.

Examining the *bark*, we at once become aware of the fact that the popular distinction of "White-oaks" and "Black oaks" is based on correct observation. The paler, ashy-gray bark of the former and the darker, often nearly black, color of the latter corresponds, as will be shown, with other essential characters, and well marks the two principal groups of our American Oaks. The bark of the White-oaks is inclined to be scaly or flaky, that of the Black-oaks is usually rougher and deeply cracked and furrowed.

The *wood* of the White-oaks is tougher, heavier, and more compact—the only wood which is fit to be used by the wheelwright or cooper, and is for their purposes unsurpassed. The wood of the Black-oaks is brittle and porous, makes poorer firewood, and, made into barrels, holds only dry substances. Undoubtedly the microscopical investigation of both classes of oak-wood will scientifically establish and confirm these distinctions.

While many other trees, such as Pines, Walnuts, Hickories, Gleditschia, etc., grow rapidly in the first decades of their life, and make narrower and narrower annual rings as they grow older, the oaks either hold their own, the annual rings being as wide in age as they are in youth, or they grow more rapidly after the first 50 or 100, or even 150 years of their existence.

The *winter-buds*, especially the terminal ones, show some characteristic differences; they are larger or smaller, acute or obtuse, smoothish or hairy or tomentose: *Quercus Garryana* can be readily distinguished from all the allied Californian oaks by its large, pointed, tomentose winter-buds.

In the LEAVES, so extremely variable in form, certain types are generally recognized. It is not here the place to expatiate on these well-known topics; but I may be allowed the observation, that those oaks, which in the perfect state have deeply-lobed or pinnatifid leaves, show in young shoots or on adventitious branchlets less divided or only dentate, sinuate, or even entire leaves (e.g. *Q. alba*, *stellata*, *falcata*, *coccinea*, *palustris*, etc.), while, singularly enough, the oaks whose leaves in the adult tree are entire or nearly so, often have on the young shoots dentate or lobed leaves. I need for examples only refer to *Q. aquatica*, *Q. Phellos*, and *Q. virens*; and even *Q. nigra* belongs here.

The *vernation* of the oak leaves has sometimes been mentioned as conduplicate, meaning that the upper sides of both halves of the nascent leaf are applied together, and this really is the case with most oaks which I have been able to examine in this early stage. We find it both in White and Black-oaks—almost always, I believe, in those with broad and deeply-lobed leaves; I mention only *Q. alba*, *macrocarpa* and *Garryana*, *Q. coccinea* and *palustris*, and also the forms allied to *Q. Prinus*, even those with narrower, dentate leaves. In the more deeply-lobed, broad-leaved Black-oaks the two halves of the leaf are, besides, plicate parallel with the principal nerves.

Next to these range the oaks with the young leaves concave and imbricately covering one another. Such we find in *Q. stel-*

lata of the first, and *Q. nigra* of the second group, both with densely tomentose, thick, young leaves. In other oaks, mostly such as have broader and more or less entire leaves, the young leaves imbricatively cover one another like those last mentioned, but are convex on the upper side, with the edges turned down or back. Such is the case in *Q. cinerea*, *myrtifolia*, *agrifolia*, *aquatica*, *chrysolepis*, and, I believe, also in *Q. undulata*, and in *Q. Wislizeni;* I find the same to be the case in the deeply lobed *Q. falcata.*

The narrow-leaved oaks of both sections have revolute young leaves, the halves being spirally rolled backwards towards the midrib, so that only the upper side of the leaf is exposed; the point of the young leaf is somewhat spreading so that the branchlet has a squarrose appearance, while in those with imbricative vernation it is compact. I find the revolute leaf in *Q. virens*, *pumila*, *Phellos*, *heterophylla*, and *imbricaria.* In *Q. Catesbæi* I observe an inflexed vernation, the long bristle-pointed lobes of the nascent leaf being curved down over the still younger one.

I believe that the characters of vernation will not only help to distinguish allied species or doubtful varieties, but will also assist in unravelling the intricate questions of hybridity.

The young leaves of almost every oak are coated with a dense stellate down, which in some (*Q. alba*, *rubra*, etc.) is early deciduous, or it disappears later, or is entirely persistent. Besides these stellate one-celled hairs, several species, those with a clammy feeling of the young leaf, have another kind of hair, single or a few stellately connected, consisting of several cells, obtuse or clavate, sometimes branched, and often colored, apparently glandular. I notice these articulate hairs, among the White-oaks, in *Q. stellata.* and less conspicuously in *Q. macrocarpa;* among the Black-oaks, in *Q. nigra*, *myrtifolia*, *cinerea*, *falcata*, *aquatica*, and *laurifolia;* in *Q. chrysolepis* the characteristic "golden scales" are no scales. but consist entirely of such articulated yellow hair, and the young *Q. Catesbæi* has the same rusty coating.

The *venation* and more or less distinct *reticulation* of the leaves also present characters not to be neglected; by them, e.g. two easily confounded Californian oaks, *Q. agrifolia* and *Wislizeni* can readily be distinguished even in sterile branchlets.

The persistence of the leaves is a good character in some species, while in others it is unreliable; *Q. pumila* and *laurifolia* on the eastern and *Q. agrifolia* on the western coast sometimes retain their leaves until the new ones are fully developed, and other specimens, even in the same neighborhood, lose them before the buds swell; some have deciduous leaves northward and partly persistent ones southward. The broad-leaved forms of *Q. undulata* are decidedly deciduous, while those with small, coriaceous, spiny-toothed leaves retain them through part of the winter, or, towards their southwestern limit, even into summer. Only such oaks ought to be called evergreen which retain the greater part of their old leaves at least until the new ones are fully grown; the leaves of some oaks persist even into the third year.

The MALE FLOWERS are important for the diagnosis of some species, and to some extent even for the grouping of them. I pass by the form and pubescence of the bracts and of the calyx lobes as well as the pubescence of the anthers (among all our oaks only observed in *Q. stellata* and *virens*); even the sometimes present cusp or point of the anthers seems to be of lesser value, because variable in some species. Of greater importance is the size and the number of the anthers. The smaller and more numerous (usually from 5 to 8 or even 10, rarely only 4) occur in the White-oaks, while in the Black-oaks the anthers are usually larger and fewer, as a rule only 4, in some species as many as 5 or 6; only in *Q. agrifolia*, which also shows other abnormal characters, 6–8 stamens are the rule, and sometimes 10 are found. The pollen-grains of both groups have a diameter of about 0.03–0.04 mm.

In numerous flowers of a certain tree of *Q. nigra* I have seen abortive pistils with prominent filiform styles—singularly enough always 2, where we might have expected 3. In flowers of *Q. agrifolia* the connective of the anthers was seen to elongate, the cells to dwindle down and finally to disappear.

The FEMALE FLOWERS furnish valuable characters to distinguish the principal groups of our oaks. The pistil consists normally of 3 carpels and 3 stigmas; not rarely 4 occur, and in some Californian species (*Q. agrifolia* and *Wislizeni*) I have repeatedly seen as many as 5. The stigmas in our species are dilated, retuse, or emarginate; in the White-oak group they are sessile, or rarely (and that sometimes in the same species) borne on short, more or less erect, styles; in the Black-oaks we always find them on longer, patulous, or recurved styles.* As the stigmas are measurably persistent, we often recognize this difference even in the mature fruit.

The FRUIT exhibits the most important characters in the period of its maturation, first noticed by Michaux, and especially in the position of the abortive ovules, the beautiful discovery of A. De Candolle. But before I speak of these I must allude to the position of the fruit on the branch. It is single or clustered in the axils of the leaves or their scars, sessile, or more or less peduncled. In the Black-oaks the peduncle is short or missing, but in the White-oaks it is sometimes several inches in length; its presence, however, is of very little specific value, as in many species either sessile or peduncled acorns are found. In some oaks this feature is connected, with slight differences, in the length of the petiole, or the shape of the leaf; the distinction between the European *Q. Robur* and *Q. pedunculata* is based on such differences, and we have an analogous difference in our *Q. alba*, where, at least here in the Mississippi Valley, the form with deeply pinnatifid leaves has usually peduncles as long or little shorter than the acorn, and the other form with more broadly-lobed leaves has shorter peduncles or sessile fruit; but sometimes we find sessile and peduncled fruit on the same tree. Some White-oaks have always sessile or nearly sessile acorns, as *Q. stellata*, while *Q. bicolor* always bears them on long peduncles.

The acorns mature either in one season or in two, and generally speaking we find the annual maturation among the White-oaks and the biennial maturation in the Black-oaks, but the exceptions to this rule prove that this peculiarity is not necessarily connected with the essential characters of the two groups. We have one western White-oak, *Q. chrysolepis*, with biennial fruit, and three Black-oaks with annual maturation, *Q. pumila* of the east, and *Q. agrifolia* and *Q. hypoleuca* of the west.

The biennial maturation is easily recognized in the oaks with deciduous leaves; the tree is never without younger or older fruit.

* A group of White-oaks with biennial fructification, peculiar to Southern Europe and Eastern Asia, the best known representatives of which are *Q. Cerris*, *Q. Pseudo-Suber*, and *Q. occidentalis*, differs from all these by their patulous or recurved styles bearing ligulate, acutish stigmas.

or, from May to September, with both; the older acorns are then seen on the older, leafless part of the branchlet, and the young, incipient ones on the younger, leafy part. In oaks with persistent leaves some difficulty may arise from the peculiarity that the branchlets which had flowered the previous year, and are now maturing the fruit, often in the second year do not elongate or make new leaves or new wood—in short, do not perform any function but the maturation of the fruit. In this case the fruit is found near the end of the branchlet, absolutely as if it were an annual fruit; but the appearance of the leaves as well as of the epidermis of the branch proves them to be over a year old, and wherever a new shoot of the present year can be discovered, the difference between this and those of the last year easily solves any doubts. In *Q. chrysolepis* this peculiarity is quite striking; very rarely (at least in the herbarium specimens examined by me) the fruit-bearing branchlets elongate and again bear flowers, which is the rule in our deciduous biennial oaks.

The cup of the acorn, an involucral organ, is in all our species covered with imbricated scales, appendicular organs which simulate bud-scales, and even occasionally seem to assume a pseudo-phyllotactic arrangement. In the Black-oaks these scales are membranaceous and never thickened at base; in the White-oaks, on the contrary, they sometimes have herbaceous tips and, at least the outer and lower ones, are always more or less thickened, inflated, or knobby at base; they are very thick, e.g. in *Q. alba* and *lobata*, and very slightly thickened in *Q. stellata* and *Garryana*; in *Q. macrocarpa* they are herbaceously tipped.

The shell of the nut or acorn is thinner in the White-oaks and thicker in the Black-oaks; a much more important and striking character is, that in the former its inside is dark, smooth, and even shining, or rarely pubescent, and in the latter densely silky-tomentose, a difference which, I believe, is constant.

Only one of the 6 ovules of the oak-ovary is developed, while the 5 others persist as small but distinctly recognizable oval, dark colored, pendulous bodies, outside of the seed-coat, in the White-oaks at the base of the perfect seed, in the Black-oaks just below its tip. Only in one of our species, *Q. chrysolepis*, are they intermediate or lateral, in some acorns almost basal, and in others scattered over the side from near the base to two-thirds up. DeCandolle has observed the same in the Cork-oak of Europe and in some Mexican White oaks. The Black-oaks with annual fructification have these ovules always suspended near the tip of the seed, and are in this respect undistinguishable from the regularly biennial Black-oaks.

It is well known that in the southeastern Live-oak both cotyledons are united into one mass—a singular but isolated fact which has no systematic significance.

In the foregoing pages I have purposely left aside the very peculiar Californian *Q. densiflora*, which is in every respect different from the other oaks, and thus far the sole representative of a peculiar group named by DeCandolle *Androgyne*. In many respects it is more a chestnut than an oak, for it has, just like the chestnuts, the same dense-flowered, erect male spikes, 10 stamens to each flower, very small anthers on long filiform filaments, with very small pollen-grains (0.017 mm. in diam., not much more than half as large as in other oaks), and in the female flowers slender, terete, pointed stigmas, grooved above. In place of the spiny involucre of the chestnut our plant has a spiny cup, and is thus made an oak and not a chestnut. The maturation is biennial. The shell of the nut is thicker and harder than in any other of our oaks, the inside thickly tomentose, and the abortive ovules are found near the top of the seed. The wood is brittle and worthless.

It results from these investigations that our oaks, leaving again aside the one last mentioned, arrange themselves into two great groups, often alluded to above as the White-oaks and the Black-oaks.

The *White-oaks* are characterized by paler, often scaly, bark, tougher and denser wood, and sessile or subsessile stigmas, and bear the abortive ovules at the base or rarely on the side of the perfect seed. Besides this, the leaves and their lobes or teeth are obtuse, never bristle-pointed, though sometimes spinous-tipped: their stamens are more numerous, the scales of the cup more or less knobby at base, the inner surface of the nut glabrous or (rarely) pubescent; the fruit generally matures in the first year.

The *Black-oaks* have dark, furrowed bark, brittle and porous wood, styles long and spreading or recurved, abortive ovules always near the tip of the perfect seed. The leaves and their lobes are bristle-pointed, at least in youth; lobes and teeth acute; teeth sometimes spinous. Their stamens are usually less numerous, the scales of their cup membranaceous, the inner surface of their nut always tomentose; the fruit generally matures in the second year:

We may then arrange our oaks in the following order:

QUERCUS, Lin.

I. **Lepidobalanus,** Endl.: Amenta mascula pendula; pollinis cellulæ 0.03–0.04 mm. latæ: flores feminei a masculis distincti; stigmata dilatata.

A. LEUCOBALANUS: Ovula abortiva infera vel raro lateralia; stamina plerumque 6–8; stigmata sessilia vel subsessilia; nux intus glabra s. rarissime pubescens.

* Maturatio annua; nux intus glabra; ovula abortiva infera.

† Folia decidua.

Q. lyrata,[1] *macrocarpa,*[2] *alba, lobata, stellata, Garryana, bicolor, Michauxii,*[3] *Prinus,*[4] *prinoides, Douglasii, undulata.*[5]

† † Folia sempervirentia.

Q. dumosa,[6] *Emoryi,*[7] *reticulata,*[8] *virens.*[9]

** Maturatio biennis; nux intus pubescens; ovula abortiva infera vel lateralia; folia sempervirentia.

Q. chrysolepis.[10]

B. MELANOBALANUS: Ovula abortiva supera; stamina plerumque 4–6: styli elongati demum recurvi; nux intus sericeo-tomentosa.

* Maturatio annua; folia persistentia s. subpersistentia.

Q. agrifolia,[11] *hypoleuca,*[12] *pumila.*[13]

** Maturatio biennis.

† Folia decidua.

Q. palustris, rubra, Sonomensis, coccinea,[14] *ilicifolia, Georgiana, Catesbæi, falcata, nigra, cinerea,*[15] *aquatica, laurifolia,*[16] *heterophylla,*[17] *imbricaria, Phellos.*

† † Folia sempervirentia.

Q. Wislizeni,[18] *myrtifolia.*[19]

II. **Androgyne,** A. DeC.: Amenta mascula erecta, basi flores femineos gerentia; pollinis cellulæ fere 0.017 latæ; stigmata linearia.

Q. densiflora.

NOTES.

1. *Quercus lyrata,* Walt., extends as far north as *Taxodium* does, to the banks of the lower Ohio in Illinois.

2. *Q. macrocarpa,* Michx., is extremely variable in the size of its acorns, and especially in the depth and the margin of its cup, which sometimes

covers the acorn scarely one-half, usually three-fourths, and occasionally entirely; the margin is profusely or sparsely fringed. — Throughout the north-west, north of the Missouri river, a low scrubby form is found, which might be designated as var. *depressa*, as it is undoubtedly the *obtusiloba* β. *depressa*, Nutt. gen. 2, 215, which has smaller leaves and much smaller acorns than the species, but is clearly a form of *macrocarpa*.

3. *Q. Michauxii*, Nutt. gen. 2, 215, excl. syn.—The figure of Michaux, quoted by Nuttall, refers to *Q. bicolor*, and none of his figures represent our plant. Elliott adopts Nuttall's name, but Chapman as well as DeCandolle consider it a form of *Prinus*. *Q. Prinus* was described by Linnæus with *foliis obovatis utrinque acuminatis*, which sufficiently well agrees with all the forms of *Prinus* proper. Our plant is distinguished by having the leaves obtuse, or mostly cordate, at base; thicker, more leathery, and tomentose, on the lower side; and the male flowers 10-androus. All the forms of *Prinus* proper have a very deciduous pubescence on the lower side of the leaf, which is acute or acutish at base.

4. *Q. Prinus*, Lin., would then comprise Michaux's varieties, *palustris*, *monticola*, and *acuminata*.

5. *Q. undulata*, Torr., has been treated of in the introduction to this paper: the different forms, there also enumerated, are — α. *Gambelii* (*Q. Gambellii*, Nutt. and probably *Q. Drummondii*, Liebm.); β. *Gunnisoni* (*Q. alba*, var. *Gunnisoni*, Torrey); γ. *Jamesii*, Torrey's original plant, figured in Ann Lyc. N.Y. 2, t. 4; the original figure reproduced with slight alterations in Nuttall's N. Am. Sylv. 1, t. 3; δ. *Wrightii*, often confounded with *Q. Emoryi*, and apparently one of the forms comprised by Liebmann in his *Q. pungens*. *Q. oblongifolia*, Torr., and *Q. grisea* Liebm., seem to be forms with more or less entire leaves; or the latter may perhaps have to be referred to the Mexican *Q. microphylla*.

6. *Q. dumosa*, Nutt., N. Am. Sylva, 1, p. 7; Torrey, Bot. Mex. Bound. p. 207. *Q. acutidens*, Torr. ib. tab. 51, is a larger form of the same. *Q. berberidifolia*, Liebm., DeProd. 16, 2, p. 36, seem to belong here either entirely or at least in part. A shrub of the southern part of California, often very squarrose, sometimes with slender and erect branches; leaves oval, obtuse, often cordate or obtuse at base, spinous-dentate or sometimes entirely dark green above, hoary tomentose or pubescent below, from ½ to ¾ or sometimes 1 inch long; fruit sessile; cup strongly tuberulate, black, between 2 and 6 lines in diameter; acorn large for the size of the plant, oval, or small and narrow.

7. *Q. Emoryi*, Torr. Emory Rep. 1848, p. 151, t. 9, *Q. hastata*, Liebm. Quite distinct from *Q. undulata* var. *Wrightii*, which is often confounded with it; the peduncled acorn of Torrey's figure may belong to that form of *undulata*. This pretty Arizonian species was collected by Emory in 1846, and soon afterwards by Wright, and then not again until Dr. Rothrock, a year or two ago, brought back fine specimens from Lieut. Whipple's Expedition. The leaves are not roundish or oval and pale as in *Wrightii*, but lanceolate, cordate at base, and dark green: the acorns in all the

specimens seen by me are sessile, the bright brown scales of the cup only slightly thickened at base.

8. *Q. reticulata*, H. B. K., has been found in Southern Arizona by Dr. Rothrock, in the expedition just mentioned.

9. *Q. virens*, Ait. A shrubby form is var. *maritima*, Chapm., *Q. maritima*, Willd., from which var. *dentata*, Chapm., cannot be separated; both have shorter and often larger acorns on shorter peduncles than the species; the former is the larger shrub, rarely as much as 10 feet high, with usually entire lanceolate leaves; the latter often bears fruit when only 1–1½ feet high; leaves sometimes dentate or sinuate-dentate, 1–2 inches long; vigorous ground shoots occasionally produce broad oval, entire, or dentate leaves, 3–4 inches long and 1½–2½ wide.

10. *Q. chrysolepis*. Liebm., has so often been spoken of in the foregoing pages that little need be added. Its fructification was misunderstood until the abundant material, brought together by Prof. W. H. Brewer for the California State Survey, permitted me to clear it up. The size of the plant, of the leaves, and of the fruit, is extremely variable; and even the yellow pubescence, which has given it its name, is neither persistent, nor is it present in all cases. Young vigorous shoots or young trees have spiny-dentate leaves; older trees, especially on fertile branches, usually entire ones. The acorns are sometimes very large and the shallow cup extremely thick: this is the form Torrey (Pacif. R.R. Rep. v. 365, tab. 9) has described as *Q. crassipocula;* Dr. Parry sends from San Bernardino still larger cups, 1¾ inches in the outer diameter. Dr. Kellogg's *Q. fulvescens*, in Proc. Calif. Ac. 1, 67 & 71, seems (from specimens seen in Hb. Brewer) to refer to the form with middle-sized acorns and cups of the ordinary shape, without that unusual thickening: his *Q. vacciniifolia*, ib. 1, 96 (106 ed. 2) is a small-leaved mountain form. Of this variety specimens are found entirely destitute of the yellow, scurfy pubescence even in the earliest youth. The anthers of this species, usually 10 in number, are always strongly pointed; the broad stigmas are closely sessile. The lateral position of the ovules has been mentioned.

11. *Q. agrifolia*, Née, the first western oak that became known (1802), is quoted by the author as inhabiting "Nootka Sound" and California perhaps by mistake, as now it does not seem to be known much north of the Bay of San Francisco, and it extends as far south as the southern boundary of the State, but does not ascend the mountains. It is a fine large almost evergreen tree, but makes miserable timber and even poor firewood. The old leaves partially fall off in winter, so that the heads begin to look less dense towards spring; in some trees the last leaves have fallen before the young ones are developed, but generally they do not come off entirely before the young verdure covers the branches. Dr. Bolander remarks that occasionally odd-looking trees are observed which in spring retain all their old leaves without bringing forth flowers or young shoots—a state of things which resembles the condition of *Q. chrysolepis*, above alluded to; that species, however, performs the function of maturing its

fruit, though it bear no young leaves, while in this case there would be in spring an almost absolute winter-like stagnation of the vegetation. It has certainly an annual fructification, but is in every respect, except in the number of the large stamens (6–8 and often more), a regular Black-oak. The acorn is always long pointed, whence the name Torrey gave it, *Q. oxyadenia*, (Sitgr. Rep. tab. 17), is not inappropriate.

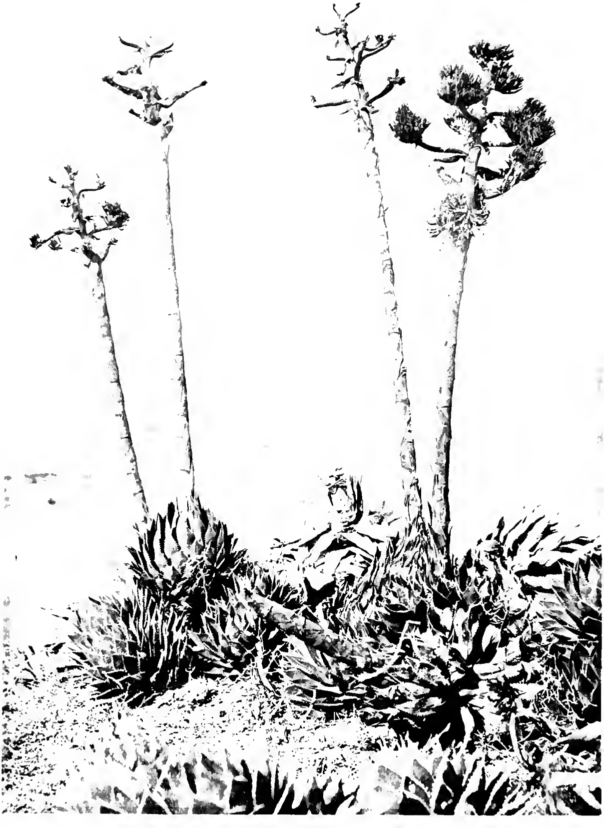
A southern variety of this species is shrubby, with smaller leaves, occasionally pubescent, and with smaller but very abundant fruit. From the often very similar *Q. Wislizeni* it can, even without fruit, always be distinguished by the dull, pale upper surface of the leaves, which is usually convex, and by the absence of reticulation on it.

12. *Q. hypoleuca* I name an Arizona oak which Torrey, in Mex. Bound. Rep. p. 207, refers to *Q. confertifolia*, H. B. K., a species with biennial fructification and slightly pubescent leaves. Our plant is characterized, besides its annual acorns, by lanceolate thick leaves with revolute margins and a white tomentose lower surface. The 5-lobed calyx is scarcely hairy and bears 4 stamens; no bracts seen even before the flowers open.

13. *Q. pumila*, Walt. Fl. Carol p. 234. Michx. Sylv. tab. 17 (where the fruit is erroneously represented as biennial, otherwise the figure is good). This interesting shrub, though first described nearly a century ago, has only, through the efforts of Dr. J. H. Mellichamp, become properly known in the last few years. Living in the immediate vicinity of its habitat, the pine barrens of the low country of South Carolina, this acute observer has aided me in the most liberal manner in studying this as well as other difficult oaks of that region.

Q. pumila is called the *Running-oak* because by the aid of its wide-spreading stolons it covers large patches, sometimes acres, with its thickets. It is often, especially where kept down by the frequent fires, only 1–2 feet high, and has been seen loaded with flowers when only of 6 inches; in other localities it grows 8–10 feet high, with stems 1 inch in diameter. The leaves, revolute in vernation, are usually about 2 inches long, lanceolate, entire and often undulate, only occasionally dentate-lobed, but in vigorous shoots sometimes broad ovate and deeply and acutely lobed; another form has obovate obtuse leaves. They are slightly pubescent when young, but soon become quite glabrous, persist through the winter and occasionally beyond the flowering period. In the male flowers I find pretty regularly 4 stamens, and in the female 3 long recurved styles. The globose fruit in its shallow cup is nearly sessile in the axils of the same year's leaves.—*Q. pumila*, Walt., Michx. Sylv., Nutt. gen., Elliott Flor.; *Q. Phellos* var. *pumila*, Mich. Querc. & Flor.; *Q. cinerea* var. *pumila*, Chapm., A. DeCand. Prod.

Var. *sericea* has similar narrow, or larger, ovate-lanceolate leaves, always silky-white underneath; the larger leaves on fertile branches grow over 4 inches long by 1¼ inches in width, and on sterile shoots even larger. —*Q. sericea*, Willd., Pursh.; *Q. Phellos* var. *sericea*, Ait.



Parker, Photographer, AGAVE SHAWII. Engelm. San Diego, Cal.

AGAVE SHAWII. Engelm.

Over a year has past since the foregoing part of this paper was published; of the concluding seven pages only a small edition for private distribution was then printed. Continued study of the genus, aided by numerous kind communications of observations as well as of specimens, have enabled me to make the following corrections and additions.

Pag. 374, l. 22. Low shrubby forms of *Q. stellata* occur on the southeastern seacoast, and of *Q. macrocarpa* on the northwestern plains.

L. 2 from below ought to read: the only oak wood.—The wood of *Q. Prinus*, however, makes an exception, being more porous than most other White-oak woods.

A careful study of the numerous American oak woods displayed by the Agricultural Department and by different States, at the Centennial Exhibition in Philadelphia, has revealed further interesting facts. The Black-oaks grow, on an average, nearly twice as fast as the White-oaks, and, if *Q. nigra* and the evergreen Black-oaks be left aside, the disproportion will be found still greater. In the average of 20 different White-oaks, from all parts of the country, I find the growth nearly equal through the first 40 years; in 14 specimens of Black-oaks the growth is more rapid in the first 30 years than between the 30th and 40th. The following little table will exhibit this more distinctly.

AVERAGE WIDTH OF THE ANNUAL RINGS

	in 20 White-oaks:	in 14 Black-oaks:
In the first 20 years	0.8 lines.	1.6 lines.
From the 20th to the 30th year	0.8 "	1.7 "
" 30th " 40th "	0.7 "	1.2 "

The heartwood of the White-oaks is always readily distinguishable from the sapwood by its darker color, varying between dark gray and light brown, but in the Black-oaks the heartwood is scarcely darker than the sap, and in some species or some individuals cannot be distinguished at all. Only in *Q. nigra* and the curious *Q. Emoryi* is it often irregularly mottled with black.

In the limited number of specimens which I could examine, the sap turned into heartwood,

	in 19 White-oaks,	in 8 Black-oaks,
after	22 years,	17 years.
having attained a thickness of	18 lines,	21 lines.

Only in these 8 Black-oaks a line of demarcation was visible.

In a geographical point of view, we notice that the Black-oaks of the present day are confined to America, and are principally developed in the Atlantic part of North America. We have there 15 species, including a single abnormal type, while west of the Great Plains and on the Pacific slope only 5 species occur, 3 of them receding from the normal type. Numerous Black-oaks are found in Mexico and Central America; in DeCandolle's Prodromus 20 are enumerated with known maturation, and of 18, of which the fructification is not ascertained, some may also belong here. In the tertiary period the Black-oaks, it seems, extended into the old world, just as many other recent North American types did.

The White-oaks are more uniformly distributed over the temperate parts of the northern hemisphere. We have on the Atlantic slope 8 species and 9 in the western half of the continent, only 2 of the latter abnormal.

Thus we have in our Flora nearly as many White-oaks as Black-oaks; but while the former are nearly equally distributed between east and west, the latter predominate eastward.

Pag. 375. *Vernation*—A too hasty examination, partly of specimens too far advanced, has led me into several errors. The vernation is *conduplicate* only in part of the White-oaks (in the European type of the genus, *Q. Robur;* in our *Q. alba, macrocarpa, Garryana*, and in all the species of the Prinus group; probably in *lyrata, Douglasii* and *lobata*). The *imbricate* vernation is the rule for the balance of the White-oaks (*Q. stellata, undulata, dumosa*, and *chrysolepis*) and for all the Black-oaks, with the exception of the few species (p. 376) with *revolute* vernation. In the oaks with imbricate vernation the outer leaves are always imbricate, but the inner ones are imbricate or flat or even slightly revolute on the margins in the species with thicker, firmer leaves (*undulata, dumosa, chrysolepis; Emoryi, agrifolia, nigra, aquatica, laurifolia, cinerea, myrtifolia*). In the others, with broader and more lobed leaves (*coccinea, rubra palustris, falcata*, etc.) the 2 or 3 innermost leaves are conduplicate. The inflexed vernation, mentioned as occurring in *Q. Catesbæi*, is also occasionally seen in *falcata*, evidently in oaks with slender-lobed leaves, but it is by no means constant and of no specific value.

The suggestion that the character of vernation would be an important assistance in classification, and in the discovery of alliances of hybrids, has been verified by actual observation, as will be shown below.

Page 376. The glandular colored pubescence appears on both sides of the young leaves in *Catesbæi*, *sinuata* and *myrtifolia;* on the lower side in *chrysolepis* and somewhat in *stellata;* on the upper side in *falcata*, and also in *Catesbæi-laurifolia.* I do not find this pubescence on seedlings of these species, nor is it often seen on the youngest leaves, but becomes developed when the leaf has attained ¼ to ½ of its full size.

The *reticulation* is generally more marked on the upper than on the lower side of the leaves, and in the Black-oaks more than in the White-oaks; an exception occurs in *Q. falcata* and (as already indicated) *agrifolia;* in both the upper surface is almost smooth; in *cinerea* and *ilicifolia* the reticulation is much less prominent than in most others.

Pag. 377. The male aments are produced from scaly buds which are not further developed, or from the lower part of branchlets, usually in the axils of budscales, or rarely from the axils of the lowest leaves; thus often in *Q. agrifolia.* They are mostly simple, but in *chrysolepis* I find them often branching, such as they are described in the Asiatic section *Pasania.*

Pag. 378, l. 16 and 17, strike out the comma after "connected." "differences" and "petiole." Add *in* before "the shape."

L. 33. *Four* Black-oaks with annual maturation, including *Q. Emoryi.*

Pag. 379, l. 22. Occasionally Black-oaks are found with cup-scales thickened at base; Prof. Sargent has collected near Cambridge fruits of *ilicifolia* with this peculiarity, and it does not seem to be rare at all in northern forms of *rubra.*

L. 6 from below. The abortive ovules are not oval and pendulous, but rather bottle-shaped bodies, suberect in the White-oaks, hemitropous in the Black-oaks.

Pag. 380, l. 5. *Q. Emoryi*, in every other respect a true Black-oak with annual fructification, has basal ovules, another remarkable instance of mere botanical characters not always coinciding with essential ones. Hence the word "always," in the first sentence of the following page, must be qualified by adding *almost.*

Pag. 381. The following is believed to be a more correct enumeration and more natural arrangement of our oaks.

I. **Lepidobalanus,** Endl.

A. LEUCOBALANUS.

* Maturatio annua.

† Folia decidua.

Q. alba, lobata (fruticosa), Garryana, stellata, macrocarpa, lyrata, bicolor (Michauxii), Prinus, Mühlenbergii (prinoides), Douglasii, undulata (pungens).*

†† Folia persistentia.

Q. oblongifolia, dumosa, reticulata, virens.

** Maturatio biennis.

Q. chrysolepis (vacciniifolia, Palmeri), tomentella.

B. MELANOBALANUS†: Ovula abortiva (excepta *Q. Emoryi*) supera, etc., ut in pag. 381.

* Maturatio annua, folia persistentia.

Q. Emoryi, agrifolia, pumila, hypoleuca.

** Maturatio biennis.

† Folia decidua.

Q. rubra, coccinea (tinctoria), Sonomensis, falcata, Catesbæi, ilicifolia, palustris, Georgiana, aquatica, laurifolia, nigra, cinerea, imbricaria, Phellos.

†† Folia persistentia.

Q. Wislizeni, myrtifolia.

II. **Androgyne,** A. DC.

Q. densiflora.

ADDITIONAL NOTES.

Q. lobata, Née, has heretofore been known only as a large tree with slender, even pendulous branches, deeply lobed or pinnatifid leaves, the lobes often retuse, notched or again lobed, pubescent below; with large, long, conical-pointed (therefore *longiglanda*, Torrey) acorns in a deep, almost always strongly tuberculated cup. No essential variation of this type has been noticed, unless we class a shrub-oak here, 2–6 feet high, which Prof. Brewer found on the mountains west of Shasta, and Mr. Lemmon near the Tuolumne River. The foliage is the same as that of *lobata*, perhaps smaller and even more deeply lobed, but the large oval acorns have their base scarcely immersed in a very shallow cup; cup 8–9 lines wide, 3–4 high; acorn 12–15 lines high, sessile or (in the Tuolumne

* The names in parentheses designate subspecies.

† The Black-oaks, many years ago, were grouped by Spach, and later by Liebmann and others, under the name of *Erythrobalanus* (Red-oaks), but with other characters and other limits than I assign them.

specimens) peduncled. The form of the acorn and cup might justify me in considering this bush as a distinct species, but, well aware of the extreme variability of the western oaks, I provisionally append it to *Q. lobata* as a subspecies under the name of *fruticosa*.

Q. Garryana, Dougl. ap. Hook., well known in California by the name of Mountain White-oak, though not found in the higher mountains; it extends farther north than any other oak on the west coast and is the only representative of the genus north of the Columbia River, is common on Vancouver Island (where a variety has been called *Q. Jacobi*, R. Br. min.) and according to Prof. Dawson has been met with sparingly on Frazer River; on the Columbia it extends as high up as the Dalles; in exposed northern situations it is scrubby. Southward it seems to be limited by San Francisco Bay. It can always be readily distinguished by its rather large, variously but commonly deeply-lobed thick leaves, tomentose or downy beneath, and by its large (3–5 lines long) tomentose winter buds. *Q. Neæi*, Liebm. (Hartweg in Hb. Gray) is a form with more knobby cups.

Q. stellata, Wang. (*Q. obtusiloba*, Michx.) is of a uniform character in the middle States, but varies considerably southward. Dr. Mellichamp finds on the coast of South Carolina, 1. a scrub form, often with almost entire, undulate or angular leaves mixed with other shrubs or trees of the normal foliage: 2. a tree with normal leaves but glabrous branchlets and glabrous anthers; and 3. a tree with flaky bark, and narrow, cuneate leaves with oval lobes, and like the branchlets glabrous; anthers unknown. The last two may prove to be hybrid forms between *stellata* and *alba*, for which see further on.

Q. macrocarpa, Michx. often occurs in the north and northwest with unusually small oblong acorns, half or more covered by the mossy cup, when it is *Q. olivæformis*, Michx.; another form has oval acorns of the size of those of *coccinea* in a shallow, mossy cup; on the lower Ohio acorns have been gathered 15–16 lines in diameter, in a very mossy cup over 2 inches wide. The leaves vary from the nearly entire, obovate, sinuate-dentate to the lyrate-pinnatifid form with almost naked midrib. The branchlets, always thick, are either corky or smooth.

Q. lyrata, Walt., originally known from the banks of the southeastern rivers, is also found in the damp woods of the lower Ohio and down the Mississippi River. It properly stands between *macrocarpa* and *bicolor* and has a good deal of both. I have seen from the same localities (Mount Carmel on the lower Wabash, *Dr. J. Schneck*, and Memphis, *A. Fendler*) specimens with the typical enclosed acorns, and others with cups, somewhat mossy on the edge, only half enclosing the acorn. The bark is flaky like that of *bicolor*.

Q. bicolor, Willd. is generally a well characterized tree with flaky bark, cuneate-obovate, coarsely sinuate-dentate leaves, white below, 6–8-androus flowers, and large acorns in long-peduncled, mossy cups; but numerous aberrant forms occur, some with light downy leaves and green below, others with much smaller or longer acorns; in some the cup is scarcely fringed.

Q. Michauxii, Nutt., such as it appears in the south and up to the lower Delaware River (*Michaux, Canby, Commons*), and to the lower Ohio (*Dr. Schneck*), would seem to be a well marked species; but my notes, p. 382, based upon too few specimens from a single locality, are not quite correct. It is certainly *Q. Prinus palustris* of Michaux (the *Q. P. discolor*, quoted by Nuttall as synonym, is *Q. bicolor*). The tree grows in low grounds; has a gray, flaky bark; leaves (usually large, 5–6 inches long) oval or obovate, regularly (commonly not deeply) dentate acute, obtuse or even cordate at base, generally thick and very soft downy below, rarely only slightly pubescent or even almost glabrous (in Delaware, *A. Commons*); male flowers mostly 10-androus; fruit the largest of the Prinus group, short-peduncled, cup shallow, obtuse or flat below, with deltoid, acute, rigid, distinctly imbricate scales, without any fringe. — Distinct as this tree seems to be, a series of forms, apparently common from the Delaware (*Canby, Commons*) to the Potomac (*L. F. Ward, Dr. Vasey*), evidently unite it, contrary to the views of most American botanists, with *Q. bicolor*. DeCandolle (Prod. l. c. p. 20) already assumed their identity; he, however, on the next page, wrongly quotes Michaux's *Q. P. palustris* for *Q. Prinus*. The leaves of this intermediate form are in some instances purely those of *bicolor*, in others more those of *Michauxii;* the acorns are subsessile, middle sized, with a deeply hemispherical cup, and less regular, often knobby and sometimes appendaged scales. If these connecting forms were not so common in the region mentioned, I might feel inclined to take them for hybrids between two distinct species; as it is, I must consider *Q. Michauxii* as a subspecies of *bicolor*.

Q. Prinus Lin., *Q. Prinus monticola* Michx., *Q. montana* Willd. Only after visiting the Alleghany Mountains and their eastern slopes, and seeing thousands of these trees, have I fully realized the accuracy of Michaux's description in his Sylva and have become convinced of the absolute specific difference of this tree from the other members of the Prinus group; and, indeed, its peculiar bark and wood distinguish it from all other White-oaks. I suppose it to be the type of Linnæus's *Q. Prinus*, because it is the most common of the group in Virginia, whence the original came from: *arbor procera Virginiana*, Pluck.; *foliis....serratis denticulis rotundatis uniformibus*, Lin. H. Cliff.—The bark of the young tree before the age of 10 or 12 years is smooth and even shining, of a purplish-brown color; then it begins to crack and in the old tree becomes thick (often 1–2 inches and more) and deeply cracked and furrowed without peeling off, so that Michaux could, not inaptly, compare it with the bark of the chestnut, which, however, is darker. The wood is more porous than that of other White-oaks, and is said to be not much more useful than that of Black-oaks, and unfit for barrels to hold liquids. Though its proper home seems to be in the mountain districts, it is not rarely seen in the low country eastward. Westward it is common in the mountains of Tennessee and Georgia, and has been collected on Seneca Lake in Western New-York; it is unknown in the Mississippi Valley proper.—The leaves are thick, often almost coriaceous, pale below with a short and close pubescence, obovate to lanceolate, sometimes even acuminate, those of the lower branches of the tree often much wider and larger than the leaves of the upper, fertile branches; teeth coarse and regular, obtuse, rarely larger, or occasionally almost obliterated in the sinuate margin; the lateral nerves usually terminate above the most prominent part of the shallower teeth, and even in the sinus and only in the most prominent teeth at their apex. Fruit short-peduncled; cup deep, somewhat turbinate, tubercled—*rough*, as the descriptions express it; base of the scales often raised in two knobs, between which the short and almost indistinct tip of the scale next below is almost buried: acorn large, sometimes 1–1¼ inches long and 1 inch thick.

*Q. Mühlenbergii,** *Q. castanea*, Mühl. ap. Willd., *Q. Prinus acuminata* Michx., occurs scatteringly throughout the middle and northern Atlantic States, in Pennsylvania only on limestone soil (*Porter*), but its proper home is the Mississippi Valley, where it entirely supplants *Q. Prinus*, more commonly on limestone hills and ridges, but also abundantly in river bottoms. Its flaky, pale ash-colored, thin bark and very tough wood (light yellowish brown when mature, whence probaby the popular name of "Yellow-oak") distinguish it at once from *Prinus*, as do also the small globose or commonly ovate acorns in a subsessile, shallow and thin cup covered with small canescent, obtusish, rarely much thickened, scales. Leaves on petioles ¾–1 or even 1½ inches long, thinner, more membranaceous, below pale and with an inconspicuous down, usually sharper serrate, often with inflexed teeth, and either lanceolate with a long acumination, 5–6 inches long by 1½–2 in width (the typical form of Michaux and Mühlenberg) or larger, sometimes even in fertile specimens as much as 7 inches long and 5 wide, broadly ovate or obovate with more rounded teeth, which form has often been taken for *Q. Prinus*, but is in bark and fruit identical with the narrow-leaved form.

Q. prinoides, Willd., distinguished from the last by its low stature, smaller, more undulate than sharp-toothed leaves on shorter (¼–½ inch long) petioles, and commonly by deeper cups with more tumid scales, is apparently well enough marked eastward, but westward, from Western Missouri to Kansas and Nebraska, where it abundantly bears when only 1–3 or up to 30 feet high (*E. Hall, G. C. Broadhead*), it runs into the arborescent *Mühlenbergii*. It is suggested that annual prairie fires are the main cause of the stunted growth of this low form (while other species are not affected in this manner), and that often large and knobby rootstocks are found to produce numerous shoots, fertile in the first season. Prof. Gray informs me that Mühlenberg, in his manuscript *Florula Lancastriensis*, considers this form a variety of his *castanea*; he enumerates

* As Mühlenberg's as well as Michaux's names for this very distinct species are preoccupied, it seems fit to commemorate the celebrated Pennsylvanian botanist's name by this oak which he had so well distinguished.

the following of the Prinus Group: *Q. castanea* with β *prinoides*, *Q. Prinus*, and *Q. bicolor*.*

Q. Douglasii, Hook, is the only Californian oak which might be confounded with *Q. Garryana*; but, if I understand it aright, it can always be distinguished by its small oval, obtuse, bright brown, slightly hairy winter buds; its smaller, more sinuate than lobed leaves, which, downy in early youth, soon become glabrous on the upper side, with a bluish tinge, whence it has received locally the name of Blue-oak, or Blue Mountain-oak. It extends not as far north as *Garryana*, probably not into Oregon, but farther south on the lower hills and mountains of the Pacific slope.

Q. undulata, Torr. Enough has been said in the introduction to this paper and on p. 382 about the wide limits of variation which this species enjoys: local botanists, however, are not agreed as to the relations these forms bear to each other. We are safe in arranging all the varieties in two groups: the first is characterized by larger, strongly lobed, darker green and decidedly deciduous leaves, and narrower, ciliate calyx lobes; the second has smaller, paler, more rigid, mostly spinous-dentate, and — at least southward—more or less persistent leaves, and broader, woolly calyx lobes. In both groups the sweet and edible acorns are oval, oblong, or sometimes elongated; the subhemispherical, sessile, short- or sometimes long-peduncled cup varies from scaly to very knobby; in the dark-leaved forms the acorns are often thicker and shorter, in the pale group slender and longer. Distinct as both groups seem to be, the original *Q. undulata*, my var. *Jamesii*, completely connects them. Var. *Gambelii*, with broader emarginate or even lobed divisions of the large leaf, on one side runs into var. *Gunnisoni* with narrow and entire lobes, and on the other into var. *breviloba* (*Q. obtusiloba* var. *breviloba*, Torr. Bot. Bound., and probably *Q. Durandii* and *Q. San Sabeana*, Buckley) with sinuate or broad- and short-lobed leaves. The forms of this group are found from Western Texas through parts of Colorado, Utah, New Mexico, and Arizona, but not west of the Colorado River. Var. *Jamesii* is a *Gunnisoni* with acute lobes of the smaller, more rigid leaves, found thus far only from West Texas to Colorado. The transition is almost imperceptible from this to the pale-leaved forms which southward become evergreen, in so far as they lose their old leaves not before the new ones develope. They do not extend as far north nor east as the dark-leaved group, but farther southwestward through the California desert and into the mountains bordering it on the west.

This pale-leaved group consists principally of var. *pungens* (*Q. pungens*, Liebm. as to sp. Wright 664: var. *Wrightii*, p. 382, which has con-

* The insects appear to understand the natural relations of the species of this group as well as we do; on all of them, and on no other oaks, I have noticed a very peculiar gall—for a gall I must take this excrescence to be—on the cups, singly or several together, usually surrounded by fringe-like scales, sometimes hollow, sometimes containing what looks like a diminutive acorn. Entomologists are, I suppose, well acquainted with these galls. Sometimes they have been taken for minute abortive acorns from the axils of cup scales; but cup scales are not leaf organs, and cannot well produce axillary buds.

stantly been confounded with *Q. Emoryi*) with small (1 inch or less long) sinuate-dentate leaves, the teeth very rigid and pungent. Var. *grisea* (*Q. grisea*, Liebm., Wright 665 from West Texas) with oblong, more or less entire, often hoary leaves, which commonly passes for *Q. oblongifolia*, can scarcely be distinguished from *pungens*, as both forms occasionally are found on the same bush. Var. *grandifolia*, with very large (3-5 inches long) nearly entire or undulate leaves and very long peduncles, was found by Dr. Palmer in Arizona and by Mr. Brandegee on the upper Arkansas.

Q. oblongifolia, Torr. Bot. Sitgr. t. 19, not of Bot. Mex. Bound., the South California "Live-oak," a bush or a middle sized tree with pale flaky bark; oblong, obtuse, coriaceous, subpersistent leaves, at first soft downy, but soon glabrous on both sides (like those of *Q. alba*); short, oval, woolly calyx lobes, and sessile or short peduncled acorns. The leaves of young shoots are usually dentate, those of fertile trees are entire or rarely sinuate.—This species seems to come to perfection on the coast mountains and in the valleys of Southern California from San Diego to San Luis Rey and Los Angeles, but extends into Western New Mexico, where it was first discovered, and into the adjacent parts of Mexico (Chihuahua, *Dr. Gregg*).

Q. dumosa, Nutt. (see p. 382), the characteristic scrub-oak of the Californian coast ranges from San Francisco southward, is closely allied to the last and still more so to var. *pungens* of *Q. undulata*, but occupies a different geographical range, has more sinuate-dentate than spiny-toothed leaves, dark green above; calyx lobes lanceolate, acute. The cup scales are strongly tuberculate, or rarely almost even.—Coulter's 661, on which Liebmann founded his *Q. berberidifolia*, is exactly this species; but Frémont's specimens, also quoted by him, at least those in Hb. Torrey, all belong to *pungens*.

Var. *bullata*, with thicker, paler, convex leaves, persistently woolly on both sides, has been found on the Santa Lucia mountains and near New Idria by Brewer, and in Pope Valley by Bolander.

Pag. 382, l. 12 from below, put *entire, dark* for "entirely dark."

Pag. 383. *Q. chrysolepis*—I distinguish as a subspecies *Q. vacciniifolia*, Kellogg, a small-leaved evergreen shrub of the Sierras, the oblong or lanceolate leaves, except in young shoots, entire, rarely more than 1 inch long, the yellowish scurf very deciduous or sometimes entirely absent. Another extreme and somewhat aberrant subspecies I name for its discoverer *Q. Palmeri*. It is a stout and scraggy shrub, in the mountains 80 miles east of San Diego, 8-10 feet high, with very rigid and spiny, sinuate-toothed, broadly oval leaves, less than 1 inch long, scurfy on the lower side; anthers about 10, smaller than in *chrysolepis*, emarginate, not cuspidate; cup obconic ($\frac{3}{4}$ inch wide, $\frac{1}{2}$ inch high); its scales almost hidden in the dense, fulvous tomentum; nut inside densely woolly, which I find in no other White-oak; abortive ovules basal.

Q. tomentella, n. sp., is an oak from the Island of Guadaloupe off the coast of the Californian peninsula, which I had formerly classed with *chrysolepis* (Palmer, Flor. Guad. Nos. 88 & 89), but which appears to be well distinguished by its tomentose young leaves and branchlets, which latter retain this coating for several years. The full-grown leaves are short-pedicelled, ovate-lanceolate acute, at base obtuse, undulate-crenate (only on young shoots spinose-dentate), glabrous above and brownish-furzy below, about 2 inches long and half as wide, and persist into the third year. Male aments tomentose, calyx lobes oval-obtuse, anthers about 10. cuspidate; female flowers short-peduncled. Large oval acorns (16 lines long) in a shallow cup covered with dense brown wool, from which protrude the small triangular tips of the scales. Maturation of the fruit unknown, but, from the close affinity to *chrysolepis*, probably biennial, though the apparently nearly allied *Q. tomentosa*, Willd. has annual fructification.

Q. Emoryi, Torr. (see p. 382, where, l. 3 from below, "Whipple" ought to read *Wheeler*). This form, which connects the White-oaks with the Black-oaks, is of the greatest interest to the student, but annoying enough to the systematic botanist. While we have several other Black-oaks with annual fructification, I know of only this one with basal abortive ovules, like the White-oaks; but the black rough bark, the wood, the small number (2-5) of large anthers, the long, recurved styles, the membranaceous brown cup scales, and the tomentose inner coating of the shell, can leave no doubt about its proper position among the Black-oaks. It grows from West Texas through New Mexico to Arizona, generally as a large bush, but Dr. Palmer and the Rev. Mr. Greene have found it also a tree up to 2 feet diameter at base and 30 feet high. Its leaves are persistent through winter, but fall about the flowering-time.

Q. rubra, Lin., so easily recognized in its typical form, is really one of the most variable of the Atlantic species, especially north and northwestwardly. All the forms have a smoothish bark with rather shallow fissures, the young leaves lose their early thick down (usually pale below and bright red above) at or soon after flowering-time, and the scales of the ordinarily very shallow, large cups are small, closely appressed, and slightly downy or almost glabrous. The lobes of the normal leaf taper almost undivided from a broad base, bearing a few coarse or small teeth; but other forms have leaves similar to those of *coccinea*, with divaricately pinnatifid lobes, or the leaves are smaller and more deeply divided, with fewer lobes, much like those of *palustris*: their acorns are always smaller than in the typical *rubra* and the cup rather deeper. Var. *runcinata* has narrower, lobe-dentate leaves, the large, regular teeth nearly entire. The acorns of *rubra* are between 6 and 12, usually 9 or 10 lines thick, ovoid, rarely elongated or sometimes subglobose. In northern forms the cup is apt to become more hemispherical or even turbinate, and the scales not rarely tumid at base after the manner of the White-oaks. This form I take to be *Q. ambigua*, Michx., which by others is thought to be a variety of the next species. Some oaks from Northern Illinois (Bebb, Nos. 4, 5 & 7), with rather larger and looser cup scales, and, except 7, with deeply pinnatifid leaves, come near to *coccinea*, and may possibly be hybrids of *rubra* and *coccinea*.

Q. coccinea, Wang. is readily distinguished by its turbinate cups with large, loosely imbricate (when dry almost squarrose), yellowish-gray pubescent scales, the acorns mostly ovoid-globose, retuse, or oval and pointed. I have, with some hesitation, followed DeCandolle and Gray in uniting with this species *Q. tinctoria*, Bart., which has longer and more pointed buds; broader, less lobed and firmer leaves, paler on the under side, smaller and more pointed acorns, at least in the few fruiting specimens I have been able to examine, and a deep yellow-colored inner bark. I suspect that specific differences may yet be discovered; for the present I venture to introduce it as a subspecies.

Q. Georgiana, M. A. Curtis, confined, as far as known, to that isolated granite rock, the Stone Mountain, east of Atlanta in Georgia, which is also the only locality for *Gymnoloma* (formerly *Rudbeckia*) *Porteri*, Gray, and for *Isoëtes melanospora*.* Leaves glabrous from the first, generally lance-oval, oval or sometimes obovate, mostly coarsely sinuate-toothed, with 2–4 teeth or lobes, rarely pinnatifid or sometimes entire or undulate; crowded acorns small, subglobose; shallow, flat cups, truncate or rarely rounded at base, with triangular, obtuse, nearly glabrous, appressed scales. Perhaps too near *Q. palustris*, from which the fruit is scarcely distinguishable, though the locality, the growth and the foliage differ.

Q. laurifolia, Michx., appears after all to be distinct from *Q. aquatica*; whether entire or lobed, the leaves of the latter mostly have a cuneate outline widest in the upper third or at least above the middle: the calyx lobes are larger and very conspicuous, and the filaments enclosed and only the anthers exsert. *Q. laurifolia* has lanceolate oblong leaves, widest about the middle whether entire or lobed; the calyx lobes are much smaller; filaments exsert; this in flowering specimens of both species from Bluffton, the only ones which I could compare. A specimen from the gulf coast of Mississippi has oval entire coriaceous leaves 4 inches long and 1½ inches wide, while those of the South Carolina plants are narrower, and rather approach to *Phellos*, but never to *aquatica*. They usually persist until the budding time, but not beyond it.

Q. cinerea, Michx. In specimens from South Carolina I find, together with the ordinary stellate pubescence, an abundance of yellow articulated

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* *Isoëtes melanospora*. n. sp. amphibia, parvula, gregaria, plerumque monoica; trunco placentiformi bilobo; foliis paucis (5–10) distichis stomatosis sine fasciculis fibrosis periphericis; velo sporangium suborbiculare totum tegente; macrosporiis (0.35–0.45 mm. diam.) minutissime sub lente verruculosis obscuris (humidis nigricantibus), microsporiis (0.028–0.031 mm. longis) papillosis obscuris.

In shallow depressions a couple of inches deep and a few feet in diameter, on the naked granite surface near the top of the mountain, where occasional rains and dews furnish temporary and precarious moisture, but where for weeks and even months the glaring sun, flashing on the naked rock, parches and bakes them: discovered by Wm. M. Canby in May, 1869; revisited by Prof. Gray in April, 1875, and by Mr. Canby and myself in September, 1876, when nothing was perceptible but the dead, matted root-fibres attached to the small shrivelled corms.—Corm 3–4 lines in diameter, flat, only ½–1 line thick; leaves 2–2½ inches long, in all the specimens examined distichous, which I have not seen in any other species: sporangia ½–¾ line in diameter, usually emarginate above, almost black from their dark contents, but without any brown cells; often remaining for a time attached by their base when their leaf has withered away. The plant, which I have cultivated for several years, seems to vegetate as soon as moisture is furnished, but lies dormant part of the year: spores mature in May and June.—This species, *I. flaccida* from Florida, and *I. Nuttallii* from Oregon, are the only American *Isoëtes* in which the spore case is entirely enclosed in and covered by the velum; and it is the only one of ours with dark spores, all the others having white ones.

hair on the young leaves, while in flowering Texan specimens it seems to be entirely wanting.

Q. Wislizeni, A. DC. With his usual acumen, A. DeCandolle discovered this species in a small fruiting specimen, brought by Dr. Wislizenus in 1851 from the American Fork of the Sacramento River, but, through a mistake of mine, he located it near Chihuahua. Since then nothing further, I believe, has been published about this remarkable oak, though an abundance of material and very full notes have been gathered by different collectors, principally by Prof. W. H. Brewer and Dr. H. Bolander.

This species is found throughout the western parts of California from Shasta to San Diego, principally in the region of the foot-hills, but does not ascend the higher mountains. In some localities it makes a "magnificent tree" 40 to 60 feet high, with a trunk occasionally 6 feet in diameter, but branching 5 or 6 feet from the ground, as most of the large Californian oaks ot both groups are wont to do. On the coast ranges from Monte Diablo to San Diego it also occurs as a small shrub with small leaves.

The bark is pale and smoothish in younger, very rough and black in older trees. The firm, leathery leaves persist 14 or 15 months on the branches: they vary excessively, often on the same tree, from broad ovate to narrowly lanceolate; cordate, obtuse, or acute at base: the margin entire, or with a few teeth or sharply and closely dentate; shoots or young trees have usually dentate, old and fertile ones more commonly entire leaves. In the earliest age the leaves are very slightly concave, and in vernation imbricate: they bear on both sides articulated hair, but soon become glabrous; the full grown leaves are mostly dark green and shining, and delicately reticulate, principally on the upper surface. They are usually 2-4 inches long and half as wide, or rarely narrower; petioles 5-9 lines long; in var. *frutescens* the leaves are only 1-1½ inches long, oval, entire, or often very sharply and deeply lobed-dentate; petioles 1-2 lines long.

The rhachis of the aments is stellate-canescent, or nearly glabrous: calyx lobes 5 or 6, large and broad, nearly glabrous or ciliate-bearded; anthers 3-6, often pointed. Bracts of the sessile (or often peduncled) female flowers large, orbicular, membranaceous; the long, recurved styles not rarely 4 or 5 in number. Acorns always elongated, 9-18 lines long, immersed $\frac{1}{3}$ to $\frac{2}{3}$ in the cup, which I find varying from 6-11 lines in depth and 5-6 lines in width; cup scales elongated, acutish, light brown, and nearly glabrous.

On one hand this species approaches to *Q. agrifolia*, with which it has often been confounded, and on the other to *Q. Sonomensis*.

Dr. Kellogg, in Proc. Cal. Ac. 2. 36 (DC. Prod. 16, 2, 79), scantily describes an oak under the name of. *Q. Morehus*, which may belong here.

Q. myrtifolia, Willd. Willdenow's description of the foliage, which cannot possibly refer to any other oak, together with his locality, makes it certain that in Dr. Mellichamp's very complete specimens we have his plant before us, and, thanks to him, I can now reëstablish this little known and often doubted species. It grows on the poorest sand ridges near Bluffton, together with *Pinus australis*, very rare there, but apparently extending along the coast to Florida. It makes an evergreen shrub from $1\frac{1}{2}$-2, usually 4-5, and up to 8 feet high. Leaves rounded ovate, cordate, obtuse, or sometimes acute at base, obtuse and in youth bristle-pointed at tip, revolute on the margin, thick and leathery, persisting 15-18 months. Leaves vary sometimes to broadly obovate, or are rarely, in young shoots, sinuate-angled; they are usually $1-1\frac{1}{2}$ or even 2 inches long, but in vigorous ground shoots have been found $2\frac{1}{2}$ and 3 inches in length by 2 in width. The young leaves are densely covered with a rusty, clammy scurf of articulated hair, which after a month or so disappears, leaving a glossy surface. Vernation imbricate; youngest leaves flat with recurved margins. Aments about $1\frac{1}{2}$ inches long with stellate-canescent rhachis, 5 oval pubescent calyx lobes, and a few (mostly only 2-3) small cuspidate anthers. Fruit sessile or usually short peduncled, single or in twos; cup very shallow, about 6 lines wide, with ovate-triangular obtuse scales; gland ovate or subglobose, 5 or 6 lines long, covered by the cup for $\frac{1}{3}$ or $\frac{1}{4}$ of its length.—*Q. myrtifolia*, Willd., Nuttall, Pursh, Elliott, only the first two of which seem to have seen sterile specimens; flower and fruit had been unknown.—*Q. Phellos* var. *arenaria*, Chapm.: *Q. aquatica* var. *myrtifolia*, A. DC.

Hybrid Oaks.

The question of hybridity in plants is in every case difficult to solve where its usual character, the sterility* of the hybrid, fails us, and where we have nothing to rely on but the rarity and individuality of a form that seems to stand intermediate between two well established species which occur in its neighborhood, and which could be considered its parents.

This is just the case in oaks. All the supposed hybrids are abundantly fertile, and those of their acorns which have been

* On the muddy banks of the Mississippi near this city, where several species of *Nasturtium (palustre, obtusum, sessiliflorum*, and *sinuatum)* are abundant, two hybrids occur among them which will illustrate the different sexual qualities which hybrids may possess. The first, an offspring of *palustre* and *sinuatum*, is a normal hybrid with small anthers and abortive, shrivelled pollen grains, with unimpregnable though apparently well-formed ovules, and small and absolutely sterile pods. It is perennial like *sinuatum*, and erect like *palustre*, abundant flowers of intermediate size, in long, virgate racemes, and, singularly enough, with uncommonly large stigmas. The other, a hybrid between *palustre* and *obtusum*, on the contrary, produces good pollen and is quite fertile, so that it might be questionable whether it really is a hybrid; and indeed it has all along been considered a form of *obtusum* until Mr. Eggert pointed out its intermediate character. The true *obtusum* is always prostrate and small (branches not more than 6 inches long), has minute whitish flowers, petals only half as long as sepals, small orbicular anthers, and elongated, suberect pods on very short pedicels. *N. palustre* is erect, has large oblong anthers and shorter patulous, long-pedicelled pods. The cross occurs in all forms, from the small and prostrate to the tall and erect one, often as if struggling between an erect and a decumbent habit, with some branches in one, others in another direction; the yellow petals are longer than in *obtusum* but much smaller than in *palustre*, anthers as in the former; pods shorter than in *obtusum*, on longer, patulous pedicels.

tested have well germinated; in fact, as far as I know, no difference in fertility or germinating power between them and the acknowledged species has been discovered. The seedlings of such questionable individuals do not seem to revert to a supposed parent, a sport of which they might be claimed to be, but propagate the individual peculiarities of the parent; "come true," as the nurserymen express it. For how many generations this may continue, and whether in time forms approaching one or the other parent may not appear, remains to be seen. At the same time it is a remarkable fact, that, notwithstanding their fertility, they do not seem to propagate in their native woods; we may properly ascribe this to a lesser degree of vitality in the hybrid progeny, which causes them to be crowded out in the struggle for existence: one of the provisions of nature to keep the species distinct; or, as Dr. Gray suggests, fertilization by one of the parents may soon extinguish the hybrid characters. I find ten forms, enumerated below, which I consider as real hybrids; of them only a few, often only single individuals, have become known. Their existence cannot well, without straining facts, be considered due to innate variability in the supposed parents. When more carefully looked for, undoubtedly more will be discovered.

White-oaks and Black-oaks are too distinct to be crossed.

Among the White-oaks hybrids seem to be much rarer than among the Black-oaks, or it may be that they are more difficult to discover. Of the former, I have thus far been able to trace 3 forms only which I must take for hybrids, and all of them point to *Q. alba* as one of the parents.

Q. alba × *macrocarpa* is sent by M. S. Bebb (No. 27) from Northern Illinois: the leaf is that of *alba*, with a persisting down on the under side; the cup is not larger than in *alba*, but a little deeper and with the prominent triangular scales of *macrocarpa*. Another specimen, much nearer *macrocarpa*, was studied by E. Hall, a number of years ago, in central Illinois (Amer. Ent. & Bot. 1870, p. 191). The leaves are those of the latter species; the bark, the down of the young leaf and inflorescence, and the acorn, more that of *alba;* while the deep cup, covering half the acorn, is that of a small fruited *macrocarpa*, but entirely destitute of a fringe; its acorns develope much slower than those of *macrocarpa*, and more conform to *alba*. Of the allied oaks, *macrocarpa*, *alba* and *stellata*, the first developes its acorns soonest and the last latest; these last are not larger than peas by the end of August, when those of *alba* are nearly full grown.

Q. alba × stellata. A specimen from the same careful observer (Bebb, No. 24) must, I believe, be referred here. Leaves similar to those of *alba*, with the narrow lobes occasionally widened forward and retuse, after the manner of *stellata*, pubescent on the under side, as well as petioles, branchlets, and shallow cups: cup scales distinct and regular but considerably tumified at base; in *alba* these scales are almost entirely changed into very prominent knobs with short obtuse membranaceous tips: in *stellata* they are lanceolate, very distinct, only slightly tumified, and more canescent. Bark and flowers of Mr. Bebb's tree are unknown to me.

Specimens from South Carolina, sent by Dr. Mellichamp, mentioned p. 389, seem to indicate other hybrid forms of the same parents. One has the leaves and furrowed bark of *stellata*, but the glabrous branchlets and glabrous anthers of *alba*. The other's bark is flaky like that of *alba*: the branchlets, the sinuate or obtusely-lobed leaves, and young acorns, are glabrous; anthers unknown. Of neither have I seen the fruit.

Q. alba × Prinus. A single tree, now unfortunately destroyed, was observed by Dr. G. Vasey near Washington. Bark "rougher and darker than in *alba*"; leaves incised-serrate, of firm texture, glossy above, pale and slightly pubescent beneath; hemispherical cups with distinct tumid scales terminating in triangular membranaceous tips. The leaves are more those of *Prinus* than *alba*, the acorns belong rather to the latter. Both supposed parents grew with it on a gravelly hillside.

The hybrid Black-oaks are much more numerous, or, to speak more correctly, more have thus far been noticed, perhaps because their leaf-forms are more various, and thus the intermediate ones are more easily recognized. The mixture of entire-leaved with lobe-leaved forms would of course be most readily discovered from the intermediate leaf-form of the illegitimate offspring; but it remains for further close examination to ascertain whether lobe-leaved species do not hybridize among themselves as well, or entire-leaved forms also mix together, producing offspring of less strikingly marked characteristics.

That we have to look for one of the parents of three of our hybrids to one and the same species, seems to correspond well with other observations, all pointing to the fact that some species of a genus are more prone to hybridize than others. This is true of *Verbena*, hybrids of which abound in this neighborhood in numerous forms as well as in a great many individuals; of most of them *V. stricta* appears to be one of the parents, perhaps because one of the most common species, or from some innate quality which makes it mix more readily with others; perhaps from a peculiar structure of the flower which may promote insect agency. Our hybrid Verbenas differ from the hybrid oaks in having almost always abortive anthers and in bearing scarcely any fertile seeds, while at the same time they are so common that evidently they are readily produced anew.

Our Black-oak hybrids are the following:

Probable Parents.		Name under which described.	Habitat.
Q. Catesbæi,	*aquatica*,	*sinuata.*	South Carolina.
Q. Catesbæi,	*laurifolia*,		South Carolina.
Q. imbricaria,	*nigra*,	*tridentata*,	Illinois.
Q. imbricaria,	*palustris*,		Missouri.
Q. imbricaria,	*coccinea*,	*Leana*,	Ohio to Missouri and near Washington.
Q. Phellos,	*coccinea*,	*heterophylla*,	N. Jersey & Delaware.
Q. ilicifolia,	*coccinea*,		Massachusetts.

Q. Catesbæi × *aquatica; Q. sinuata*, Walt. Car. 235, DC. l. c. 74. It is quite probable that in the tree observed by Dr. Mellichamp, several years since, near Bluffton, S. C., we meet with Walters' obscure and long ignored species. Mr. Ravenel has also observed a similar form in South Carolina, and indicated *cinerea* as one of the parents. Dr. M.'s tree grows on a sandy ridge with *Catesbæi*, *falcata* and *virens*: *aquatica* and the rarer *cinerea* are not far off. It is 40 feet high and well grown, has a "very dark, deeply cracked bark, which is red inside like *Catesbæi*." Leaves 4, rarely 5–6 inches long, about half as wide, attenuated at base into a partially margined petiole, 3–6 lines long; leaf itself oblong to obvate, sometimes almost rhombic; sinuate with shallow obtuse lobes to divaricately dentate-lobed; lobes obtuse, or acute and bristle-pointed, dark green and shining on upper surface, paler but glabrous and with some axillary down beneath: leaves imbricative in vernation; in early youth both sides, the lower more than the upper, are covered with the rusty, articulated pubescence of *Catesbæi*: male flowers with 4 large, pointed anthers. Acorns sessile: cup hemispherical, turbinate, 8–10 lines wide, 5 or 6 high; nut oval, 8–9 lines high and 6–8 thick, ⅓ or ¼ covered by the cup. The leaves of seedlings are lanceolate to obovate, spinulose-dentate or sinuate, rarely entire. In the seedlings of this plant as well as of the regular *Catesbæi* none of the fulvous glandular pubescence, which is so characteristic of the young leaf of the grown plant, is yet developed.—One of the parents is doubtless *Q. Catesbæi*, as, among other characters, this abundant rusty down proves: as the other *aquatica*, *cinerea*, or *falcata*, present themselves; *falcata* is excluded by the form of its leaves; *cinerea* might be the parent, as I formerly assumed, but the usually obovate outline of the leaf as well as the character of the acorns seem to point rather to *aquatica*.

(*Continued on p.* 539.)

Corrections of the present Theory of the Moon's Motions, according to the Classic Eclipses.

By Prof. G. SEYFFARTH. A.M., Phil. & Theol. D.

Multiformi Luna ambage torsit ingenia contemplantium et, proximum ignorari sidus, indignantium.—*Pliny, H. N.* ii 0, 12.

INTRODUCTION.

The present disquisitions were, four years ago, called forth by the learned treatise, "Historical Eclipses," reprinted in *Nature*, New York, July 25, 1872, to which my attention was directed by Dr. C. H. F. Peters, Director of Litchfield Observatory, Hamilton College, Clinton, N. Y. The meritorious author of the treatise, J. R. Hind, Director of Bishop's Observatory, Twickenham, Eng., made the historical chronology of the Romans, Greeks, and Babylonians, as set down in Petavius's *Doctrina Temporum*, and *bona fide* repeated down to Clinton in all later chronologies, the groundwork of his computations of ancient eclipses; and, moreover, he presumed Hansen's Lunar Tables, principally based on Ptolemy's Almagest, to be perfectly correct. To both very much divulged prejudices I remonstrated in an extensive letter of Feb. 11, 1873, which, soon after, was transmitted to Prof. Hind. Compliance with the added request to publish my communications in an astronomical journal seems to have been prevented by circumstances down to this day. In the mean time many friends of history, even distinguished astronomers, being occupied with re-examining the usual theory of the moon, desired, for the promotion of science, the publication of my disquisitions concerning the true dates of ancient eclipses and the resulting amendments of our Lunar Tables. These particulars, apart from others, may excuse the final appearance of these historico-astronomical investigations.

In the next place the reader has to bear in mind that all, both historical and astronomical dates, to be mentioned hereafter, refer to the astronomical method of counting the years, and not to the so called historical one, because the former is the most practical and the only true one. The historians commence, in consequence of Beda Venerabilis, the original Dionysian Era too late by one year, and augment all dates preceding the Christian Era by a unit; and hence they refer Christ's birth to a wrong year. The astronomical year 400 B.C. is, according to the historians, the 401st B.C., and so forth.

It is an axiom that no theory of the moon's motions can be correct, as long as it does not correspond with the times and magnitudes of the most reliably ascertained eclipses of old. The most trustworthy ancient eclipses, however, are those mentioned in the classical works of the Romans and Greeks; for, their authors were, in nearly all instances, eye-witnesses, otherwise reporters, of what earlier eye-witnesses had perceived. Thus Livy, Cicero, and others, mention the eclipses recorded in the *Annales Maximi*, and this great work, still existing in Tiberius's days, contained all remarkable events of Roman history which the annalists of the Capitol had, day by day, once recorded. The classical authors, moreover, were reasonable and honest men; they were able to speak truth, and willing to do it. What would they have gained by telling falsehoods, by improvising eclipses which nobody had seen, or by referring them to wrong years, seasons, days, and hours? Of this character are, for instance, Thucydides, Xenophon, Aristophanes, Herodotus, Pindar, Plutarch, Josephus, Philostratus, the Roman chroniclers, Livy, Cicero, Tacitus, Pliny, and the like. All these ancient authors deserve confidence as long as the impossibility of their traditions is not clearly demonstrated. This is and must be the stand-point of all historians.

Formerly, it is true, the eclipses in Ptolemy's Almagest were considered to be the most reliable ones, but erroneously; for, Ptolemy, 140 A.C., had not, with his own eyes, observed those ancient eclipses; and their particulars are not the result of Babylonian observations, but the fruits of Ptolemy's computations, as will be seen below. Had Babylonian astronomers themselves observed the minutes of those eclipses, the times and magnitudes of the latter, as specified in the Almagest, would agree with each other and with the classic eclipses. Instead of this, careful computations of Ptolemy's 19 lunar eclipses, by means of Hansen's Lunar Tables, have brought to light that one of them finished prior to the rising of the moon, and that another obscuration of the moon amounted only to a quarter of an inch, which nobody would have perceived with the naked eye. Paradoxes similar to these are coming. Granting that the Babylonian eclipses were exactly described in Ptolemy's Almagest; granting that Hansen was right in deducing from the same eclipses the secular accelerations of the moon's motions and other elements of his Tables,—how is it that the latter do not correspond with the ascertained Roman and Greek eclipses? The obscuration of the sun in —400, July 1, e.g., which was, according to the *Annales Maximi*, a total one in Rome, amounted, according to Hansen's theory, to 2′ 34″ only. How came it to pass that all the Lunar Tables, from Ptolemy down to Damoiseau, based both on the Almagest and modern observations, proved incorrect some years after their construction? The reason is that the *terminus a quo*, the Babylonian eclipses in the Almagest were wrong ones; that Ptolemy had referred them to wrong years; that the longitudes of the moon, her Nodes and Apsides, were in 721 B.C. other ones than those determined by means of the Almagest.

In short, it is evident that, in establishing a true theory of the moon's motions, either the eclipses in the Almagest or else those in the Classics must be given up. *Tertium non datur*. It is true that, sometimes, the astronomers determined the dates of Greek and Roman eclipses *a priori*, and in spite of the actual history and chronology, and only by the instrumentality of Lunar Tables based on the eclipses in the Almagest; but this was obviously a gross mistake. For all events of Greek and Roman history are at present, by infallible historical and mathematical certainties, so accurately fixed that none of them can be referred to a date later or earlier by one, or ten, or twenty years. These evidences, finally, are confirmed by an authority which every astronomer will respect. In 1857, Prof. Airy was still fully convinced of the correctness of Hansen's theory of the lunar motions; for in that year he determined, by means of the said Tables, the dates of three total eclipses which he (but erroneously) referred to 309, and 555, and 583 B.C. (See Transactions of the R. Astron. Soc. 1857, vol. xviii. p. 92, and Month. Not. vol. xvii. p. 233.) Yet, a few months ago, our newspapers report as follows: "In his last report Prof. Airy devotes a few words to the great work he has been engaged in, namely, the preparation for the *formation of Lunar Tables*, according to a *new treatment of the theory* by which he hopes to be able to give greater accuracy to the final results, by means of operations which are entirely numerical throughout the work. Considerable progress has been made in these numerical developments, and he expects, at least, to put *his theory* in such a state that there will be no danger of its entire loss in the event of his death."—This is, indeed, a gratifying confirmation of my iterated researches concerning the secular accelerations of the moon's motions. First in 1846 I essayed to harmonize the classic eclipses with the usual theory of the moon based on the Almagest. (See the author's *Chronologia Sacra*, p. 281 to 358.) The same was done, but much more carefully, in Seebode, Jahn, and Klotz's "Archiv für Philologie," 1848, p. 586; in Jahn's "Astronomische Unterhaltungen," 1853, p. 172; in "Göttinger Gelehrte Anzeigen," 1855, No. 125; in my "Berichtigungen der alten Geschichte und Zeitrechnung," 1855, p. 92; in "Transactions of the St. Louis Academy of Science," 1860, p. 385. Twenty years ago I predicted, without being a prophet, that Hansen's Lunar Tables would, after forty or fifty years, prove as incorrect as Damoiseau's Tables did in 1851, on occasion of the total eclipse of the sun in Germany; and from the publication of Hansen's Tables to 1875, less than twenty years having elapsed, the incorrectness of those Tables comes to light.

These arguments will suffice for understanding that the theory of the secular accelerations of the moon, her Nodes and Apsides, mainly depends upon the classic eclipses, and not upon Ptolemy's computations in the Almagest; for the ancient eclipses which, according to reliable eye-witnesses, coincided with sunrise, or sunset, or certain hours of the day, determine the real longitude of the moon on the respective hours. To this class of ancient eclipses refer, e.g., the solar eclipse in —478, Feb. 27, 15h. 30m., perceived, during sunrise, at Smyrna, and that in —752, May 25, 16h., which was seen in Rome 2 hours and about 30 minutes after sunrise. Further, the eclipses which were total in certain localities determine the real longitudes of the moon's Nodes on the respective days. From the very small eclipses witnessed by ancient authorities we learn how far the longitude of the moon's Nodes must be diminished in order to obtain a corresponding obscuration of the sun. Thus the very small eclipse of the sun in —420, Jan. 18, 2h., ♉ 17° east of the sun, was invisible in Athens. and yet the eye-witness Aristophanes saw it. Finally, many of the twenty-nine total solar eclipses mentioned in the classics were. according to our Lunar Tables, annular ones; and by means of them the usual secular acceleration of the Apsides can be corrected. To this class, e.g. the eclipses in —581, Mar. 27; —400, July 1; —360, May 12; —306, June 13. belong.

Since, then. the classic eclipses are very important in establishing a correct theory of the moon's motions, the next task must be. first. to collect. at least to A.D. 400, all reports of the classic authors referring to an eclipse either of the sun or the moon, and specifying the localities, and magnitudes, and hours of the respective eclipses; in the second place, to reduce the latter to their real years. The chronology of ancient eclipses is inseparably connected with the historical Chronology of the Romans, Greeks, Babylonians, Egyptians. Chinese; and, in this respect, history has made considerable progress since Ptolemy. especially since Petavius, whose chronology is notoriously based upon Ptolemy's erroneous Historical Canon.

New Astronomical and Historical Subsidiaries of Ancient Chronology and History.

Since the year 1627, in which Petavius's *Doctrina Temporum*. the basis of all later Chronological Tables down to Clinton and Fischer, made its appearance, a great many of both astronomical and historical materials have come to light, by which all events of Roman, Greek, Babylonian, Egyptian, Hebrew, and other histories. especially the dates of ancient eclipses, are incontrovertibly fixed, as will be seen in the author's "Astronomia Ægyptiaca," 1833; in his "Chronology of the Roman Emperors" (Gettysburg Quarterly Review, 1872, p. 47), and the other aforecited works (p. 403). It will be sufficient to specify only, and as briefly as possible, the following:

1. *Planetary Configurations*, *Lectisternia*, *Pulvinaria*, *ἱεραὶ κλίναι*, that is to say. representations of the ancient seven planets—Saturn, Jupiter, Mars, Sun, Venus, Mercury, and Moon —together with the Signs and smaller parts of the Zodiac with which the former were conjoined on certain days of certain years. Nearly all these autoptical observations were performed on the cardinal day preceding the historical event which they referred to. These planetary configurations are the most solid fundamentals of ancient chronology, because none of them returns twice

during a period of 2146 years, in which the procession of the fixed stars amounts to 30 degrees, one sign of the Zodiac; and because the ancients, being destitute of the Copernican System, could not calculate earlier places of the seven planets. All epochs of ancient history determined by a planetary configuration are fixed with mathematical certainty. We mention the following ones only:

Sixteen Egyptian monuments, representing the planetary configuration, observed on the day of the summer solstice in −2780, previous to the beginning of the first Canicular period on July 19th, the time of Menes' arrival in Egypt. Hence the Canicular periods of 1460 Julian years commenced in −2780, −1320, + 140, and not, as Petavius imagined, one year earlier. Together with the same dates, the Apis periods of 25 Egyptian years, each of 365 days only, commenced; and hence these periods recommenced, during the period from −1320 to +140, in all years which being divided by 25 give the remainder 20, e.g. in −520, −495, −320. This is very important, because several events of Persian and Greek histories are linked to the epochs of Apis periods. With the same July 16 in −2780, moreover, the Egyptian period of 30 years, called τριακονταετηρίς, so often mentioned on Egyptian monuments, had begun. To-wit, in −2780, July 16, a close conjunction of Mars with Saturn took place, and this conjunction returned after 30 Egyptian years, whereby several epochs of Egyptian and Greek histories are mathematically fixed. The renewals of this Triacontaeteris occurred, during the period from —1320 to +140, in such years, of which the number being divided by 30 leaves the remainder 0, e.g. in −210, in which Ptolemæus Epiphanes, "the lord of the Triacontaeteris," was born. A copy and the explanation of the planetary configuration of −2780 will be found in the author's "Berichtigungen," etc.

The Olympian Altars. Pausanias (v. 14) and the Scholiast of Pindar (Ol. v. 10, x. 59) narrate that at the beginning of the Olympiads six altars were erected, and each of them contained two statues, one of a planetary, and one of a zodiacal god. This planetary configuration, expounded in the same "Berichtigungen," p. 230, refers to −777, March 29, the day of the vernal equinox, preceding the first Olympian games. Consequently the latter were celebrated in June of the year −777, and hence "Ol. i. 1" signified, conformably to all ancient eras, the first year subsequent to the end of the quadriennial period of the first Olympiad. Hence the second Olympian games were delivered in −773; and it was a deplorable mistake, committed by Petavius, to commence the Olympiads two years earlier, −775, instead of −773. The consequence of this blunder was that Petavius and his followers antedated all events of Greek history in general by two years. All Olympian games were repeated every four years, namely, prior to the summer solstice, in such years before Christ, of which the number being divided by 4 gives the remainder 1; but after Christ, in all years, of which the number being divided by 4 leaves a remainder of 3, e.g. in −1 and +3. It is, moreover, a strange phenomenon, not yet explained, that several fathers of the church, and some later authors, commenced the Olympiads two years earlier. But these are exceptions to the rule. (See Ideler's Chronologie, ii. p. 465.)

The Statue of the Olympian Zeus. Subsequent to the battle at Marathon, the Greeks, applying the gold taken from the Persians on occasion of the Marathonian battle, erected a grand statue to Zeus, the deliverer of the country; and on the pedestal of his statue the planetary configuration referring to the same battle was represented. This astronomical monument, described by Pausanias (v. 11, 3), concerns the autumnal equinox, Sept. 25 in —489, as will be found in my "Berichtigungen," etc. p. 234. The date of the battle, August 6th in −488, is confirmed, as will be seen below, by the solar Calendar of the Greeks. Consequently, Petavius has antedated the battle, and the reigning-time of Xerxes by one year.

The Parthenon frieze in Athens contains the planetary configuration concerning the battle at Salamis, subsequent to the battle at Thermopylæ. The latter Herodotus (vii. 206) refers to the celebration of the Olympian games, and to the Archonship of Kalliades, i.e., according to Petavius, to −479, but the Parian Marble puts the battle in the following year. The latter is confirmed by the aforesaid planetary configuration, observed on the winter solstice in −479, and by Thucydides (i. 18), who counts ten years from the battle at Marathon, on Aug. 6 in −488, to the battle at Salamis in −478, Sept. 23. Consequently, Petavius has again antedated these events by one year.

The planetary configuration (Solin. Pol. i. 18) *referring to the foundation of Rome* demonstrates that Rome was founded in −752, and not, as Petavius imagined, in −753. (See Seebode, Jahn, and Klotz's Archiv f. Philol. 1848, p. 596.)

The Lectisternium (Liv. v. 13; Dion. xx. 9), viewing the Bruma in −396, evidences that the tribuni Ginucius, Pomponius, etc., ruled in −395 and not in −397. Petavius, having shortened the history of the Roman kings by one year, arbitrarily intruded in −331 a consular year, which is not to be found either in Livy or other annalists. (See "Berichtigungen," etc. p. 229.)

The Lectisternium (Liv. xxii. 10) puts beyond any question that the Coss. Geminus and Flaminius ruled in −215, and not in −216. (See "Berichtigungen." etc. p. 226.)

The Ara Albani, representing the nativity of Emperor Augustus, demonstrates that Cicero was consul in −62, and not in −63; that, accordingly, Augustus was born one year later than Petavius stated. (See "Berichtigungen," etc. p. 239.)

The Puteolian Basis, the nativity of Tiberius, refers his birth to −40, and not to −42. Hence the consuls Blancus and Lepidus officiated two years later than Petavius and his adherents presumed. (See "Bericht." etc. p. 223.)

The Puteale Capitolinum refers the birth of Claudius to the year −8. (See "Bericht." p. 244.)

The Ara Gabinia, the nativity of Vespasian, states that he was born in the year +9. ("Bericht." p. 208.)

The Ara Capitolina, the nativity of Caligula, argues that his birth and the respective consuls Germanicus and Capito belong to the year +14, and not, as Petavius brought out, to +12. (See "Berichtigungen," etc. p. 226.)

The Borghesian Candelabre (*Ara*) represents the nativity of Claudius like the *Puteale Capitolinum*, but takes into view the preceding vernal equinox, March 22, −7. (See "Bericht." etc. p. 248.)

The nativity of Galba, represented in "Memoires des Sciences," Paris, 1709, p. 110, Pl. i., refers to the year −1, Sept. 22.

The nativity of Cæsarion (Rosellini's Monum. del Egitto, vol. iv., Pl. cccxlix.) puts Cæsarion's birth in −45; consequently, Cæsar's expugnation of Alexandria in the last month of −46, and not in −47.

All these astronomical monuments concur in demonstrating that the usual chronology of the Egyptians, Romans, and Greeks, antedates the concerned events, respectively, by one or two years.

2. *The Solar and Lunar Calendars of the Greeks.* — Many ancient authors, e.g. Theodorus Gaza (Petavius's Uranol. c. 9), Censorinus (De d. n. 18), witness that the Greeks used not only lunar, but also both solar months and tropic years. The latter concerned the civil life of the Greeks, but their festivals were celebrated according to the former; for instance, the Olympian games. The latter, it is well known, were performed from the 11th to the 16th days of the lunar month preceding the summer solstice (Thucyd. v. 49. 50; Scholiast to Pind. Ol. iii. 35). The new moons commencing the lunar months of the Greeks and Romans were the days on which the first crescent after sunset became visible, viz. commonly 24, sometimes 48 hours after the astronomical conjunction of the moon with the sun; hence the full moons were, like the days, 24 to 48 hours after the astronomical full moons. Since, moreover, the lunar year contained only 354 days, the Greeks and Romans had, every two or three years, to add a thirteenth lunar month, a second Poseideon or December, in order to keep the lunar year in harmony with the seasons of the tropic year. The solar year of the Greeks was first discovered by Halma (Chronologie de Ptolemée, p. 40) in an ancient manuscript; and I do not understand how it came to pass that Clinton, Fischer, and other modern chronologers, knew nothing about this very important calendar, as follows. We join the names of the Macedonian months, because the latter commenced with the same days of the Julian year. (Demoth. D. C. Or. G. i. 280.)

Attic.	Macedonian.	Julian.
Gamelion,	Appellæus,	December 4.
Anthesterion,	Audynæus,	January 3.
Elaphebolion,	Peritius,	February 2.
Munychion,	Dystrus,	March 4.
Scirophorion,	Artemisius,	May 3.
Hecatombæon,	Dæsius,	June 2.
Metageitnion,	Panemus,	July 2.
Boëdromion,	Lous,	August 1.
Pyanepsion,	Gorpiæus,	August 31.
Mæmacterion,	Hyperberetæus,	September 30.
Poseideon,	Dius,	October 30.
Five or six additional days,		November 29.

As the ancient Romans commenced the months with the appearance of the crescent subsequent to the astronomical new moon, and, accordingly, each day with sunset, 6 hours prior to the Julian day, beginning at midnight; it is natural that our Mènologium commences, e.g. Pyanepsion with Sept. 1, and so in all other cases. In order to harmonize the Greek days, likewise beginning with sunset, with our civil days, we have the Julian dates in the preceding table diminished by a unit. The Spartan months began, as we learn from Thucydides (v. 19, iv. 118; Plut. Nic. 28), two days later.

The leap-years of the Greeks were, as Censorin (De d. n. 18) reports, the same in which the Olympian games were celebrated. In such years, the first three months of the Greek year commenced with the following day of the Julian months, as specified in the Table.

By means of this Solar Calendar of the Greeks, e.g. the following events of Greek history are incontrovertibly fixed; first, the years in which Archon Apseudes ruled. Diodor (xii. 36) reports that, during the archonship of Apseudes, Meton commenced his Lunar year and Lunar cyclus of 19 years with the 13th day of Scirophorion, that is, as our Table shows, with the 15th day of May, Julian style. In —428 the new moon happened on May 13th about 7 o'clock after noon, and consequently the crescent became visible on May 15th after sunset. Since then no new moon coincides twice with May 13th during a period of 19 years; the archonship of Apseudes, extending from July in —429 to July in —428, is mathematically fixed. Petavius and his adherents put Apseudes earlier by one year, but erroneously. By the way, this fact demonstrates that Ideler's exposition of Meton's Lunar Calendar is wrong, because he referred Apseudes to a wrong year. This result, moreover, is confirmed by Ptolemy (Alm. iii. 2, p. 162, 163. H.), who reports that, during the same year of Apseudes, Meton and Euctemon found the summer solstice coinciding with sunrise on June 27 (Phamenoth 21st), because the summer solstice happened, according to our Solar Tables, on the same day at 5 o'clock a.m., during the year —428

These two facts involve a result of great importance. The Peloponnesian war commenced, on the part of the Athenians, with their naval expedition against Sparta, which took place in the early spring during the archonship of Apseudes' predecessor, viz. Pythodor I. (Thuc. ii. 2; Diod. xii. 36; Argum. Medeæ; Schol. Av. 998); accordingly, in January of the year —429, and not, as Petavius imagined, in —430. This is confirmed by the nearly total eclipse in —429, Jan. 26, 21h. (Thuc. ii. 28), observed during the embarkation of the Athenians. The Peloponnesian war it is well known, came to an end with the destruction of the Piræus on March 19th (Munichion 16th), as Plutarch's Lys., Xenophon's Hell. ii. 4, 43, etc., witness, in the course of the archonship of Pythodor II.; and this year is confirmed by the solar eclipse in —401, Jan. 18. Accordingly, Pythodor II. must have ruled from July in —402 to July in —401 (Xen. Hell. ii. 3, 1). Now, from the spring in —429 (Pythodor I.) to the spring in —401 (Pythodor II.) really 28 years elapsed, and consequently the Peloponnesian war lasted 28, and not 27 years, as Petavius "*post ingentem laborem*" brought out: to-wit, the latter knew not that the first chapters of Xenophon's Hellenica, containing the history of an entire year, are lost; that Thucydides (v. 26) expressly testifies to the Peloponnesian war commencing with the expedition against Sparta one year after the destruction of Potidæa by the Spartans, and finishing with the destruction of the Piræus, lasted "four times seven years"; that, inclusive Endius (Thuc. viii. 9), Xenophon (ii. 3, 10) specifies, for the same period, 29 annual Ephori of the Spartans; that the Parian Marble, as every historian knows, counts for the same time, 28, and not 27 archons. I do not understand how Petavius arrived at the conclusion that "the good Xenophon erred" (*bonus Xenophon erravit*).

The same Calendar, moreover, serves to fix many other epochs of Greek history, as follows: Herodotus (vi. 106, 120) reports that the battle at Marathon was fought on the 6th day of Boëdromion, that is, according to our Calendar, on August 6th, namely, "three days after the full of the moon." During a period of 19 years, it occurs only once that 3 days prior to August 6th a full moon takes place, which was the case in —488. The astronomical full moon happened on July 31st, the civil of the Greeks (p. 408) two days later, because the crescent had become visible first two days after the real conjunction of the moon with the sun. Subsequent to this full moon the Spartans marched out, namely, on August 3rd, and they arrived on the battle-field "after three days"; consequently on August 6th, but "after the end of the battle," as Herodotus narrates. Accordingly, the battle at Marathon belongs to —488 (Arch. Phœnippus), and not, as Petavius imagined, to —489 Thus, in the same time, the year is fixed in which Xerxes occupied Attica, viz. in —478, for Thucydides (i. 18) bears witness that the latter occurred "ten years after the Marathonian battle" in —488, to which it is likewise referred by the planetary configuration on the pedestal of the Olympian Zeus (p. 406).

Further. the eye-witness Aristophanes (Nubes, 580) testifies that in the tenth year of the Peloponnesian war (—420) both a very small eclipse of the sun and a total of the moon were, in the early spring, a short time prior to Kleon's orderly election as strategus, perceived in Athens; and the Scholiast in Scaliger's Synagoge (Euseb. 1658, p. 431) reports that the former took place on the 16th day of Anthesterion, i.e. according to our Calendar (p. 408), on January 18th. Since it happens very seldom to see two eclipses within 15 days, and because only after 19 years a solar eclipse coincides again with January 18th, which was the case in —420, two hours after noon, the 10th year of the Peloponnesian war and the archonship of Aristophanes are fixed with mathematical certainty.

Furthermore, Thucydides (viii. 20) specifies 21 days from the eclipse of Nicias to the capture of the Attic army in Sicily (Thuc. vii. 50; Clinton F. H. ii. 70), and the latter event happened on the 27th day of the Spartan month Carneius, the 29th of Metageitnion (Plut. Nic. 28; Thuc. iv. 118); accordingly on the 30th day of July, Julian style (p. 408). Therefore Nicias's eclipse, perceived 21 days prior to Metageitnion 29th, belongs to the 8th day of Metageitnion, i.e the 8th of July; and on this very day, 7h. 45m. after noon, an eclipse of the moon took place in —410, and not, as Petavius imagined, in —411. Since this was the 20th year of the Peloponnesian war (Thuc. vii. 18), the latter must have commenced in —429. Petavius, again, has antedated by one year all events reported by Thucydides.

The ten Attic Pritany ruled each 36 days, and their office commenced on the 1st day of the lunar Hecatombaeon (Corsini F. A. ii. 26). An inscription, referring to Archon Glaucippus (Boeckh's Corp. Insc. i., Pt. ii., Nos. 107 & 108), parallels the dates of the lunar months of this year with the dates of the solar ones as follows: The 1st day of the 2nd Pritany coincided with the 8th day of the solar Metageitnion (July 10), the 13th day with the 21st, the 17th with the 25th, the 22nd with the 30th of Metageitnion, the 23rd with the 1st of Boëdromion, the 24th with the 2nd, the 36th with the 14th day of the solar Boëdromion. According to our solar calendar the 8th day of Metageitnion commenced on July 10th, and consequently the 1st Pritany must have begun 36 days prior to the 8th day of the solar Metageitnion, that is to say, on July 3rd, being the 1st day of the lunar Hecatombæon. Indeed, the first astronomical new moon during the archonship of Glaucippus took place in —408, on the 1st day of June about noon, and the crescent appeared on June 3rd after sunset, with which the 1st Pritany commenced to officiate. This inscription, therefore, puts beyond any question that Archon Glaucippus ruled in —408, and not, as Petavius imagined, in —409.

A similar inscription (Corpus Insc., Pt. ii., No. 11, p. 50) reads as follows: *Ἐπὶ Νικοδόρου ἄρχοντος ἐπὶ τῆς Κεκροπίδος ἕκτης Πρυτανείας, Γαμελιῶνος ἑνδεκάτῃ, ἕκτῃ καὶ εἰκόστῃ τῆς πρυτανείας κ. τ. λ.* Hence, during the archonship of Nicodorus the 26th day of the 6th Pritany coincided with the 11th day of Gamelion (Dec. 14). Accordingly the 1st Pritany must have ruled earlier by 206 days ($5 \times 36 + 26 = 206$), i.e. since May 23rd, and this day must have been the first day of the lunar Hecatombaeon. This was the case only in —312, for the astronomical conjunction took place on May 20th about midnight, and the crescent appeared on May 22d after sunset, with which the lunar month Hecatombaeon began. Consequently Archon Nicodorus must have ruled since July in —312, and not, as Petavius fancied, two years earlier.

Alexander the Great was, notoriously, born on the 6th day of Hecatombaeon (Dæsius), i.e. June 7th, Archon Elpines. Ol. 106, 1, namely, "during the Olympian games" (Plutarch Al. 3; Cic. De div. i. 23). The latter being celebrated from the 11th to the 16th day of the lunar Hecatombæon preceding the day of the summer solstice (Thuc. v. 49. 50; Schol. Pind. Ol. iii 35), the respective new moon must have preceded Alexander's birth-day (Jun. 7) by about 11 days, and this was the case only in —353; for during this year the astronomical new moon happened on May 25 about 11 p.m., and the crescent became visible on May 27th, and hence the Olympian games were in —353 celebrated from June 5th to 9th. Thus Alexander was born on the 2d day of the Olympian games in —353, and not in —355, as Petavius brought out. All these astronomical certainties concur in demonstrating that Petavius has antedated all events of Greek history, all Olympian years, and all archons, from —489 to —407, by one, thence by two years, as the archonship of Nicodorus and Alexander's birth evidence.

The latter is confirmed by the lunar eclipse preceding the battle at Arbela; for Arrianus (Al. iii. 7, 6) and Cicero (De div. i. 53) report that this small eclipse, 11 days prior to the battle at Arbela, happened in Pyanepsion (Aug. 31 to Sept. 30) "a short time before sunrise, whilst the sun stood in Leo." About that time only one lunar eclipse occurred in August and a short time previous to sunrise, viz. that in —328, Aug. 31, 5 hrs. after midnight in Arbela (☊ 12° west of the sun). Consequently the battle at Arbela belongs to the year —328, and not, as Petavius imagined, to —330.

3. *The Solar Calendars of the Hebrews.*—Formerly it was universally believed that the Hebrews used only lunar months, but the contrary has come to light. See the author's "Chronologia Sacra," etc. p. 26–68, and "Zeitschrift der Deut. Morg. Ges." 1848, p. 344, and "Berichtigungen," etc. p. 14. There the matter having been discussed *in extenso*, we only briefly mention the principal proofs. Josephus parallels very often the Greek solar months with the Hebrew months. The Hebrew months were solar ones in Syria, Arabia, Ascalon, Gaza, etc. Greek and Roman authors, especially Josephus, the Books of the Maccabees, and the New Testament, refer Saturdays to certain days of Hebrew months, which would have been impossible provided the latter were lunar months. Even the Talmud bears witness that the Hebrews, prior to the destruction of Jerusalem by Titus, used only both solar months and a tropic year. Moreover, the Old and New Testaments—especially Josephus, Philo, and Hebrew inscriptions—demonstrate that the Hebrews celebrated their feasts according to their ecclesiastic year, commencing 17 days prior to their civil year (Minjan Shtaroth). The commencement of the ecclesiastic year is, apart from other arguments, fixed by

Eusebius (Hist. Ecc. iii. 4), Chrysostomus (L. iv. De sacerdot. i. 7), and others, who report that Dionysius Areopagita, while travelling in Ethiopia, perceived, A.D. 33, an eclipse of the sun on the 14th day of Nisan, which eclipse, by the way, was invisible in Palestine, and it differed from the obscuration of the sun during the crucifixion of Christ. Further, the commencement of the civil year is fixed by Josephus, who reports that the civil months began in the midst of the ecclesiastic months (*κατὰ σελήνην*), for *σελήνη* signifies very often the full of the moon, especially the 17th day after the astronomical new moon, and, in general, the middle day of all months of the tropic year. This is confirmed by the *σάββατον δευτερόπρωτον*, that is to say, the *second first day* of the year, the newyears day of the civil year (Ev. Luke, vi. 1), which day is still celebrated among the Jews like the Sabbath at the beginning of the ecclesiastic year. Hence the months of the Hebrews, since the Babylonian captivity, commenced on the days of the Julian Calendar, as follows. It is, however, to be remembered that the Hebrews commenced the day six hours prior to the beginning of our days.

Ecclesiastic Year.	Civil Year.	Julian Year.	
1. Nisan		March 6.	
	Nisan	March	22.
2. Ijar		April 5.	
	Ijar	April	21.
3. Sivan		May 5.	
	Sivan	May	21.
4. Thammuz		June 4.	
	Thammuz	June	20.
5. Ab		July 4.	
	Ab	July	20.
6. Elul		August 3.	
	Elul	August	19.
7. Thishri		September 2.	
	Thishri	September	18.
8. Marcheshvan		October 2.	
	Marcheshvan	October	18.
9. Kislev		November 1.	
	Kislev	November	17.
10. Tebeth		December 1.	
	Tebeth	December	17.
11. Shebat		December 31.	
	Shebat	January	16.
12. Adar		January 29.	
	Adar	February	14.
Intercalary days		March 1.	
	Intercalary days	March	17.

By means of these Calendars many epochs of the Old and New Testaments, of the Books of the Maccabees, and even of Roman history, are determined. For instance, the Talmud (Tract Thaan. fol. 29, 1) bears witness that Titus "destroyed the temple on the 9th day of Ab, on a Saturday"; consequently on July 28th, "just after a new class of the priests had entered the temple," that is, on July 27th at sunset. This day being only A.D. 71 a Saturday, it is evident that Jerusalem was taken in 71, and not in 70 A.D.; accordingly, that Vespasian reigned one year later than Petavius brought out: for Jerusalem was, notoriously, destroyed in the 2d year of Vespasian. Further, Josephus (B. J. v. 9, 4; Ant. xiv. 4, 3 & 16, 4) and other authors report that during Cicero's consulate (Ol. 179, 1) Pompeius captured the temple of Jerusalem on a "Saturday" and "on the 10th day of Tishri," i.e. Sept. 11th, which was only in —61 a Saturday. Consequently Cicero ruled one year later than Petavius imagined; and Ol. 179, 1, commenced in June —61, and not two years earlier. Remember that the Hebrew day commenced on the preceding Julian day with sunset.

4. Transits of Venus, the so-called self combustions of Phœnix.—The ancient traditions concerning that famous myth will be found collected in the "Zeitschrift d. Deut. Morgenl. Ges.," 1849, p. 63, of which the summary is as follows:—The ancients distinguished two Phœnixes, depicted in many copies of the sacred records of the ancient Egyptians, and accompanied with their respective names, *Bennoh* and *Choli.* The latter name agrees with the Hebrew name *Chol* (Job 29: 18), the Coptic "*Alloe*, Phœnix"; the former (*Bennoh*) is obviously the Coptic *Bene* (Jer. viii. 7), the Latin *Venu(s)*, ancient *Benu(s)*, probably related with the Coptic *Wein*—splendere, pulchrum esse. Hence Hermapion translates the image of the Phœnix on the Flaminian Obelisk by φοινίκιος, i.e. pulcher, venusius. Accordingly Bennoh signified Venus, but Choli was the planet Mercury, called the "wrong Phœnix"; and their combustions mean their transits before or behind the sun's disk. Venus, it is well known, crosses the solar disk in case the distance of her nodes from the sun amounts to less than 1° 49′; otherwise Venus transits south or north from the borders of the sun. The ancients, however, being destitute of telescopes, it was extremely difficult to determine real transits of Venus before or behind the sun's disk. Their only help was to observe, with the naked eye, the latitude of Venus a short time prior to her conjunction with the sun, and hence it came to pass that the ancients sometimes took close conjunctions of Venus with the sun for transits of the former. For the same reason the ancients determined very different periods of the reappearance of Phœnix. By means of such ancient transits of Venus many epochs of Roman history are incontrovertibly fixed.

First, Pliny (H. N. xxx. 3; x. 2) narrates that the year u.c. 657, i.e. —95, coss. Licinius and Cn. Cornelius, was the 215th year of the Phœnix period. Consequently a transit of Venus must have occurred in —309 ($95+214=309$), coss. Bubulcus Brutus III. and Aim. Barbula II. Pliny's authority is Manilius, the notorious Roman astronomer. Indeed, in —309, Nov. 22d, the longitudes of the sun and Venus were 7^s 26°, and that of the ☋ was likewise 7^s 26°. Accordingly Venus traversed in —309 nearly the centre of the sun, but behind it, because the former was in its superior conjunction with the sun. This astronomical fact in u.c. 443 puts beyond the reach of controversy that Rome was founded in —752, and not, as Petavius made out, in —753: that the consuls Licinius and Cornelius as well as Brutus III. and Barbula II. ruled one year later than formerly was believed.

Further, in Tacitus (Ann. vi. 28) we read: "P. Fabio et L. Vitellio coss. post longum sæculorum ambitum Phœnix in Ægyptum venit præbuitque materiam doctissimis indigenarum et Græcorum, multa super eo miraculo disserendi." About that time only one close conjunction of Venus with the sun was possible, viz. A.D. 36, May 31, on which day the ☊ of Venus lay 6° west of the sun. During this conjunction the distance of Venus from the sun amounted to 38′ only. Consequently the said consuls ruled one year later than Petavius stated.

Aurelius Victor (Claud. iv. 12): "hujus (Claudii) anno sexto." says he, "DCCC. urbis, mire celebratus visusque apud Ægyptum phœnix"; and Pliny (H. N. x. 2) reports: "Cn. Valerius phœnicem devolasse in Ægyptum tradidit. Q. Plautio, Sex. Papinio coss. (A.D. 38); Allatus est in urbem, Claudii principis censura, a. u. DCCC.: et in Comitiis propositus, quod actis testatum est." Suidas (v. Φοῖνιξ) and Salinus (c. 36) narrate the same. About that time only one close conjunction of Venus with the sun was possible, namely, A.D. 48, May 29: for the ☊ of Venus lay only 5° west of the sun; therefore Venus stood, during the conjunction, 32′ only from the sun's northern borders. In the same year, as Aurelius Vict. (Claud. iv. 12) reports, "in Ægæo mari repente insula ingens emersit nocte, qua defectus lunæ acciderat," namely, A.D. 48, June 14, 6h., which confirms Venus's transit A.D. 48. All these reports put beyond question that the foundation of Rome, as well as the consulates and the reigning of Claudius, are to be postdated by one year.

Since, however, so many hypotheses exist concerning the myth of Phœnix, it will be necessary to add some new proofs clearly evidencing that the *true Phœnix* signified the planet Venus, and that its combustions were transits of Venus. Thus, for instance, Lepsius (Vorbedingungen zur Entstehung einer Chronologie, etc. Berlin. 1848, p. 180) imagined the Phœnix to signify the human soul, purified, during the period of its transmigrations, in animal bodies. Hence he concluded that the Phœnix period, commencing with the Canicular periods, contained exactly 1500 years, sometimes however 1,000 years, sometimes 500, sometimes only 250 years. This chimera, however, is inconsistent with all ancient reports concerning the Phœnix, and it is apparently refuted by all epochs of ancient history to which a reappearance of the Phœnix is linked. The true Phœnix, represented by a crane (Jer. viii. 7) is simply Venus, as its Coptic name *Bene*, and the hieroglyphic term *Bennoh*, and many other circumstances demonstrate. Further, the Egyptian sacred records, e.g. Lepsius's Todtenbuch (xxx. 81) themselves enumerate the planets, according to their apparent celerities, in the following order: [Saturn.] Jupiter, Mars, Venus, Mercury; of which, the latter two are called "Bennoh" and "Choli." The same records (iv. 13) call the same Bennoh "the greatest of the stars," and this clearly denotes Venus. The said hymns, moreover, refer to Bennoh what the Greeks and Romans referred to Venus, viz. all objects of beauty, e.g. "the four gamuts (musical scales) of the Muse of the seven tones." Besides, Strabo (x. 3, p. 474) tells us that "the ancients veiled their physical conceptions by riddles, and added myths to their scientific contemplations." Thus, e.g., the 12 works of Hercules signified the effects of the sun, during the year, in the 12 signs of the Zodiac and the corresponding 12 months. The myth, according to which Hercules, being still in his cradle, killed two serpents, signifies the sun's victory over the two houses (signs) of Saturn (serpents), near the point of the winter solstice. The myth, according to which Typhon (the water) killed Osiris (the main-land), and Pontus (the sea) overcame Demarus (*adam-arez*, the earth), refer to the deluge. The myth allegorizing Jupiter (the sun) to burn Semele (the vineyard), whereupon he saved and perfected Bacchus in his thighs, simply contains a mythical description of the origin of the vine, and the like. Therefore the myth of the Phœnix burning itself in Heliopolis (the sun), must involve a similar contemplation of a natural phenomenon, and not the transmigrations of the human souls. The ancients expressly say that only one specimen of the fowl (planet) Phœnix (Bennoh) is in existence, and "nobody had seen it eating."

5. *The Seasons of the Greeks*, discussed *in extenso* in the author's "Berichtigungen," pp. 67 & 262, are very important in correcting the common Greek history, and establishing a correct chronology of the Greek eclipses, especially those mentioned by Thucydides and Xenophon. Plutarch (Symp. iii. 7, 1; viii. 10) certifies that the Greek year was divided into "two equal parts," viz. θέρος and χειμών, of which the former commenced subsequent to the winter solstice, or, according to the aforementioned Calendar, with the month Anthesterion (Jan. 3d). Hence the Greek summer contained the six months January, February, March, April, May and June, and the following months belonged to the Greek winter. Moreover, that θέρος was divided into the spring (ἔαρ) and the shorter θέρος,—the former comprising January, February, March, the latter April, May, June. Χειμών likewise was subdivided into ὀπώρα (July, August, September), and the shorter χειμών (October, November, December). Plutarch's reports are confirmed by Thucydides and Xenophon: for Thucydides (iv. 52, 117; v. 20; vii. 19, etc.) expressly says that the spring (ἔαρ) belonged to the semi-annual θέρος. This division of the Greek year, moreover, is easily proved; for in Homer's days and later times Sirius rose heliacally, i.e. prior to sunrise, on July 25th, and Orion rose on July 10th. Both risings Homer (Il. xxii. 17), Aristotle (Probl. xxvi. 4), and Theophrast (De vent. p. 414)

refer to ὀπώρα, and hence Homer (Il. v. 3) calls Sirius expressly ἀστὴρ ὀπωρινός, the star of the autumn. Consequently the season of autumn (ὀπώρα) must have contained the months July, August, and September. Accordingly all other Greek seasons must have begun with the aforesaid months. Even the Greek name of our January, viz. Ἀνθεστεριών, the month of flowers, demonstrates that the Greek spring commenced three months prior to our spring. Further, Thucydides (v. 49. 50) testifies that χειμών began soon after the Olympian games, which were always held in θέρος, and a short time prior to the summer solstice. Thucydides, moreover, refers the rising of Arcturus after sunset to the middle of θέρος, and in that time Arcturus rose about the end of March, and hence θέρος must have contained the months from January to July. Again, Plutarch (Symp. iii. 7, 1; viii. 10. 3) bears witness that Anthesterion, commencing with January 3d, was "the first month after χειμών." Still further, Harpocratio (v. Μαιμακτ.) tells us that χειμών commenced with the month Maemacterion, of which the first day, as we have seen (p. 408), coincided with September 30th, Julian style. Hence this quarter of the Greek year must have been followed by ἔαρ, beginning with January 3d. Moreover, Xenophon (Hell. vii. 5, 14) testifies that the Mantinean battle "on the 12th day of Scirophorion" (May 15th) happened in θέρος, and prior to χειμών. Add to this that Thucydides (iv. 52) certifies the small solar eclipse in the 8th year of the Peloponnesian war to have taken place "soon after the beginning of θέρος," and about that time only one small eclipse of the sun was possible in the early θέρος, viz. that in —420, Jan. 28th, as we shall see hereafter. Finally, Plutarch (Æm. Paul. c. 16) narrates that the battle near Pydna was preceded by a lunar eclipse in the last days of the summer (θέρος φθίνοντος), and about that time only one eclipse of the moon coincided with the end of θέρος, viz. that in —166, June 10th; conseqnently χειμών must have commenced with Metageitnion (July 2d), whilst θέρος began on January 3d.

These arguments will suffice to convince every intelligent reader that the Greek seasons θέρος and χειμών, of six months each, commenced respectively on January 3d and July 2d. By means of these Greek seasons many epochs of Greek and Roman history are fixed. For instance, the consuls Æm. Paullus II. and Lic. Crassus must have ruled in —166, and not, as Petavius imagined, in —167; because the battle near Pydna being fought during the same consulate, happened, as we have seen, in —166. This date confirms the aforesaid result, that, down to Julius Cæsar, all events of Roman history, as determined by Petavius, have to move down one year.—Again, the eye-witness Thucydides (ii. 28) testifies that the solar eclipse observed in Athens in the course of the first year of the Peloponnesian war, Arch. Pythador I., happened in θέρος soon after noon. About that time only one eclipse agrees with Thucydides, viz. that in —429, Jan. 22, 22h. P. T. Petavius, on the contrary, recurred to the eclipse in —430, Aug. 3, 5h. 30m. after noon; but, alas! this eclipse belongs to χειμών, and not to θέρος.—The eye-witness Aristophanes (Nub. 580) testifies that, in the course of the 10th year of the Peloponnesian war, on occasion of Cleon's election as strategus, during the early spring, a partial eclipse of the sun and a total one of the moon happened; of which, the former, according to the scholiast in Scaliger's Synage, took place on Jan. 18th (Anthesterion 16th). These two facts demonstrate that the events of the Peloponnesian war narrated by Thucydides happened one year later than Petavius made out.—Xenophon (Hell. ii. 3, 4) bears witness, that, during θέρος of the last year of the Peloponnesian war, an eclipse of the sun was perceived which Petavius referred to —403, Sept. 2d. But, alas! this eclipse of Sept. 2d belonged to χειμών, and not to θέρος. The eclipse under consideration happened two years later, viz. in —401, Jan. 18, 9 o'clock a.m. Thus the seasons of the Greeks, apart from all other arguments, evince that the Peloponnesian war commenced in —429, and ended in —401; that the same lasted 28 full years, as Thucydides and Xenophon testify: that all events narrated by Thucydides come down by one year; that the first part of Xenophon's Hellenica is, at present, missing; and that all events narrated by Xenophon, all Greek archons and Olympian games subsequent to the year —407, are to be postdated by two years.

6. *Greek and Roman Inscriptions and Coins.*—Subsequent to Petavius's "Doctrina Temporum," 1627, many Greek and Ro-

man inscriptions and coins have come to light which, not being subjected to learned or unlearned alterations, are decisive in fixing the years of Greek and Roman history. We specify the following:

The Fasti Capitolini. This catalogue of Roman consuls, going down to Tiberius, originated from the Annales Maximi, the work of the Capitolian annalists, who had, from the beginning of Roman history down to Tiberius, recorded, day by day, all remarkable events of Roman history. This precious monument refutes the usual Roman history and chronology in two principal points. First, it demonstrates that Petavius shortened the period of the Roman kings by one year, and authoritatively intruded a consular year in —331, u.c. 421. The consuls L. Papirius Cursor with C. Poetil. Libo II., whom Solinus (c. 40) mentions again five years later, have never ruled, as the Fasti Capitolini, Livy, Diodor, and Cassiador, bear witness. (See the author's "Berichtigungen," p. 56). In the second place, Petavius shortened the ruling time of Julius Cæsar by one year; the latter must have ruled six years, and not five years. For the Fasti Capitolini bear witness together with Livy that Cæsar was dictator in the course of six consecutive consular years; and even Josephus (Ant. xviii. 2, 2), Cicero's letters of this time, Dio Cassius, and other authors, count six years from Cæsar's crossing the Rubicon to his death. (See the author's "Berichtigungen," p. 52)

The Ancyran Marble, written by Augustus himself, evidences that Cæsar died in —41, and not in —43; and that Augustus died, not A.D. 14, but A.D. 16. For the Ara Albani, the nativity of Augustus (p. 407), furnishes evidence that Augustus was born in —61, coss. Cicero and Antonius, whilst the former delivered the fourth Catilinaria, and "Capricornus rose heliacally" (Sueton. Aug. 94), consequently in February of —61, especially, according to the erratical lunar calendar of the Romans, ix. Kal. Oct. Moreover, Cicero's consulate is fixed, as we have seen (p. 415), by the capture of the Hebrew temple on Sept. 11 in —61, a "Saturday." Now, according to the Ancyran Marble, Augustus himself tells us that, subsequent to Cæsar's assassination, he came from Apollonia to Rome whilst he was 19 years and some months old (annos undeviginti natus). Accordingly Cæsar must have died in —41, and not in —43 (61 — 20 = —41), and this date is confirmed by many other ancient reports. (See the author's "Berichtigungen," p. 52.) Since Augustus, moreover, being born in —61, died aged 77 years (Joseph. Ant. xviii. 2, 2), he must have died A.D. 16, and not, as Petavius taught, two years earlier (—61 + A.D. 16 = 77). Further, the following inscriptions evidence that Claudius reigned only 12 years, instead of 13 years, as Ptolemy's Canon and Petavius state. In Gruter's Thesaurus (p. 238, no. 39) and Wolf's Suetonius (no. 2 & 3) the following inscription will be found: "T. Claudius, Drusi filius, Cæsar Augustus Germanicus, Pont. Max., Trib. pot. V., Imp. X., P. p., Cos. design. IIII.," etc. The first Tribunitia potestas of Claudius commenced on that day on which his predecessor Caligula died, i.e. A.D. 43, Jan. 24th, and consequently his 5th Trib. pot. began A.D. 47, Jan. 24th, in which year Claudius became Cons. designatus IV. Since all consuls, as is well known, were designated six months previous to the beginning of their consulates, Claudius must have been consul quartum A.D. 48. Petavius, on the contrary, refers the fourth consulate of Claudius to A.D. 49, and gives the consules suffecti C. Valerius Asiaticus, associated with M. Junius Silanus, the whole of the year 48. The same is proved by another inscription (Gruter's Thesaur. p. 238, no. 39; Wolf's Sueton. no. 3), which reads as follows: "Ti. Claudius, Aug. German., pont. max., Trib. pot. V., imp. XI., p. p., cos. IIII.," etc. For this inscription refers to the days from January 1st to January 24th, A.D. 48, in which Claudius already officiated as consul, whilst his 6th Tribunitia potestas commenced later, on January 24th, A.D. 48. Add to these authorities the decree of Claudius in Josephus's Ant. xx. 1, 2: *Κλαύδιος Καῖσαρ Γερμανικὸς, δημαρχικῆς ἐξουσίας τὸ πέμτον, ὕπατος ἀποδεδειγμενος τὸ τέτραρτον—ἐγράφη πρὸ τεσσάρων Καλανδῶν Ἰουλίου ἐπὶ ὑπάτων Ρούφου καὶ Πομπηίου Σιλάνου.* For this decree concerns June 27, A.D. 47, during which Claudius, being invested with his fifth Tribunitia potestas, became Cos. des. IV. Accordingly Claudius was Cos. IV. A.D. 48, and Rufus with Silanus were, A.D. 47, coss. suffecti instead of Vinicius II. with Statilius Taurus Corvinus. The conclusion therefore is that the latter being coss. suffecti, the following consuls ruled only one year later than Petavius brought out. That, moreover, Claudius reigned only 12, and not 13 years, is confirmed by numismatics and epigraphics, because no coin and no inscription referring to Claudius's supposed 13th year are in existence.

Another class of inscriptions evidences that Vespasian likewise reigned one year less than, down to this day, was generally believed. Gruter's Thesaurus (p 270, 2; 243) and Eckhel's D. N. (vi. 343) contain the following inscriptions: "Imp. Cæsari Vespasiano Aug., Pont. Max., Tribun. pot. VIII., imp. XVII., Cos. VIII., des. IX., censori.," etc.; and, "Pontifici Max. .... Trib. pot. .... Imp. XVII., Cos. VIII., des. VIIII., conservatori," etc. Of the latter inscription Gruter obtained two copies, made in different times and by different persons. These inscriptions apparently demonstrate that Vespasian, like Claudius, administrated two consecutive consulates. Petavius, on the contrary, puts between these 8th and 9th consulates of Vespasian a whole year, the consules suffecti Commodus Verus and Novius Prisius. Accordingly, Vespasian must have reigned one year less than Petavius imagined; he must have governed nine years, instead of ten years. This is confirmed by Eutropius, and both by numismatics and epigraphics. There exists not one coin, and not one inscription, vindicating the supposed 10th year of Vespasian.

The coins of Julius Cæsar concerning the introduction of his solar calendar, which happened 2 months and 15 days prior to Cæsar's assassination, represent a crescent, because the first Julian year had commenced with the appearance of the crescent. The same crescent is, moreover, testified by Macrobius (Sat. i. 14). It was only in —41 that a crescent became visible in Rome on the first day of the first Julian year. Since, then, during a period of 19 years, only one new moon coincides with January 1st, and only in —41 a crescent was to be seen on the beginning of January, it is clear enough that the Julian Calendar was not introduced, and that Cæsar died, not in —43, but —41. According to Petavius, the first day of the Julian Calendar would have commenced twenty-two days prior to the new moon, which stands in direct opposition to both Macrobius and the coins.

The *calendrical inscriptions* according to which the archons Glaucippus and Nicodorus respectively ruled later by one or two years, have been spoken of in the premises (p. 411–12).

The *Parian Marble*, which specifies the most important events of

Greek history, and refers them to the epoch —261, demonstrates that the archons down to the year —407 ruled one year, the following two years, later than Petavius stated. Since, moreover, Persian history is connected with the Greek, the same monument evidences that all events of Persian, Median, Assyrian, and Babylonian histories, connected with certain archons, likewise happened respectively one or two years later than Ptolemy's Historical Canon says. Accordingly, the eclipses in the Almagest, being linked to certain years of the same kings and archons, must necessarily be referred to other dates than those cited by Ptolemy.

7. *A number of Solar and Lunar Eclipses unknown to Petavius.*—Since the year 1627, in which Petavius's Doctrina Temporum appeared, several ecliptic new and full moons, unknown to Petavius, have come to light, which are well qualified to correct the present history and chronology of the Greeks, Romans, Egyptians, and other nations of old. We specify the following only:

The total eclipse of the sun in Rome, u.c. 450, —400, July 1st, 17h. 45m., mentioned by Cicero (De rep. i. 16), which work was discovered about sixty years ago. The same is the case with the Armenian Eusebius, who mentions several eclipses formerly unknown.

The solar eclipse preceding the conquest of Nineveh by Cyrus, in —532, Jan. 27th, 15h. 45m. P. T., described by Xenophon (Anab. iii. 4, 7).

The total eclipse of the moon, and the very small one of the sun, at Athens, in —420, Jan. 18, 2h., and Feb. 2, 6h., of which the former happened on the 16th day of Anthesterion (Jan. 18). Aristoph. Nubes 581, and the Scholiast in Scaliger's Synagoge.

The total eclipse of the sun at Thebes, Bœotia, in —465, Dec. 20. (Pindar in Dionys. Hel. p. 167, 18 Sylb.)

The total eclipse of the sun in Pekin on the day of the autumnal equinox in —2192, of which the date is fixed by a planetary configuration. (Gaubil's Histoire de l'Astron. Chinoise, Paris, 1732, vol. 2, p. 140.)

The partial eclipse of the moon, observed during the year of the first Canicular period, at Tanis, Egypt, in —2780, May 22d, 13h. (Suidas, v. Ἆπις; Plutarch Symp. Q. 1. p. 718; De Iside. p. 368; Strabo xvii. 555; Ammian xxii. p. 245. etc.)

With these new chronological resources are to be numbered

8. Pingré's Computations of all Ancient Eclipses, visible in the Old World from 1000 *B.C. to A.D.* 2000.—These computations, published in "Histoire de l'Académie R. des inscriptions et belles-lettres." T. xlii. p. 78. Paris, 1786, and "L'art de vérifier les dates," vol. i. p. 243, Paris, 1818, and p. 147, Par. 1819, rely on Halley's Tables referring to Paris time. In all instances Pingré determined the magnitudes of the lunar eclipses, and, so far as the solar eclipses are concerned, he described the curves of the total shadow of the moon, viz. at the beginning, at noon, and at the end of each eclipse. These computations, relying on Halley's Tables, it is true, have been declared to be inexact (Bode's Astron. Jahrbuch, 1820, p. 202), and yet they are very useful in determining the dates of ancient eclipses. It is true, moreover, that Halley's and La Hire's Tables, if applied to modern eclipses, prove incorrect, but they quite sufficiently agree with all the old eclipses; for the *terminus a quo* of Halley's Tables were the eclipses in the Almagest, and the same are the bases of Burckhardt's, Damoiseau's, and Hansen's Tables. Pingré's computations, at any rate, furnish, with few exceptions, the dates of all ancient ecliptic full and new moons mentioned by Roman, Greek, and other authors.

These astronomical and historical auxiliaries, unknown to Petavius and his followers, viz planetary configurations, transits of Venus, calendrical inscriptions, observations of the solstices, eclipses referred to certain days of the tropic year, the solar calendars of the Greeks and Hebrews, new Greek and Roman inscriptions, Julius Cæsar's coins, the seasons of the Greeks,—these new resources of ancient chronology, I say, will suffice to re-estabish the true ancient history and the chronology of the eclipses mentioned in the classic and other historical works. For all ancient eclipses are linked to certain years of the Æra urbis conditæ, or to that of the Olympiads, or to certain years of the Babylonian and Roman kings and emperors, or to certain consuls and archons; and by the very same historical and mathematical certainties numberless events of Roman, Greek, and Babylonian histories are incontrovertibly fixed.

Before, however, entering into a closer examination of the true dates of ancient eclipses, it will be necessary to prove the incorrectness of the present theory of the moon's motions, and to determine *approximately* the corrections of the principal statements of the usual Lunar Tables. We confine ourselves to the secular accelerations of the moon, her Nodes and Apsides, because the solution of the whole of the problem belongs to professed astronomers only. In all the following computations I shall apply Lalande's Tables owing to their handiness, and because they sufficiently agree with Damoiseau's and Hansen's Tables so far as the old Babylonian, Greek, and Roman eclipses are concerned.

Approximate Corrections of the present Theory of the Principal Motions of the Moon.

It is a well known fact that the total eclipse of the sun observed in Germany A.D. 1851, happened later than Damoiseau's Tables, inclusive of Airy's correction, had predetermined, and that in that year the longitude of the moon's Node was somewhat shorter. The late Prof. Moebius, Director of the Leipzig Observatory, and myself observed this eclipse, and we found that both the beginning and ending of the obscuration happened 57 seconds later, and that the obscuration of the sun amounted in Leipzig to less than 10 inches, as was predicted by means of the said Tables. Prof. D'Arrest, however, who observed the same eclipse in Danzig, found that the obscuration of the sun commenced and finished only 56 seconds later than Damoiseau's Tables, corrected by Airy, had predetermined. Now, granting the mean motions of the moon, her Nodes and Apsides, to depend, as all astronomers maintain, on the law of gravitation, it follows that the difference of the computation and the observation of the eclipse A.D. 1851 is to be put on account of the secular accelerations of the moon's motions, erroneously derived from the Babylonian eclipses in the Almagest. The following compuations will, in the first place, demonstrate that on occasion of all ancient ecliptic new moons the longitude of the nodes must have been somewhat shorter than Damoiseau's Tables state. The total eclipse of the sun "u.c. 350, Nonis Junîs," i.e. —400. July 1st, 17h. 57m. mean Roman time, belongs to the most reliably ascertained eclipses of the ancients, because it is corroborated by the Annales Maximi, Ennius, and Cicero (R. P. i. 16). Pingré (Art de vér. les dates) refers the conjunction to July 1st, 17h. 45m. mean Paris time, and this result agrees, with trifling exceptions, with the following computation, the work of Prof. D'Arrest, who applied Damoiseau's Tables and Airy's corrections of the latter. The letter *t* signifies time.

Long.	☉	95°	0′	30″ 7	+ 2′	23″ 8. t.	
Long.	☽	94	53	49 5	+ 33	16 8. t.	
Lat.	☽	0	29	31 0	+ 3	2 1. t.	
Sunrise in Rome				16h. 27m. (local time).			
Conjunction in long.				17h. 57m. 59s. Paris time.			
				18 38 34 Roman time.			
☉ and ☾		95°	1′	1″ 8			
Lat.	☾	—0	28	51 6			
Paral.	☾	0	57	21 5			
Rad.	☾		15	38 1			
Paral.	☉			8 4			
Rad.	☉		15	48 2			

According to this computation the southern obscuration of the sun amounted to 2′ 34″ 2, i.e. nearly to 1 inch only. This result clearly demonstrates that the secular acceleration of the moon's Nodes, adopted in our Tables, is incorrect, and that the computed longitude of the ☊ must be diminished. Supposing the ☊ was 7° west of the point to which Damoiseau refers it, then the following figures result, as the computation of Mr. Heym, then Adjunct of the Leipzig Observatory, shows. The applied Tables were those of Carlini and Damoiseau.

New moon	17h. 57m. 2s. mean Paris time.			
Long. of ☉ and ☽	3^s	4° 55′	4	
Motus hor. ☉ in long.		2	40	
Motus hor. ☽ in long.		33	38	
Lat. ☽		+32	8	
Motus hor. ☽ in lat.		3	03	
Long of ☊	3	6	029	(1° 46′ E.)
Long. ☊ —7°	2	28	520	(6° W.)
Paral. ☽			57′ 62	
Rad. ☽			15 72	
Rad. ☉			15 80	
Siderial time		6h. 25m. 51s.		
Obliquity of the ecliptic		23° 46′ 5		

According to these statements the obscuration of the sun commenced at 15h. 43m., and ended at 17h. 29m.; its middle was 16h. 36m.; whilst 10 inches of the sun's northern limb were covered in Rome. Hence it is evident that the western distance of the ☊ from the sun must have been about 5° only. According to Lalande's Tables the longitude of the sun was likewise $3^s\ 3^\circ\ 58'$, and that of the ☊ $3^s\ 5^\circ\ 5'$.

The total eclipse of the moon, and the partial one of the sun, in the 10th year of the Peloponnesian war, i.e. −420, of which the latter was seen on January 18th, both being observed by the eye-witness Aristophanes (Nub. 581), belong to the most reliably ascertained eclipses of ancient history; and yet the ecliptic new moon in −420, Jan. 18, 2h., was, according to our Tables, invisible on our globe, because the ☋ lay 17° west of the sun. Even Pingré states that on the said day no solar eclipse was possible in the old world. Consequently the longitude of the ☋ must have been shorter by about 5°, which agrees with the aforesaid eclipse.

Further, the eye-witness Thucydides testifies that the nearly total eclipse of the sun in −429, January 26th, 22d, happened, in Athens, after noon (*μετὰ μεσημβρίαν*); consequently the longitude of the moon must have been shorter, and the conjunction must have been later by about three hours.

Herodotus reports that the total eclipse of the sun in Smyrna (Sardes), noticed by the whole Persian army, in −478, Feb. 27, 15h. 30m., coincided with sunrise in Sardes. According to our Tables, however, this eclipse was over prior to sunrise in Sardes; consequently the longitude of the moon must have been shorter, and, again, the conjunction must have been retarded by about 3 hours and 20 minutes.

The whole Roman history bears witness that Rome was founded on the day of the Roman parilia (the vernal equinox), and that during the building of the city an eclipse was seen within the third hour after sunrise. Tarutius narrates that the same eclipse was observed at Teos in Ionia; our Tables, on the contrary, state that this eclipse was invisible in Rome, even in Asia Minor. In order to obtain a corresponding eclipse, the longitude of the moon in −752, May 25, 16h. must be shortened, and the conjunction postponed by about 3 hours 50 minutes.

Finally, many eclipses of the sun, reported by ancient authors to have been total, were, according to the present theory of the moon's motions, annular ones. On occasion of the total eclipse in −400, as we have seen (p. 424), the radius of the sun was greater than that of the moon by 10 seconds.

Add to these the following eclipses: –360, May 12, 3h. 15m., at Thebes, Bœotia; –306, June 13th, 22h. 45m., a little east of Syracuse; –201, Oct. 18, 23h. 30m., near Carthage, and so forth, which were likewise, according to ancient authorities, total, but, according to our Tables, annular ones.

These examples will be sufficient for understanding that the present theory of the moon's motions principally fails concerning the secular accelerations of the moon, her Nodes and Apsides.

Now, remembering, on the one hand, that the present theory of the moon relies on the Babylonian eclipses in Ptolemy's Almagest, and that the times and magnitudes of those eclipses, specified in the Almagest, are the results of Ptolemy's computations; that, on the other hand, the dates of the classic eclipses are mathematically fixed,—the problem remains to bring our Lunar Tables into harmony with the reports of the classic authors. For this purpose we proceed in the following way.

Since the total eclipse in A.D. 1851 commenced and ended, at Danzig, 56 seconds later than our Tables had predetermined, we presume the real longitude of the moon on that day to have been shorter by 13 seconds, which gives a retardation of 24 seconds. The longitude of the Perigeum may be diminished by 17 seconds, which effected the conjunction to come later by 32 seconds. These corrections would explain that the said eclipse commenced and finished later by 56 seconds than it was expected. Moreover, since the central shadow of the moon then traversed unexpectedly higher degrees of latitude of our globe, we presume the longitude of the moon's Nodes to have been, during the conjunction, shorter by 37 seconds. These quantities increase, of course, proportionally to the squares of times; and hence we obtain the following

TABLE OF APPROXIMATE CORRECTIONS.

Epochs.	Long. Moon.			Long. Apsides.			Long. Nodes.			Time ☾.		
+ 1800	– 0°	0′	13″	– 0°	0′	17″	– 0°	0′	37	+ 0h.	0m.	24s
+ 1700	0	0	52	0	1	42	0	2	28	0	1	36
+ 1600	0	1	58	0	2	37	0	5	33	0	3	36
+ 1500	0	3	28	0	4	39	0	9	52	0	6	24
+ 1400	0	5	26	0	7	16	0	15	26	0	10	0
+ 1300	0	7	49	0	10	28	0	22	12	0	14	24
+ 1200	0	10	40	0	14	16	0	30	13	0	19	36
+ 1100	0	13	55	0	18	42	0	39	28	0	25	36

Epochs.	Long. Moon.			Long. Apsides.			Long. Nodes.			Time ☾.		
+ 1000	− 0°	17′	37″	− 0°	23′	24″	− 0°	49′	57″	+0h.	32m.	24
+ 900	0	21	46	0	29	15	1	1	40	0	40	0
+ 800	0	26	20	0	25	23	1	14	37	0	48	24
+ 700	0	31	20	0	42	25	1	28	48	0	57	36
+ 600	0	36	48	0	49	43	1	44	13	1	7	36
+ 500	0	42	40	0	57	21	2	0	52	1	18	24
+ 400	0	47	42	1	5	51	2	28	45	1	28	20
+ 300	0	55	44	1	14	49	2	37	52	1	42	24
+ 200	1	2	56	1	24	17	2	58	13	1	55	36
+ 100	1	10	33	1	34	48	3	19	48	2	9	36
+ 0	1	18	36	1	45	42	3	42	37	2	24	24
− 100	1	27	6	1	57	6	4	6	40	2	40	0
− 200	1	30	22	2	9	22	4	31	57	2	56	24
− 300	1	45	23	2	21	42	4	58	28	3	13	36
− 400	1	54	51	2	34	51	5	26	13	3	31	36
− 500	2	5	11	2	48	37	5	55	12	3	50	24
− 600	2	16	6	3	2	57	6	26	25	4	10	0
− 700	2	27	2	3	17	33	6	56	52	4	30	24
− 800	2	38	47	3	43	15	7	29	33	4	51	36
− 900	2	50	42	3	49	32	8	3	28	5	13	36
− 1000	3	3	7	4	6	14	8	38	37	5	36	24
− 2200	6	6	1	8	12	18	17	16	37	11	12	24
− 2300	6	24	7	8	36	18	18	3	58	11	45	36
− 2800	8	1	1	10	36	46	21	44	32	14	43	36
− 3400	10	11	39	13	42	22	28	52	13	18	43	36

All these figures are not at all rigorous—they are only approximate; for, in the first place, the Constant, which is in all instances to be taken into account, is entirely neglected. Moreover, since other elements of our Tables are naturally connected with the secular motions of the moon, her Apsides and Nodes, it is self-evident that the former are likewise liable to corresponding alterations. Nevertheless the preceding Table will be useful in fixing the dates and magnitudes of all ancient eclipses observed by the Romans, Greeks, Babylonians, Egyptians, and Chinese. I claim only to have collected and fixed the classic eclipses down to A.D. 400, and to have corrected the principal elements of our Lunar Tables approximately.

The Actual History of the Romans.

The historical chronology of the Romans having been discussed in the author's "Chronologia Sacra," 1846; "Berichtigungen," 1855; "Summary of Recent Discoveries," 1857 (2d ed. 1859); "Göttinger gelehrte Anzeigen," No. 125, 1855; "Chronology of of the Roman Emperors," Gettysburg Quarterly Review, 1872, p. 47; "Chronologie der Römischen Kaiser," Rudelbach's Zeitschrift, Halle, 1872, p. 50; "Probst's Theologische Monatshefte," Allentown, 1872, p. 168, and in the premises,—it would be superfluous to repeat *in extenso* all that has been done in this respect; it will be sufficient to remember, in short, the principal proving arguments. The following Table shows the difference of Petavius's and the author's Roman histories and chronologies. Since the consuls, preceding the introduction of the solar calendar of Julius Cæsar, commenced to rule on different days of the lunar calendar, and since the dates of Roman eclipses depend on the times of the consulates, the days on which the earlier consuls commenced to rule are, in accordance with Livy, specified in all instances. The asterisk (*) joined to the years of the *æra urbis conditæ* denotes the Olympian games celebrated in the same years. The names of the consuls are abbreviated. *T* signifies total eclipse, *P* partial one.

ROMAN KINGS, AND THE RESPECTIVE ECLIPSES.	Reigns.	Petav.	Seyf.	U. C.
Romulus born........................	....	−772	−771	−19
1. ⊙ T. ☋ 14° E., Nov. 19, 0h. 45m. Plut. Romul. 12.				
Foundation of Rome on the parilia..Rom.	I	753	752	+ 0
2. ⊙ ☊ 1° E., May 25, 16h. Cic. Div. ii. 37; Plut. Rom. 12.				
Romulus dies after 37 years, during a solar eclipse...........................	XXXVII	716	715	37
3. ⊙ T. ☊ 2° E., Jun. 5, 21h. 15m. Cic. R. P. i. 16; Livy i. 16; Plut. Rom. 22; Dion. H. ii. 56; Sen. Ep. xviii. 5, 31; Lamp. c. 2.				
Numa Pompilius reigns	I	716	715	37
Tullus Hostilius reigns during 32 years ..	I	671	670	82
4. ⊙ T. ☊ 1° E., Jan. 11, 18h. Livy vii. 28; Comp. Livy i. 31...........	XXVIII	643	642	110
Tarquinius Superbus's 32d year	XXXII	582	581	170*
5. ⊙ T. ☊ 2° E. in Miletus, March 27, 17h. 45m. Pliny H. N. ii. 12, 9.				
ROMAN CONSULS, AND THE RESPECTIVE ECLIPSES.				
Val. Max. & Ver. Tricostus since the Kal. Aug. u.c.300		454	453	300
Trib. mil. Publ. Cornelius since the Idus Decembres.		402	401	351*
6. ⊙ T. in Rome, ☊ 1° 5′ E., July 1st, 17h. 45m. Cic. R. P. i. 16		401	400	350
Coss. Mart. Rutilus and T. Manlius since the Kal. Quintiles..................................		342	341	411*

ROMAN CONSULS, ETC. (*continued.*)	Petav.	Seyf.	U. C.
7. ☉ T. in Rome, ☋ 10° E., Sept. 25, 18h. Livy vii. 28; J. Obseq. c. 22	−341	−340	−412
L. Papirius II. and Poetilius Venno, Kal. Jul.; Livy viii. 19	329	328	423
App. Claudius and L. Volumnius, since the Kal. Jan.	294	293	458*
8.? ☉ ☋ 12° E., March 23, 23h Livy x. 23.			
Liv. Salinator & Æm. Paullus, since the Idus Mart..	218	217	534*
9. ☽ ☋ 3° W in Mysia (25° W.), Mar. 9, 4h. Polyb. v. 58, p. 383.			
Corn. Scipio & Semp. Longus, since the Idus Martiæ	217	216	536
10. ☉ small, in Sardinia, ☋ 5° E., Feb. 11, 2h. 30 m. Livy xxii. i.			
Nero and Salinator, since the Idus Martiæ	206	205	547*
The Olympian games celebrated. Livy xxvii. 35, xxviii 7; Polyb. xi. 5.			
Serv. Scæpio and C. Servilius, since the Idus Martiæ	202	201	550*
11. ☉ T. ☊ 3° W., near Carthage, Oct. 18, 23h. Zonar. Ann. ix. 14.			
Cl. Nero and Serv. Pulex, since the Idus Martiæ....	201	200	551
12. ☉ small, near Cumæ, ☋ 13° E., March 3, 23h. Livy xxx. 38	200	199	
T. Flaminius and Paitus Cato. since the Idus Martiæ	197	196	555
13. ☉ small, in Rome, ☊ 3° W., Aug. 6, 15h. 30m. in —197. Julius Obseq. c. 48.			
14.? ☉ small, ☊ 11° W., July 25th, 21h. 45 m., in —196. Jul. Obseq. c. 48.			
Purpurio and Marcellus; Isthmia æst. celebr. Livy xxxiii. 32	194	193	558
Corn. Scipio and C. Lælius, since the Idus Martiæ..	189	188	563
15. ☉ ☋ 4° E., July 16, 20 h. Livy xxxvii. 4.			
Manlius and M. Fulvius, since the Idus Martiæ	188	187	564
16. ☉ ☊ 3° W., —186, Jan. 10th, 23h. 30m. Livy xxxviii. 36 (2-3 p m.)	187	186	565
Q. Martius and Cn. Servilius, since the Idus Martiæ.	168	167	585
17. ☽ T. ☋ 3° E., in Macedonia. Cicero De R. P. i. 15; Plutarch. Æmil. 17; Valer's M. xi. 1.			
L. Æm. Paullus and C. Licinius, since the Id. Mart.	167	166	586
18. ☽ ☋ P. 5° W., in Macedonia, June 10, 13h. 30m. Livy xliv. 37 (from 2-4 a.m.); Pliny H. N. ii. 12; Quintil. i. 10, 49.			
C. Marius and C. Flavius, since the Kal. Januar....	103	102	649
19. ☉ T ☋ 15° E., Dec 2, 19h. Jul. Obs. 103 (3d h.) Rome.			
C Marius and L. Valerius, since the Kal. Januar...	99	98	653
R. Antonius and A. Posthumius, since the Kal. Jan..	98	97	654
L. Aurelius and L. Manilius, since Kal. Jan. (vi. Id. Dei)	64	63	688
Horatius born, his coss. Suet. v. Hor. p. 52. Horat. Carm. iii. 21, 1; Epod. 13, 8; Epp. i. 20, 27 (See —5).			
L. Jul. Cæsar and C. Marius Fig., since Kal. Jan. ..	63	62	689
M Tullius Cicero & Caj. Antonius, since Oct. 13 in —	63	62	690
20. ☽ T. ☊ 5° 57′ E., Oct. 27, 8h. Cicero De Cons. s. ii. 17.			
D. Silanus and L. Licinius, since Kal. Jan. (Nov.)..	62	61	691*

ROMAN CONSULS, ETC. (*continued.*)	Petav.	Seyf.	U. C.
21. ⊙ Mar. 27, 4h. 15m. ☊ 0° W. Jul. Obseq. c. 123	—61	—60	—692
C. Jul. Cæsar and Marcus Calpurnius	58	57	694*
L. Calpurnius and A. Gabinius	57	56	695
P. Cornelius and Q. Cæcilius Metellus	56	55	696
Cn. Cornelius and L. Marc. Philippus	55	54	697
Cn. Pompeius and M. Licin. Crassus	54	53	698*
L. Domitius and Appius Claudius	53	52	699
Cn. Domitius and Marc. Valerius Mesalla	52	51	700
Cn. Pompeius III. and Q. Cæcilius Metellus, v. Kal. Mart.	51	50	701
Serv. Sulpicius and M. Cl. Marcellus, Kal. Jan. (Dec. 30, —50)	50	49	702*
Luc. Æm. Paullus and C. Cl. Marcellus, Kal. Jan. (Dec. 19, —49)	49	48	703
C. Cl. Marcellus and L. Corn. Lentulus, Kal. Januar. (Dec. 8, —48)	48	47	704
22. ⊙ T. in Rome, ☋ 12° E., Jan. 3, 21h. Lucan's Phars. i. 535; Dio 41, 14; Petron. Sat. c. 122.			
23. ☽ T. in Rome, ☊ 3° W., Jan. 18, 9h. Lucan's Phars. i. 535.			

CONSULS AND EMPERORS.	Emp.	Petav.	Seyf.	U. C.
J. Cæsar Dictator I.	I	48	47	704
J. Cæsar Consul II. and P. Serv. Vatia, Kal. Jan., Nov. 27 in —47	II	48	46	705
J. Cæsar Dict. II., Kal. Jan., Nov. 16, —46	III	47	45	706*
J. Cæsar Dict. III., Kal. Jan., Nov. 5, —45	IV	46	44	707
J. Cæsar Dict. IV., Kal. Jan., Oct. 24, —44	V	45	43	708
J. Cæsar Dict. V., Kal. Jan., Oct. 13, —43 Oct. 13, —43, ann. confusionis begins.	VI	44	42	709
J. Cæsar Dict. VI., since the 1st Julian Jan. Jan. 1st, the crescent visible.	VII	43	41	710*
24. ☽ T. in Asia, ☊ 7° E., Mar. 13, 1h. 45m. Ovid Met. xv. 769.				
25. ⊙ T. in Asia, ☊ 7° W., Mar. 27, 11h. 45m. Serv. ad Geo. i. 467; Ovid Met. xv. 789; Tibull. ii. 5.75; Joseph. A. xiv. 22; Euseb. Chron. p. 197 ad Ol. 184, 3.				
Julius Cæsar dies on Mar. 15... Augustus	I	43	41	710*
Pansa and Hirtius, since the Julian Jan. 1	II	42	40	711
26. ⊙ ☋ 14° E., in Rome, Aug. 10, 16h. 15m. Dio 47, 40.				
Plancus and Lepidus, since Jan. 1st of the Julian year	III	41	39	712
27. ⊙ ☋ 6° E., in Rome, July 30, 18h. 15m Dio 47, 40; p. 529 R.				
L. Antonius Pietas and P. Servil. Vatia	IV	40	38	713
Calvinus II. and Pollio. Olympian games celebrated. Joseph. An. xiv. 14, 4; xv. 10, 1; B. J. i. 9, 13; his coss.	V	39	37	714*
28. ⊙ ☊ 9° W., in Rome, Jan. 13, 21h. 30m. Euseb. Chron. ii. 197, ad Ol. 185, 2.				

CONSULS AND EMPERORS (*continued*).	Emp.	Petav.	Seyf.	u. c.
Censorinus and Calvis. Sabinus	 VI	−38	−36	−715
Pulcher and Flaccus	 VII	37	35	716
Agrippa and Gallus	... VIII	36	34	717
29. ☉ ☊ 7° W.. in Rome, Oct. 31, 22h. Fasti Sic. ad Ol. 185, 4.				
Poplicola and Nerva.....................	 IX	35	33	718*
Cornificius and Pompeius................	 X	34	32	719
Libo and Antonius.......................	 XI	33	31	720
Augustus II. and Tullus	 XII	32	30	721
Ahenobarbus and Sosius..................	... XIII	31	29	722*
Augustus III. and M. Valerius Messalla Corvinus	... XIV	30	28	723
30. ☉ ☋ 10° E., in Rome. Jan. 4. 19h. Fasti Sic. ad Coss. Augustus III. and Corvilius (Corvinus).				
Augustus and Crassus	 XV	29	27	724
Augustus and Apuleius	... XVI	28	26	725
Augustus and Agrippa II.	.. XVII	27	25	726*
Augustus and Agrippa III.	.. XVIII	26	24	727
Augustus and Taurus.....................	... XIX	25	23	728
Augustus and Silanus....................	 XX	24	22	729
Augustus and Flaccus	... XXI	23	21	730*
Augustus and Muræna	...XXII	22	20	731
Marcellus and Aruntius..................	..XXIII	21	19	732
Lollius and Lepidus.....................	..XXIV	20	18	733
Apuleius and Nerva	...XXV	19	17	734*
Saturninus and Vespillo	..XXVI	18	16	735
Marcellus and Lentullus	.XXVII	17	15	736
Furnius and Silanus.....................	XXVIII	16	14	737
Ahenobarbus and Scipio	..XXIX	15	13	738*
Libo and Piso...........................	...XXX	14	12	739
Crassus and Augur	..XXXI	13	11	740
Nero and Varus	.XXXII	12	10	741
Messalla and Appianus	XXXIII	11	9	742*
Tubero and Maximus	XXXIV	10	8	743
Antonius and Africanus	XXXV	9	7	744
Germanicus and Capitolinus	XXXVI	8	6	745
Censorinus and Gallus	XXXVII	7	5	746*
Horatius dies his coss. aged 58 years. (Sueton. v. Hor. (see −63.)				
Nero and Piso...........................	XXXVIII	6	4	747
Balbus and Vetus........................	XXXIX	5	3	748
Augustus and Salla......................	 XL	4	2	749
Sabinus and Rufus	... XLI	3	−1	750*
Lentulus and Messalinus.................	...XLII	2	+0	751
31. ☽ ☊ 0° W. in Jerusalem, Jan. 9, 11h. 30m. Joseph. Ant. xvii. 6, 4.				
Augustus and Silvanus	..XLIII	−1	+1	752
Lentulus and Piso.......................	..XLIV	+0	+2	753
C. Cæsar and L. Aim. Paullus	...XLV	+1	3	754*
Vinicius and Varus......................	..XLVI	2	4	755
Lanio and Servilius	XLVII	3	5	756
Catus and Saturninus....................	XLVIII	4	6	757
L. Valerius Messalla and Cn. Corn. Cinna Magnus...........................	..XLIX	5	7	758*

CONSULS AND EMPERORS (*continued*).	Emp.	Petav.	Seyf.	u. c.
32. ⊙ ☋ 15° E., in Rome, Feb. 5, 23h. Dio lv. 22, p. 390 St., his cons., and the 48th year of Augustus.				
Æm. Lepidus and L. Aurel. Nepos......	L	−6	−8	−759
Silianus and Creticus....................	LI	7	9	760
Camillus and Quinctilianus............	LII	8	10	761
Sabinus and Camerinus................	...LIII	9	11	762*
Dolabella and Silanus.................	LIV	10	12	763
Lepidus and Taurus..................	LV	11	13	764
Cæsar and Capito.....................	LVI	12	14	765
Silius and Plancus....................	...LVII	13	15	766*
Pompeius and Apuleius................	..LVIII	14	16	767
Augustus obit on Aug. 19.....Tiberius	I			
33. ⊙ ☋ 0° E., August 20, 16h, in Asia. Euseb. Chr. Arm. ad Ol. 198, 1; Hieron. Chron. p. 157; Dio lvi. 29, p. 472 St.				
Drusus and Flaccus....................	II	15	17	768
34. ☽ T. ☊ 8° E., near Laybach, Jan. 30, 8h. Tacit. i. 28; Dio lvii. 4. p. 522 St.				
Taurus and Libo......................	III	16	18	769
Rufus and Flaccus....................	IV	17	19	770*
The Olympian games celebrated in the 3d yr. of Tiberius. Ol. 199, 1; Euseb. Chron. Arm. ad Ol. 199, 1; Cramer's Anecd., Paris, p. 15.				
Tiberius and Germanicus...............	V	18	20	771
Silanus and Flaccus...................	VI	19	21	772
Messalla and Cotta....................	VII	20	22	773
Tiberius and Drusus...................	...VIII	21	23	774*
Galba and Agrippa.....................	IX	22	24	775
Pollio and Veter......................	X	23	25	776
Cetheius and Varro....................	XI	24	26	777
Isauricus and Agrippa.................	XII	25	27	778*
Gethulicus and Sabinus................	...XIII	26	28	779
Crassus and Piso......................	...XIV	27	29	780
Silanus and Nerva.....................	XV	28	30	781
R. Geminus and F. Geminus............	...XVI	29	31	782*
Quartinus and Longinus...............	...XVII	30	32	783
Tiberius and Sejanus..................	..XVIII	31	33	784
35. ⊙ T. ☋ 8° E., in Nicæa, Bithynia, Sept. 11, 22h. 30m. Euseb. Chr. i. p. 77, ii. p. 202, ad Ol. 202, 4, and the 19th year of Tiberius; Paul. Diac. Hist. misc. 7 to the 6th hour of the day; Fasti Sic. p. 222 P.				
Ahenobarbus and Vitellius.............	...XIX	32	34	785
Galba and Felix......................	XX	33	35	786*
F. Persicus and Vitellius.............	...XXI	34	36	787
Gallus and Nonianus..................	...XXII	35	37	788
Plautius and Papinius.................	..XXIII	36	38	789
Proculus and Nigrinus................	.(XXIII)	37	39	790*

CONSULS AND EMPERORS (*continued*).	Emp.	Petav.	Seyf.	U. C.
Tiberius ob. March 16th.......Caligula	I			
Julianus and Aprenas..................	II	−38	−40	−791
Caligula II. and Cæsia	III	39	41	792
Caligula III. alone	IV	40	42	793
Caligula IV. and Saturninus	.... (IV)	41	43	794*
Caligula ob. January 24th.... Claudius	I			
Claudius II. and Largus	II	42	44	795
Claudius III. and Vitellius	III	43	45	796
36. ⊙ (great) ☊ 0° E., Rome, July 31, 22h. Dio lx. 26, p. 76.				
Crispinus and Taurus	IV	44	46	797
Vinicius Quartinus and Corvinus........	V	45	47	798*
Coss. suffecti Caj. Val. Asiaticus and M. Jun. Silanus......................	....	[46]		
37. ☽ ☋ 8° W., in Rome. Dec. 21, 16h. 45m. Cassiodor. his coss. and to the 5th year of Claudius. Seneca Q. N. ii. 26, his coss.				
Claudius IV. and L. Vit. Nepos III.	VI	47	48	799
38. ☽ ☊ 7° W., June 14, 6h., in Greece. Aur. Victor: Claud. iv. 22, to the 6th year of Claudius, and to u.c. 800, in which Phœnix appeared. Dio lx. 29, his coss.				
Vitellius and Vipsanius	 VII	48	49	800
Gallus and Verannius	... VIII	49	50	801
Vetus and Nervilianus	IX	50	51	802*
Claudius V. and Orfitus.................	X	51	52	803
Faustus and Titianus...................	XI	52	53	804
Torquatus and Antoninus...............	 XII	53	54	805
Marcellus and Aviola	... XIII	54	55	806*
Claudius ob. Oct. 13th ....Nero	I			
Nero and Vetus	II	55	56	807
Saturninus and Scipio	III	56	57	808
Nero II. and Piso	IV	57	58	809
Nero III. and Messalla..................	V	58	59	810*
Vipstanus and Fontejus Capito..........	VI	59	60	811
39 ⊙ T. ☊ 1° W., Campania, Oct. 12, 19h.: Armenia 10h. 30m. Pliny H. N ii. 70 (72) his coss.; Tacit. A. xiv. 12; Dio lxi. 16, p. 36 St.; Euseb. Chron. ad Ol. 209, 2; Hieron. ad Ol. 209. 3.				
Nero IV. and Lentulus..................	... VII	60	61	812
Paitus and Turbilianus	... VIII	61	62	813
Celsus and Gallus	IX	62	63	814*
Regulus and Rufus	X	63	64	815
Bassus and Frugi......................	XI	64	65	816
Silianus and Atticus	 XII	65	66	817
Telesinus and Paulinus. The Olympian games postponed by Nero...........	... XIII	66	67	818*
40. ⊙ ☊ 3° W., Rome, May 31, 3h. Philost. V.A. 4. 43, p. 183 Ol., his coss.				
Capito and Rufus	... XIV	67	68	819

CONSULS AND EMPERORS (*continued*).	Emp.	Petav.	Seyf.	U. C.
41. ☽ T. ☊ 2° E., Rome, May 5, 12h.; and				
42. ☽ T. ☊ 2° W., Rome, Oct. 28, 18h. 30m. Dio xlv. 8, p. 180 St.; xlv. 11, p. 184, ad Coss. Galba & Crispinus(?); Zonar. xi. 16, p. 574.				
Trachalus and Italicus	.. [XIV]	68	69	820
Nero ob. June 9th .... Galba	 I			
Galba and Rufinus	...... [I]	69	70	821
Galba ob. January 15th	 I			
Otho ob. April 16th .... Vitellius	 I			
Vitellius ob. Dec. 20..July 1, Vespasian	 I			
Vespasian II. and Titus	 II	70	71	822*
43. ☽ P. ☋ 8° E., Rome, March 4, 8h. Pliny H. N. ii. 13 (10) his coss.				
44. ☉ P. ☊ 8° W., Rome, Mar. 19, 22h. Pliny l. l. his coss.				
Vespasian III. and Nerva	 III	71	72	823
Vepasian IV. and Titus II.	 IV	72	73	824
Domitian and Messalinus	 V	73	74	825
Vespasian V. and Titus III.	 VI	74	75	826*
Vespasian VI. and Titus IV.	 VII	75	76	827
Vespasian VII. and Titus V.	... VIII	76	77	828
Vespasian VIII. and Titus VI.	 IX	77	78	829
Coss. suff. Verus and Priscus	..... [X]	[78]		
Vespasian IX. and Titus VII.	 X	79	79	830*
Vespasian ob. June 23d .... Titus	 I			
Titus VIII. and Domitian VII.	 II	80	80	831
Nonius and Verucossus	 III	81	81	832
Domitian XVII. and Clemens. Olympian games .... Domitian	... XIV	95	95	846*

Subsequent to Titus, the emperors and consuls reigned, according to Petavius, in the same years to which the author refers them. This is, apart from other arguments, demonstrated by the celebration of the Olympian games in the 14th year of Domitian, and by all the later ones; for the Olympian altars (p. 405) mathematically determine that the Olympian games were celebrated in such years *before Christ*, which being divided by 4 give the remainder 1; but *after Christ*, in such years, which being divided by 4 leave the remainder 3; and of this character is A.D. 95, etc.

Chronology of the Roman Eclipses down to Titus.

We proceed now to the following questions: First, to what years of the Christian and ante-Christian eras do the Roman eclipses really belong? Secondly, in what localities and in what hours of the day were they observed by ancient eye-witnesses? Further, of what magnitudes were they according to classical reports? Finally, respecting the presumed corrections of the secular accelerations of the moon, her Nodes and Apsides (p. 429), are they approximately correct? In answering these questions, it is an indispensable duty to cite the respective passages of the classics, as has been done more explicitly in Seebode, Jahn & Klotz's Archiv f. Philol., 1848, p. 586. We follow the chronological succession of the Roman Eclipses.

1. Plutarch (Rom. c. 12) reports that about six months prior to Romulus's birth a total eclipse of the sun (ὁ ἥλιος ἐξέλιπε παντελῶς) happened on the 19th day of November (Χοιὰκ τρίτῃ καὶ εἰκάδι), during the 3rd hour (τρίτης ὥρας), Ol. 2, 1. The same total eclipse (τὸν ἥλιον ἐκλιπεῖν ὅλον) is mentioned by Dionysius Halicar. (ii. 56). Since Rome was founded in –752 on the Parilia, as we have seen (p. 407), whilst Romulus was "19 years of age," the eclipse under consideration belongs to Nov. 19th in –771. The Olympiads being in later times counted from –775, the date Ol. 2, 1, likewise refers to –771. Moreover, about that time only one eclipse was possible on Nov. 19, viz. that in –771, 45m. past noon. According to the present theory of the moon, as Pingré's computation states, the conjunction took place in —771, Nov. 19th, 0h. 45m. P. T. The ☋ lay 14° E. of the sun, and the obscuration of the sun was invisible south of the 27° N. Lat. It is to be remembered that Plutarch relies on the report of the famous astronomer Tarutius, and that the astronomers commenced the day with noon; therefore the said 3rd hour commenced at 3 o'clock p.m. According to our correction, the longitude of the ☋ for –771 was shorter by about 7° 17′, and hence the same eclipse was total, or nearly total, in Latium. The correction of the longitude of the moon for the same epoch was (p. 429–30) about –2° 30′, i.e. 4h. 43m. Consequently, the ancient reports agree sufficiently with the Table on p. 429–30. Petavius referred to the eclipse in –771, June 24th, 10h. 15m. a.m., ☊ 13° W.; but June 24th never corresponded with Chœak (November), and the obscuration of the sun reached only the 60° of northern latitude, and therefore it was invisible near Rome.

2. Plutarch (Rom. 12) reports that Romulus, being 18 years old, founded Rome in Ol. 6, 3, on the 9th day of Pharmuthi, between the 2d and 3d hours of the day, and that during the same hour of the same day a partial eclipse of the sun took place (σύνοδος ἐκλειπτική), observed also in Teos, Asia Minor. Since Plutarch, as we have seen, counts the Olympiads from -775, the foundation of Rome on the Parilia belongs to -752, and Pharmuthi corresponded with March and April. Solinus (Pol. i. 18) says: "Romulus fundamenta murorum jecit, xviii annus natus, xi. Kal. Majas (Apr. 21), hora post secundam ante tertiam plenam"; and he specifies the planetary configuration, previous to this event, which refers again the foundation of Rome to -752, and to the day of the Roman Parilia. Even Cicero (Divin. ii. 47) certifies to the same eclipse. Since about that time no solar eclipse about the vernal equinox, as Pingré's computations evidence, was possible except that in -752, May 25, 16h., the beginning of the æra urbis conditæ is incontrovertibly fixed. This eclipse took place nearly 4 hours later (p. 429), which corresponds with the ancient reports, according to which the same eclipse was observed nearly 2h. 30m. after sunrise in Rome. Moreover, the longitude of ☊ 8° E. was shorter by 7° 11′, and hence a small obscuration of the sun was visible both in Rome and Teos. Petavius had reference to the eclipse in -753, July 5th, 5h.; but Rome was founded on the Parilia and not in July, and in -753, July 5th, Romulus was 17 and not 18 years old. Moreover, July 5th belonged to Ol. 6, 4, and not to Ol. 6, 3. Besides, July 5th corresponded by no means with Pharmuthi (March and April). In consequence of this blunder Petavius antedated by one year all events of Roman history down to Julius Cæsar, and hence his chronology of the Roman eclipses is in general wrong.

3. Livy (i. 16), in accordance with the Annales Maximi and many other authorities, reports that Romulus, having reigned 37 years, disappeared during a total eclipse of the sun. Cicero (De rep. i. 16) writes: "Defectio solis, quæ Nonis Quinctilibus fuit regnante Romulo, quibus Romulum tenebris natura ad humanum exitum abripuit" Plutarch (Rom. c. 27) represents this eclipse to have been a total one (τοῦ ἡλίου τὸ φῶς ἐκλιπεῖν—νύκτα κατασχεῖν). The same we read in Florus (i. 1), Seneca (Ep. xviii. 5, 31), Dionysius Hal. (ii. 56), Lampridius Com. (Ant. c. 2); and

Livy shows this eclipse to have taken place past noon in Rome. Since the Romans obtained their lunar calendar first by Numa, it is evident that the "Nonæ Quinctiles" referred to the ancient solar year of the Romans, and hence the Nonæ Quinctiles signified, as is well known, June 5th. About that time only one solar eclipse coincided with June 5th, viz. that in −715, June 5th, 21h. 15m. Moreover, from the foundation of Rome in −752 down to −715, as history reports, exactly 37 years, 1 month, and some days elapsed. That eclipse, however, preceded noon in Rome, but, according to our Table (p. 429–30), the conjunction took place 4h. 30m. later, which agrees with Livy. Further, the place of the ☊ was then, according to all Lunar Tables, 2° E. of the sun, and hence Pingré found that, during this eclipse, the shadow of the moon described the following curve: −14°, +10°, −9°. Consequently this eclipse was invisible in Rome. According to our Table (p. 429–30) the longitude of the ☊, however, was shorter by nearly 7° 3′: it lay, in accordance with history, 4° W. of the sun. Petavius referred to the eclipse in −714, May 26, 5h. 30m.: but this ecliptic new moon happened not on the "Nonæ Quinctiles," viz. June 5th; it coincided with sunset, and not with noon: it was, moreover, a small one ☊ 6° W. (the curve of the moon's shadow being 25°, 34°, 40°); and from Petavius's date of the foundation of Rome in −753 to this eclipse, not 37 years only, as history says, but 39 elapsed.

4. Livy (vii. 28) reports that, in the course of the consulate of Rutilus and Torquatus, u.c. 409, an eclipse about sunrise and a shower of stones occurred, and that both *prodigia* had likewise happened in the last years of Tullus Hostilius, who died in −638. Indeed, a similar eclipse occurred in −642, Jan. 11, 18h., ☊ 1° E. (−6° 28′); but Livy (i. 31) mentions only the shower of stones, and not the eclipse; therefore the latter is dubious.

5. Pliny (ii. 12, 9) reports that, u.c. 170, and Ol. 48, 4, a total eclipse of the sun, predicted by Thales, occurred in Miletus. Solinus (Pol. c. 15, 16) refers the same eclipse to Ol. 49 [1], and to the 604th year after the destruction of Troy; consequently to —581 (1184 − 603 = 581). Since Rome was founded in −752, the 1st Julian year p.u.c. commenced in −751, and hence u.c. 170 commenced likewise in −581, to which Pliny refers the Thalesian eclipse. Pliny, moreover, counting the Olympiads from −775, confirms the date; because Ol. 48, 4, began, according to the Romans, with January in –581. This eclipse, moreover, was a total one in Miletus, and it coincided with sunrise. For Themistius (Or. xxvi. p. 317, Dind.) says: *προεφήτευσαν—Μιλησίοις, ὅτι νὺξ ἔσοιτο ἐν ἡμέρᾳ καὶ δύσετο ἅμα ὁ ἥλιος καὶ ὑποθεύσεται αὐτὸν ἡ σελήνη, ὥστε ἀποτέμνεσθαι τὴν αὐγὴν καὶ τὰς ἀκτῖνας.* Herodotus (i. 74 & 103) combines the eclipses in –581 and –621, as we shall see hereafter, and refers the latter to noon, the former to sunrise (*εἶδον νύκτα ἀντὶ ἡμέρης γινομένην*). Eusebius (Chr. ii. p. 161) likewise refers this Thalesian eclipse to Ol. 48, 3, i.e. –581. About that time only one eclipse coincided with sunrise in Miletus, viz. that in –581, Mar. 27, 17h. 45m.; for, according to our Table (p. 429–30), the obscuration of the sun happened 4h. 9m. later. The longitude of ☊ being 2° E. according to the present theory, the curve of the moon's shadow was –22°, –4°, +13°; but, according to our Table (p. 429–30), the place of the ☊ was about 4° W. Hence the eclipse was total near Miletus.

6. Cicero (De rep. i. 16)—"Anno CCCL. fere post Romam conditam," says he, "Nonis Junîs soli luna obstitit et nox. Atque hac in re tanta inest ratio atque sollertia, ut ex hac die, quam apud Ennium et in Maximis Annalibus consignatam videmus, superiores solis defectiones reputatæ sint, usque ad illam quæ Nonis Quinctilibus fuit regnante Romulo" (no. 3). These words are uttered by Scipio, who, as Ideler's Chronology states, referred, according to Dionysius, the foundation of Rome to –750. Hence u.c. CCCL is the year –400, and about that time only one eclipse was possible in June or July, viz. that in –400, July 1st, 17h. 45m., ☊ 1° 5′ E., which was invisible in Rome (p. 426). According to our Table (p. 429–30), however, the place of the ☊ was 4° 21′ W., and the conjunction happened 3h. 31m. later. (See the specialities of this eclipse, computed by means of Carlini's and Damoiseau's Tables, in the premises, p. 427). From –407 to –401 and –399 to –398 no similar eclipse was possible.

7. Livy (vii. 28) and Jul. Obsequens (c. 22) report that u c. 490, during Rutilus and Manlius's consulate, extending from the Kal. Quinctiles (July) in –341 to the same in –340, "nox interdiu visa intendi," which words signify a total or great eclipse of the sun at sunrise. Since the lunar months of the Romans, as is well known, sometimes preceded our solar ones by 30, even

by 60 days, and vice versa, it was natural that July corresponded sometimes with our September. About that time only one great eclipse happened near sunrise in Rome, viz. that in _340, Sept. 25th, 18h., ☋ 10° E. This eclipse, however, preceded sunrise in Rome, and, the present theory of the moon being true, it would have been a small one; but, according to our Table (p. 429–30), the obscuration happened 3 hours later, and the longitude of the ☋ was 4° shorter. According to Pingré, the shadow of the moon extended only to 48°, 32°, 12° N. Lat.; hence this eclipse was, according to the present theory, invisible in Rome.

8. Livy (x. 23) narrates that u.c. 457, coss. Claud. Cæcus and Vol. Flamma, "prodigia fuerunt — supplicationes in biduum." Solar eclipses belonging to Roman prodigia, Calvisius referred to the eclipse in _295, Nov. 6, 22h. 30m., ☊., 3° W.; but it was not yet known that the consuls of this time ruled one year later than Petavius had stated, and that the Roman year commenced several months later than the Julian one (Comp. no. 7). Hence the eclipse reported by Livy was that in _293, March 23d, 23h. (+3h. 13m.), ☋ 12° E., or rather 7° E. Without this correction the shadow of the moon would seem to have reached 0°, 29°, 58° only.

9. Polybius (v. 78, p. 383 Sh.) reports that coss. Liv. Salinator and Æmil. Paullus, u.c. 535, a lunar eclipse (ἐκλείψεως σελήνης) was observed in Mysia (29° E.) Petavius alluded to the eclipse in _218, March 19th, 14h., because he had antedated the consuls by one year. Polybius's eclipse is that in _217, March 9, 4h., ☋ 3° W. According to our Table (p. 429–30), the said eclipse happened three hours later, and without this correction the eclipse would have preceded sunset in Mysia.

10. Livy (xxii. 1) and Obsequens (c. 31) bear witness that u.c. 536, i.e. _216, a small eclipse of the sun (solis orbem minui visum) happened in Sardinia. This was the eclipse in _216, Feb. 11, 2h. 30m., ☋ 5° E. According to the usual theory of the moon's Nodes, the obscuration of the sun in Sardinia amounted to eight inches, which clearly contradicts Livy; consequently the longitude of the ☋ must have been shorter by about 4° 34′ (p. 430). Since, moreover, in _217, no solar eclipse was possible, this eclipse again demonstrates that Petavius has antedated the consuls down to Cæsar by one year.

11. Zonaras (An. ix. 14, p. 441, ὁ ἥλιος σύμπας ἐξέλιπεν) narrates that, during the battle at Zama, near Carthage (35° 30′ N. Lat.) a total eclipse of the sun happened. Petavius had reference to the eclipse in – 201, Oct. 18, 23h. 30m. ☊ 2° W.; which eclipse, however, was very small in Northern Africa, because the curve described by the moon's shadow was 37°. 2°, – 18°. The longitude of the ☊ being rather 6° 30′ W. of the sun (p. 430), the obscuration of the latter must have been total, or nearly total, near Carthage. Moreover, Zonaras erroneously referred the same eclipse to the battle at Zama, for Livy puts the latter in – 200, coss. Cl. Nero and Serv Pulex. To the same consuls Livy (xxx. 2) refers a phenomenon described as follows—"arcus solem tenui linea amplexus est, circulum deinde ipsum major solis orbis extrinsicus inclusit"; which words Petavius took for a description of an annular eclipse of the sun observed in – 202, May 6, 1h. 45m. p.m., ☋ 7° E.; magnitude of the obscuration of the sun 7 inches on the northern part of the sun's disc. This eclipse, however, contradicts the series of the consuls, and the description rather points us, as Struyk in Ruperti's Maazin (i. p. 353) maintained, to a ring, or iris, encompassing the sun's disc.

12. Livy (xxx. 38) and Obsequens (c. 45) report that u.c. 551, coss. Cl. Nero and Serv. Pulex, a small eclipse of the sun was noticed at Cumæ, near Rome (Cumis solis orbis minui visus). The year u.c. 551, extending from the Parilia in – 200 to the same in – 199, and the consuls reigning since the Idus Martiæ, the said eclipse was that in – 199, March 3, 22h., ☋ 13° E. This eclipse, however, was hardly visible at Cumæ, because the shadow of the moon touched only 12°, 32°, 67°; but, according to our Table (p. 429–30) the longitude of the ☋ was shorter by 4° 31′.

13 & 14. Julius Obsequens (c 48) refers another small eclipse (solis orbis minui visus) to u.c. 555, and to the consuls Flaminius and Paitus, who ruled since the Idus Martiæ in – 196. The only eclipse of this year on July 25th, 21h. 45m., ☊ 11° W., was invisible in Italy. The eclipse in – 197, Aug. 6, 15h. 30m., happened, according to Calvisius, one hour prior to sunrise, but, according to our Table (p. 430), two hours after sunrise. The ☊ lay 3° W., and the curve described by the central shadow of the moon was 34°, 34°, – 5°; but, according to our Table (p. 430), the ☊ lay 7° 30′ west, and hence this eclipse was indeed a small one in Rome.

This eclipse is not mentioned in the original work of Obsequens. but in its later additions, and hence it may be offered in excuse that the late interpolator confounded the consuls Lentulus and Tappulus with Flaminius and Paitus.

15. Livy (xxxvii. 4) certifies that coss. Corn. Scipio and C. Lælius, who ruled since the Idus Martiæ in — 188, u.c. 564, about the Idus Quinctiles (June 13th), and about the time of the Ludi Apollinares (July 5th), and, especially, about noon (interdiu), a partial solar eclipse occurred in Rome (cœlo sereno interdiu obscurata lux est, cum luna sub orbem solis subisset). U.c. 564 being the year — 187, and the said consuls ruling in the same and the following years, we obtain the eclipse in — 187, July 16, 20h., ☋ 4° E., whilst the curve of the central shadow of the moon was 24°, 46°, 19°. According to our Table (p. 429–30), the longitude of the ☋ 4° E. must be shortened by about 4° 27′, and the conjunction happened 2h. 54m. later. In the preceding year, — 188, no solar eclipse was possible; for which reason our chronology of the consuls is confirmed, and that of Petavius refuted.

16. Livy (xxxviii. 36) reports that u.c. 565, i.e. — 186, a short time prior to the coss. Salinator and Messalla of the same year, a great eclipse of the sun occurred between the 3d and 4th hours of the day (luce inter horam tertiam ferme et quartam tenebræ obortæ fuerant). Since the aforesaid consuls ruled from the Idus Martiæ in — 186 to the same in — 185, our eclipse, observed prior to the Idus Martiæ in — 186, was that in — 186, Jan. 20, 23h. 30m., ☊ 3° W.; curve, Southern Egypt, Arabia, Western India, centr. 17°. Accordingly this eclipse would have been very small, or invisible, in Rome, and the obscuration of the sun would not have taken place between the 3d and 4th hours past noon (interdiu). Our Table (p. 429–30), however, brings the ☊ nearly to 7° 30′ west of the sun, and the conjunction to about 2h. 55m. past noon. In — 187 no eclipse was possible in January, February, March, April, and May. Petavius, on the contrary, alluded to the eclipse in — 187, Jul. 16, 20h.; but this is irreconcilable with the Annales Maximi referring to an eclipse in January or Februarv, and not to an eclipse 4h. 40m. after sunrise. Besides, this eclipse again confirms the result that the consuls, down to J. Cæsar, ruled one year later than formerly was believed

17. Cicero (De rep. i. 15) bears witness that a total eclipse of the moon (serena nocte subito candens et plena luna defecit) was seen near Apollonia (20° 10′ E.) during the year preceding the consulate of Æm. Paullus and Cæpio, which office commenced in — 166, Idus Mart., consequently in — 167. Plutarch (Æm. Paul. c. 17) confirms the statement that this eclipse was a total one (ἡ σελήνη ἐμελαίνετο καὶ τοῦ φωτὸς ἀπολιπόντος αὐγὴν χρόας ἀμείψασα παντοδαπὰς ἠφανίσθη). This is the eclipse in — 167, June 21st, 7h.45m., ☋ 3° E., which, as Cicero says, Gallus, "anno fere antequam Consul est declaratus, haud dubitavit postridie palam in castris docere, nullum esse prodigium." Gallus being consul in — 164–5, he was designatus in — 166, and, since that eclipse happened one year prior to Gallus's designation, the former indeed belonged to June in — 167. This eclipse has erroneously been confounded by Petavius with the following.

18. Livy (xliv. 37) says: "Gallus pronunciavit, nocte proxima — ab hora secunda ad quartam horam noctis lunam defecturam esse. — Nocte, quam pridie Nonas Septembres insecuta est dies, edita hora luna cum defecisset." Pliny (H. N. ii. 12) writes: "Gallus—tum Tribunus militum — pridie quam Persus superatus a Paulo est, in concionem ab imperatore productus—ad predicandam eclipsin." The same we read in Quinctil. Ins. or. i. 10, 47: Frontin. Stra. i. 12, 8; Justin. H xxxiii. 1.; Plutarch Æm. c. 17. Since the battle near Pydna (20° 10′ E.) belongs to the consulate of Æm. Paullus and Lic. Crassus (— 166), and to the first days of the lunar September of the Romans, the partial eclipse was that in — 166, Jun. 10. 13h. 30m., ☋ 5° W. The obscuration of the moon amounted, according to the present theory of the moon, to 11¾ inches, which disagrees with Livy, who reports that this eclipse lasted only two hours. Total eclipses of the moon lasting three hours, and never only two, it is apparent that the longitude of the ☋ must have been shorter, namely, by about 4° 24′, as our Table (p. 429–30) shows. Moreover, *nox*, in its specific sense, designated the time from midnight to morning, whilst *vesper* lasted from sunset to midnight. Hence *mane* comprised the hours from sunrise to noon: *dies* specifically extended, as we have seen, from noon to sunset; accordingly *vespera* was the time from sunset to midnight; wherefore Venus, being visible after sunset, was called Vesper. Hesperus. Now, Livy narrates that the middle of our eclipse was 3 o'clock a.m. local time, whilst the usual Tables refer the middle of the same eclipse to about 2h. 10m. a.m., Pydna time. This result confirms our Table (p. 429–30). Petavius erroneously referred both eclipses (Nos. 17 & 18) to —167, June 21st, 7h. 45m.

19. J. Obsequens (c. 103) reports that u.c. 649, coss. C. Marius and C. Flavius ruling since the Kal. Jan., "hora diei tertia solis defectus lucem obscuravit." This is the great eclipse in —102, Dec. 2d, 19h., ☋ 15° E.; for on that day the sun rose in Rome about 7h. 30m. a.m. (local time), and hence the third hour of the day in Rome extended from 9h. 0m. to 9h. 45m. a.m. The middle of the said eclipse coincided in Rome with 7h. 42m. a.m., consequently nearly two hours too early. But, according to our Table (p. 429–30), the conjunction happened 2h. 40m. later. Moreover, the moon's shadow touched, according to Pingré, 41°, 22°, 35° only, and hence this eclipse could not *obscurare lucem* in Rome. Our Table (p. 429–30), on the contrary, shortens the longitude of the ☋ by 4° 6′, and makes the eclipse greater.

20. Cicero (De cons. suo, ii. 17) testifies that, in the course of his consulate, and about the Latinæ, held in January of the lunar year, which at that time preceded the Julian January (as we shall see below, Nos. 22 & 23) by some 60 days, and whilst the mountains of Albano were already "covered with snow," a total eclipse of the moon (luna stellanti nocte peremta est) occurred in Rome. The beginning of Cicero's consulate in —62, is, apart from all other evidence, fixed by the Ara Albani (p. 407), the nativity of Augustus; for this emperor was born whilst Cicero delivered the fourth Catilinaria in January, and the said planetary configuration refers to —62, Dec. 23. Moreover, Josephus (An. xiv. 4, 2; B. J. v. 9, 4) reports that, during Cicero's consulate (Ol. 179, 1), Pompeius captured the Jewish temple on the 10th day of Thishri (Hyperberetæus). i.e. Sept. 11 (p. 414), being a Saturday (*Κρόνου ἡμέρα*, Dio 37, 15), and this day was only in —62 a Saturday. Hence Cicero's eclipse was that in —62, Oct. 27th, 7h. 30m., ☊ 5° 37′ E. (—4°). Ideler points us to the eclipse on May 3d, 3h. 30m. a.m., but during May no snow exists in Italy near Rome.

21. Jul. Obsequens (c. 123) reports that, coss. Afranius and Cæcilius, u.c. 693, an eclipse of the sun happened one hour prior to sunset (die toto ante sereno circa horam undecimam nox se intendit, deinde restitus fulgor). The said consuls ruled in —58 since the Kal. Jan., and u.c. 693 commenced about the same time; but the eclipse in —58, July 31, 9h. 15m., ☋ 14° E., was invisible in Europe, because it commenced after sunset. The same is the case with the eclipse in —58, March 5, 7h. 30m. ☊ 16° W. One year earlier the ecliptic new moon happened on March 16th, 4h. 45m., ☊ 8° W., which likewise followed sunset; wherefore Petavius transferred this eclipse to Spain, and yet it was there also invisible. The only eclipse coinciding with sunset was, at that time, that in —60, March 27th, 4h. 15m. P. T., ☊ 0° W.; curve, —15°, 3°, 24°. Since the ☊, however, lay rather nearly 4° W. of the sun, the obscuration of the latter must have been nearly total in Rome, where the sun set about 6h. 4m. (local time), in Spain 20m. later. During this eclipse, as Pingré's Cometography states, Posidonius discovered a comet, probably near the sun, which would have been impossible without a great obscuration of the sun in Rome. The correction of the secular acceleration of the moon, amounting for —60 to about + 2h. 34m., the retardation of the apsides is to be taken into account. Moreover, since Obsequens lived 400 years A.C., and since at that time the true series of the consuls was already corrupted, as the chronographer of A.D 354 bears witness, it is not to be wondered at that Obsequens referred this eclipse to the consuls Afranius and Cæcilius instead of Silanus and Licinius.

22 & 23. Lucan (i. 535, "Titan involvit orbem tenebris—Phœbe expalluit umbra"), Petronius (Sat. cxxii. 44, "Titan vultus caligine texit"), and Dio (xli. 1, 14, p. 692 St., "ὁ ἥλιος σύμπας ἐξέλιπε"), bear witness that whilst J. Cæsar, having crossed the Rubicon, marched against Rome, two total eclipses were noted within fifteen days, coss. Marcellus and Lentullus, u.c. 704, i.e. —47. The season when these eclipses took place is fixed by Lucan, who certifies that on that day "the Rubicon was covered with ice," and that Cæsar crossed it three weeks after the inauguration of the consuls, Kal. Jan., which at that time coincided with Dec. 8. Cæsar himself (Bell. C. i. 13) says that he, having passed over the Rubicon, took first of all Corfinium on viii. Kal. Mart., i.e. on the 28th of January. The said solar eclipse took place on Jan. 3d, 21h. 30m., ☋ 12° E., curve touching 30°, 22°, 48°; consequently the obscuration of the sun was, in Italy, a very small one. But, according to our Table (p. 429–30), the longitude of the ☋ was 3° 53′ shorter, and the conjunction happened 2h. 30m. later, to the effect that a total, or nearly total, obscuration of the sun took place at that time near Rome. The total lunar eclipse took place on Jan. 18th, 9h. 30m., ☊ 0° W. Since the phenomenon of two eclipses within fifteen days recurs only after long intervals, the first year of Cæsar's reign is fixed with mathematical certainty. Petavius arbitrarily referred Cæsar's first year to —50, but failed to produce two eclipses in January of —50.

24, 25. Ovid (Met. xv. 789) reports that about the day of Cæsar's assassination (Mar. 15) a total eclipse of the moon had taken place (sparsi lunares sanguine currus); and Servius (ad Virgil. Georg. i. 467) says, "Constat occiso Cæsare solis fuisse defectum ab hora sexta usque ad noctem." The sixth hour means, according to the Julian day, sunrise, and the obscuration of the sun from sunrise to sunset involves the opinion that on the occasion of solar eclipses our globe is successively twelve hours under the shadow of the moon. Virgil (Geor. i. 467) mentions only a solar eclipse about the time of Cæsar's death—"sol caput ferrugine texit"; and the same we read in Ovid (Met. xv. 789)—"Lucifer ferrugine textus erat"; and Tibullus (ii. 5, 75)—"solem defectum lumine vidit." Euseb. Chr. ii. 197, refers the same eclipse to Ol. 184, 3, consequently to the same year —41, because he commenced the Olympian years with the preceding local newyears day. Both eclipses, it is true, were invisible in Rome; but the said authors intended only to commemorate the singular phenomenon, that, about the time of Cæsar's assassination, two eclipses occurred, and that the Roman astronomers had, for a long time prior thereto (p. 445), been able to determine in advance the times of eclipses. The eclipses referred to are the following: ☽ —41, March 13th, 1h. 45m. p.m (P. T.), ☊ 7° E., obscuration 8,5 inches. ☉ —41, March 27th, 11h. 45m. p.m., ☊ 7° W. The former being partial, was total, according to our Table (p. 429–30), because the ☊ lay only about 3° 10′ E. of the sun, which agrees with the ancient reports. Since in the preceding year —42 two eclipses within fifteen days was impossible, these eclipses put it beyond question that Cæsar ruled 6 yrs. 3 mos., and not, as Petavius and his adherents believed, 5 yrs. 3 mos.; that, moreover, Cæsar died in —41, and not, as stated in all our Chronological Tables, in —43. This result, *from which the whole of the Greek history depends*, is historically and astronomically confirmed by the following eighteen irrefutable arguments:

The Fasti Capitolini and other authorities attest that Cæsar was six times dictator, but, according to the present chronology, five dictaturæ only came out, and this contradiction our chronologers could not obviate by the hypothesis that the Romans omitted to mention Cæsar's first dictatorship. Even Josephus, Plutarch, Cassiodor, Eusebius, and others, assign to Cæsar a reign of six years and three months, and not of five years and three months.

Further, supposing Cæsar to have governed only five years and three months, then we have to accept the absurdity that during Cæsar's last year two annual magistri equitum existed simultaneously, namely, Antonius and Lepidus. (See Fischer's "Römische Zeittafeln.")

Furthermore, Josephus (Ant. xiv. 4, 2) reports that Pompeius captured Jerusalem, in the course of Cicero's consulate, on Sept. 11th, a Saturday (Dio 37, 15), consequently, as has been shown, in —62. On the same day of the week, during the consulate of Agrippa and Gallus, Herod conquered Jerusalem, but "27 years later." (Joseph. B. J. v. 9, 4; Ant. xiv. 6, 4), i.e. —35. According to Petavius, however, the interval amounts to 26 years only, because he had shortened the ruling-time of Cæsar by one year.

Moreover, the battle at Pharsalus was given, coss. Cæsar II. and Vatia Isauricus (—47), v. Idus Sept. (June 28th) in —46 (B. C. iii. 85), and, two months after, Pompeius died pridie Kal. Oct., i.e. Aug. 18 in —46. From this day to Cæsar's assassination on March 15th, says Plutarch (Cæs. § 267), four years and some months elapsed. Consequently Cæsar died in —41, and not in —43. The nativity of Cæsarion (p. 407) mathematically confirms that Pompeius died in —46, and Cæsar took Alexandria in December —46.

Add to this that Augustus, being born in January, —61, as we have seen (p. 407), testifies himself to have been 19 Roman years old (Mon. Anc. 1, "annos undeviginti natus") subsequent to Cæsar's death. The latter, accordingly, belongs to —41, and not to —43. The same results from the ages of Cæsar, Varro, Virgil, Horace (p. 432, 434), Cleopatra, and other notables of that period, who would otherwise have been made to live one year less than history reports.

To these the following astronomical certainties may be appended. Macrobius (Sat. i. 14) reports that the first day of the Julian Calendar commenced, consistently with the preceding Roman months, with a new moon, the same day on which the crescent appeared in Rome, and this was the case only in —41, Jan. 1st. Even the Julian coins, struck at the same time, and for the purpose of perpetuating the introduction of the tropic year, represent the crescent as visible on the first day of the first solar January of the Romans, as will be seen in Eckhel's "Doctrina Numorum." According to Petavius, who referred the introduction of the Julian year to —41, the crescent appeared 22 days prior to the first day of January.

The last lunar year, the so-called *annus confusionis* of the Romans, contained, as the ancients report, and as every historian knows, 445 days; in other words, fifteen lunar months; wherefore that lunar year must have commenced on Oct. 13th, being the 445th day prior to the 1st day of January of the first Julian year. The Romans being in the habit of beginning their lunar months and years with the appearance of the crescent, the *annus confusionis* must have begun in —43, Oct. 13, because on that day only the crescent became visible, 445 days prior to the beginning of the first Julian year. According to Petavius, who referred the beginning of the *annus confusionis* to Oct. 13 in —45, the Romans had been in the habit of commencing their lunar months 22 days previous to the new moons. Is not this nonsense?

Many ancient authors (Plutarch, Cæs. 63; Sueton, Cæs. 81; Dio, 44, 17; Obsequens, c. 127) recount that in the night preceding Cæsar's assassination i.e. on March 14th, Calpurnia, Cæsar's wife was awakened by the light of the full moon (lunæ splendore, καταλαμπούσης τῆς σελήνης). The latter happened, as we have seen (p. 448), on March 13th in —41; consequently the still full-orbed moon (σελήνη, p. 414) rose in Rome, on the 14th day of March, about 8 o'clock p.m., and so it could, about midnight of the same day, awaken Calpurnia. In —43, on the contrary, to which Petavius refers Cæsar's assassination, the moon rose about daybreak, and, being crescent-shaped, could not awaken anybody "at midnight" on March 14th.

The fact that Cæsar died in —41, and not in —43, is, finally, confirmed by the Olympian games, celebrated, as Cicero testifies in several places (Epis. ad Att. 15, 5 & 24; 16, 7), three months after Cæsar's decease: for the planetary configuration of —777 (p. 404) demonstrates that the Olympian games were celebrated in all years before Christ which, being divided by 4, give the remainder 1, and of this character is the year —41.

Further, Livy (27, 35; 18, 7) and Polybius (11, 5) narrate that during the consulate of Nero and Salinator, i.e., as we have seen (p. 432), in —205, u.c. 547, the Olympian games were celebrated. Petavius, on the contrary, refers the same consuls to —206, and Cæsar's death to —43, to the effect that the Olympian games were once celebrated every third year. In —205, even a Roman embassy, as Livy in the Annales Maximi found, had been sent to attend the same Olympian games.

Further, Cramer's An. P. p. 151, and Euseb. Arm. ad. Ol. 199, 1. bear witness that during the third year of Tiberius, who reigned since the death of Augustus on Aug. 19th, A.D 16, the emperor's quadriga conquered during the Olympian games, consequently A.D. 18. According to Petavius, who refers the third year of Tiberius to A.D. 17, and the consuls Nero and Salinator to —206, the Olympian games again would once have been enacted every three years.

Moreover, Plutarch (Anton. p. 942) relates that Antonius and Cleopatra assisted at the Olympian games in the course of Ahenobarbus and Sosius's consulate, i.e. in —29 (p. 435), which agrees with the Olympian games in —41, and those in the years +19, —205, and —777. According to Petavius, the said consuls ruled in —31 (p. 435), and accordingly the Olympian games were repeated every three years, if Petavius was right.

Again, Josephus (B. J. i. 21, 8; Ant. xvi. 5, 3) recounts that Herod I. participated in the Olympian games during the 25th year of his reign. This Herod obtained the crown of Palestine within the consular year of Calvinus and Pollio in —37, and in the same year the Olympian games took place (Joseph. An. xiv. 14, 4; xv. 10, 1; B. J. i. 9, 13). After that time Herod is said to have reigned 37 years (Joseph. Ant. xvii. 8, 1). The same king, assisted by Sosius, conquered Jerusalem during the consulate of Pulcher and Flaccus in —35 (p. 434), and after this year he is said to have actually reigned 35 years (Joseph. Ant. xiv. 16, 2; xv. 1, 2). The year —35 is confirmed by the report (Dio xlix. 22) that Herod took Jerusalem on the 10th day of Hyperberetæus (Sept. 14th), "being a Saturday"; for in —35 only the 11th day of September was a Saturday. The year being fixed in which Herod's reign of 35 years commenced, it is evident that Herod must have died in the year called 0, that is to say, during the first year of our original Dionysian era, and subsequent to Christ's birth, as the Evangelists and the Fathers of the Church bear witness. These results are astronomically confirmed by the total lunar eclipse in the year 0, January 9, 11h. 30m., ☊ 3° E., which preceded Herod's death by about three months (Joseph. An. xvii. 6, 4). According to Josephus, Herod died a short time prior to Easter, celebrated always on March 20th (p. 414), and nearly three months after the eclipse on Jan. 9th of the year 0. Since, then, Herod visited the Olympian games in the 25th year of his reign, he assisted at them in — 9; and this, again, is a year which, being divided by 4, gives the remainder 1, like — 41.

Besides these epochs, thirteen years of later times are mentioned by Roman and Greek authors, during which the same Olympian games have been held. We specify the following: Philostratus (V. A. iv. 24, 17; 18, 34) relates that the Olympian games took place seven years prior to Nero's departure for Greece, namely, A.D. 59, Ol. 209, 1. Nero himself, coss. Telesinus and Paulinus, went over to Greece for the purpose of attending the Olympian games to be held in the same year, A.D. 67, as Philostratus (v. 7, 11), Pausanias (x. 36, 4), Eusebius (ad Ol. 211, 1), Cramer (Anecd. ii. p, 151), Dio (63, 8), Suetonius (Nero 19), Josephus (B. J. ii. 20, 1), Suetonius (Vesp. 4), recount.

Further, Philostratus (V. A. viii. 14) relates that, coss. Domitian XVII. and Clemens, i.e. A.D. 95, Ol. 218, 1, the Olympian games were celebrated.—Again, Pausanias (Perieg. v. 21, 6) reports that the Olympian games were re-enacted A.D 127, Ol. 226, 1.) The same author (x. 34, 2) writes that during the third year of Aurelius and Verus, Ol. 235, 1, the same games were repeated.

Furthermore, Gellius (N. A. viii. 3), Lucian (viii. 297), Ammian (xxix. 1, 39), Hieronymus (a. A. 2181), and others, report that the philosopher Peregrinus burned himself to ashes while the Olympian games were taking place in Ol. 236, 1, A.D. 167.—Still further, Malala (xii. 372) recites that the same games were transferred to Antiochia in the 260th year of the Antiochian era, which commenced in —48, consequently A.D. 211, Ol. 247, 1.—Besides, Censorin (c. 18, 21) says that u.c. 991, Ær. Act. 267, Ær. Jul. 283, in the first year of Gordian, i.e. A.D. 239, Ol. 254, 1, the Olympian games were repeated.—Again, Libanius (i. p. 91, 94) tells us that, subsequent to Julian's death, Ol. 285, 1, the same festival took place A.D. 263.

Finally, Cedrenus (p. 325) bears witness that the Olympian games, interdicted by Theodosius during his 16th year, came to an end A.D. 395, Ol. 293, 1; u.c. 1146. All these epochs of the Olympian games concur in putting beyond question that, after Christ, these games were repeated in such years which, being divided by 4, leave the remainder 3. And these arguments will suffice to convince every unbiased man that Cæsar died in —41, and not in —43; that, consequently, the following consuls and emperors, down to A.D. 47, ruled two years later than Petavius brought out. (See the Chronological Table p. 433–37.) In one word, the Olympian games are the basis of the whole Greek and Roman histories.

We return now to the chronology of the Roman eclipses observed after J. Cæsar's death in —41.

26. Dio Cassius (L. xlv. to the coss. Hirtius and Pansa, u.c. 711) reports that a small eclipse of the sun occurred in —40 (*τό τε φῶς τοῦ ἡλίου ἐλαττοῦσθαί τε καὶ σβέννεσθαι*), and the Chronicon Paschale refers the same eclipse to the second year of Augustus, Ol. 184, 4; consequently to —40, viz. to Aug. 10, 16h. 15m., ☋ 14° E. According to the present theory of the moon, however, the obscuration of the sun reached only 60°, 71°, 39°, and finished prior to sunrise in Rome. Our Table (p. 429) puts ☋ 10° only E. of the sun, and the conjunction 2h. 29m. later. In —41 and —42 no solar eclipses were visible in Rome, as Pingré's computations evince.

27. Dio Cassius (xlvii. 40, p. 519, Reim.) mentions a great eclipse of the sun (*ὁ ἥλιος τότε ἐλαττοῦτο καί ἐλάχιστος ἐγένετο*), u.c. 712, coss. Lepidus II. and Plancus. This is the eclipse in

—39, July 30, 18h. 15m., ☋ 6° E., curve 44°, 55°, 29°. The conjunction happened (p. 429) about 2h. 29m. later, and the longitude of the ☋ was shorter by about 3° 50′. Hence this eclipse was a great one in Rome.

28. Eusebius (Chron. ii. 197, ad coss. Censorinus and Calv. Sabinus, Ol. 185, 2) mentions a solar eclipse which belongs to the year — 37, because in —36, the real consulate of Censorinus and Sabinus, no eclipse of the sun was possible in Europe. This eclipse, —37, Jan. 13th, 21h. 30m., ☊ 9° W., curve 47°, 33°, 51°, was nearly total in Rome, owing to the longitude of the ☊ being shorter by about 3° 50′.

29. The Fasti Siculi (p. 190) report that coss. L. Gellius Poplicula and M. Coccejus Nerva, u.c. 719, Ol. 185, 4, *ἔκλειψις ἡλίου ἐγένετο.* The said consuls ruled in —33, but no eclipse was visible in that year; wherefore we have again to recur to the preceding year, viz. to the eclipse in —34, Oct. 31st, 22h., ☊ 7° W., curve 62°, 28°, 14°, which was greater in Rome by reason of the ☊ lying about 10° west of the sun.

30. The Fasti Siculi (p. 190) mention another eclipse (*ἔκλειψις ἡλίου ἐγένετο*), coss. Augustus III. and Corvilius (read Corvinus), u.c. 722, Ol. 187, 4 (?). The aforesaid consuls officiated in —28, during which the eclipse of Jan. 4, 19h. (+2h. 26m.), ☋ 10° E. (—3° 48′), curve 24°, 13°, 42°, occurred. In the preceding year both ecliptic new moons happened after sunset. In —30, which Petavius referred to the same consuls, the only eclipse, on Aug. 20, 7h. 15m. p.m., was likewise invisible in Italy. The eclipse in —27, June 18, 15h. 45m., curve 20°, 38°, 10°, ☊ 1° W., was greater, but it does not agree with the consuls, and preceded sunrise in Rome.

31. Josephus (A. xvii. 6, 4) reports that an eclipse of the moon happened in Jerusalem on the night preceding the fast-day solemnized in commemoration of the siege of Jerusalem by Nebuchadnezzar, which siege commenced on the 10th day of the tenth month (Tebeth) of the civil year, as proven by 2 Kings, xxv. 1. *Ὁ Ματθίας*, Josephus says, *ἱερόμενος ἐν νυκτὶ τῇ φερούσῃ εἰς ἡμέραν, ᾗ ἡ νηστεία ἐνίστατο, ἔδοξεν—καὶ ἡ σελήνη δὲ τῇ αὐτῇ νυκτὶ ἐξέλιπεν.* This eclipse, moreover, occurred, according to Josephus, nearly three months before Easter (March 20th) and the death of Herod. About that time only one lunar eclipse was visible in Jerusalem during January (Tebeth, p. 414), viz. that in the year 0 of our era, Jan. 9, 11h. 30m. p.m., ☊ 0° W. On this occasion it may be seen that the Hebrews never used lunar months; for on the 9th or 10th day of any lunar month no lunar eclipse could take place, consequently Tebeth and all other Hebrew months must have been solar ones. (See p. 414.) It is evident, by the way, that, prior to the Babylonian captivity, Tebeth 1st must have coincided with Jan. 1st, as has been demonstrated in the author's Chronologia Sacra, p. 40. Petavius and Ideler referred this eclipse to —3, March 12th, 13h., ☊ 8° W., obscuration 4¼ inches; but this eclipse was invisible because the ☊ lay 11° 42′ W., and it is refuted by Josephus's History, which specifies that two months intervened between the eclipse and Herod's death, previous to March 20th.

32. Dio (lv. 22, p. 390 St.) asseverates that in the 28th year of Augustus, which year extended from Mar. 15, A.D. 6, to Mar. 15, A.D. 7, u.c. 759, coss. Messalla and Cinna, a small eclipse of the sun was seen in Rome (*τοῦ ἡλίου τι ἐκλιπὲς ἐγένετο*). This is the eclipse A.D. 7, Feb. 5, 23h., ☋ 15° E., which was, however, invisible in Rome, as Pingré states, provided the longitude of the ☋ was not shorter by 3° 23′ (p. 429). In A.D. 5, to which Petavius refers the 28th year of Augustus and the aforesaid consuls, no such eclipse was possible at all.

33. Eusebius Armen. mentions a solar eclipse about the time of Augustus's death (Aug. 19) in Ol. 198 (*καθ' ὃν χρόνον ἔκλειψις ἡλίου ἐγένετο*). The same is reported by Hieronymus (Chron. ii. p. 157), and by Dio (lvi. 29, p. 472 St.) Since Jerome commences the Olympiads, in accordance with the Roman year, on Jan. 1st, his Ol. 198, 1, coincided with A.D. 16. Indeed, during this year, only one day after Augustus's death, an ecliptic new moon occurred, viz. on Aug. 20th, 17h., ☋ 2° E., curve 27°–30°, 15°, 12°. Since the sun rose on that day about 5 o'clock (Rom. T.), the conjunction took place, in consequence of the parallax, prior to sunrise, but, according to our Table (p. 429), 2h. 23m. later. The longitude of the ☋ being shorter by 3° 37′, it is probable that the eclipse was perceived in Thebes, Egypt, 25° N., or in Ethiopia. Petavius referred, in accordance with Ptolemy, the death of Augustus to A.D. 14, and, no solar eclipse being possible in A.D. 14, he metamorphosed even this eclipse into a "supernatural phenomenon."

34. Tacitus (Ann. i. 28) and Dio Cass. (lvii. 4, p. 522 St.) report that nearly six months after Augustus's death a total eclipse of the moon happened, soon after sunset, in Laybach, Tyrol, which eclipse terminated the rebellion of the legions there stationed. This is the eclipse of A.D. 17, January 30th, 8h., ☊ 8° E., obscuration 6 inches. Since, however, the ☊ lay only 4° 20′ E. of the sun (p. 429), the eclipse was indeed a total one. Petavius had in his mind the eclipse of A.D. 14, Sept. 26ht, 18h. (Laybach T.); but this eclipse commenced a short time before sunrise, and not soon after sunset. It is, moreover, opposed to all the facts; for, from Augustus's death (Aug. 19) to Sept. 26th, only 38 days elapsed, and this short time was insufficient to accomplish what, according to Tacitus's detailed description, was done during this period. This eclipse apparently confirms the fact that the consuls after Cæsar ruled two years later.

35. Phlegon and Thallus (Euseb. Chr. i. 77 & ii. 202; Paulus Diac. Hist. Misc. 7, p. 253; Syncel. p. 256, Ven.; Fasti. Sic. p. 222, Par.), bear witness that in the 19th year of Tiberius, Ol. 202, 4, a total eclipse of the sun (ἔκλειψις ἡλίου τελεία) had been seen about noon (ὥρη ἕκτῃ τῆς ἡμέρας) in Nicæa, Bithynia (40° 30′ N., 27° 30′ E.) The years of the emperors commenced in Egypt and other Roman provinces, it is well known, with the local newyears day preceding the epoch of their actual reign; and hence the 19th year of Tiberius began in the autumn of A.D. 32. Accordingly, the attested eclipse must have been that in A.D. 33, Sept. 11, 22h. 30m. P. T., ☋ 8° E., curve 78°, 63°, 33°. According to our Table (p. 429–30), the conjunction happened 2h. 18m. later, and the ☋ lay 4° 25′ only east of the sun, and hence the eclipse was total in Nicæa, and, as history reports, there it coincided with noon.

36. Dio Cass. (ix. 26, p. 776) relates that "on Claudius's birthday" (Aug. 1st) an eclipse of the sun occurred in Rome (ὁ ἥλιος ἐκλείψειν ἔμελλεν). The only eclipse, about that time, coinciding with the 1st day of August was that of A.D. 45, July 31, 22h. ☊ 0° W., curve 22°, 19°, —14°. The longitude of the ☊ being shorter by 3° 30′, the obscuration of the sun in Rome must have been nearly total. Dio refers the same eclipse to the 5th, and not to the 3d year of Claudius, probably because Γ (3) was taken for E (5), being very similar to the former.

37. The decree of Claudius, and the inscriptions referring to his consulates, demonstrate, as we have seen (p. 422), that Claudius reigned not 14, but 13 years only, and that the consuls Asiaticus and Siianus were extraordinarii, and not ordinarii. Hence all consuls subsequent to A.D. 47 must have ruled only one year later than Petavius stated. This result is mathematically confirmed by the transit of Venus referred to the 6th year of Claudius (p. 415) and to the 800th year urbis conditæ; for, since Rome was founded in the spring of —752, the 800th year u.c. was annus Domini 48 (800—752=48, or 799—751=48). According to the same rule, the third centennial jubilee of Rome was, as Livy narrates, celebrated, coss. Valer. Maximus and Vir. Tricostus in —452 (p. 431), i.e. u.c. 300; consequently, the lunar eclipse referred to the 5th year of Claudius belongs to A.D. 47. Seneca (Q N. ii. 26) mentions an eclipse of the moon observed in the course of the consulate of Valerius Asiaticus, i.e. A.D. 47; but the same eclipse Cassiodor refers both to the consuls Vinicius Quartinus and Corvinus and to the 5th year of Claudius. Consequently Valerius Asiaticus must have been a consul suffectus in the 5th year of Claudius, A.D. 47, whilst Quartinus and Corvinus were ordinarii. Hence the said eclipse was that in A.D. 47, June 25, 15h. 30m. (+2h. 15m.), ☊ 1° E. (—3° 29′) Petavius referred the same consuls to A.D. 45, during which year, however, no lunar eclipse whatsoever occurred.

38. Aurelius Victor (Claud. iv. 12) reports that in the same year in the course of which the jubilee of Rome was celebrated, and Phœnix appeared, i.e. in the 6th year of Claudius, an eclipse of the moon happened. The same eclipse Dio Cassius (lx. 29) refers to the coss. Claudius IV. and L. Vitellius III., i.e. A.D. 48. Hence the attested eclipse was that in A.D. 48, June 14, 6h. p.m., ☊ 7° W. During the same eclipse, however, the island of Thera emerged from the Ægean sea, which Seneca (Q. N. ii. 26) refers to the preceding year, in accordance with Eusebius (Chron. ii. p. 204, ad Ol. 205, 4).

39. Pliny (H. N. ii. 70=72) says: "Solis defectum Vipstano et Fontejo consulibus, qui fuere ante paucos annos, factum......

Campania hora diei vii et viii. sensit, Corbulo, dux in Armenia, inter horam diei x. et xi. prodidit visum." As the same author (ii. 79) informs us that the Roman priests only counted the hours from midnight ("a media nocte ad mediam"), and since the same eclipse was seen in Armenia between 10 and 11 o'clock after sunrise (diei), it is evident that this eclipse coincided (p. 429) with about noon, R. T. Tacitus (xiv. 12) simply reports, "sol repente obscuratus"; but according to Dio (lxi. 16. p. 36 St.) this eclipse was total (σύμπας ἐξέλιπεν) in Calabria. This is the eclipse A.D. 60, Oct. 12th, 19h. (+2h. 11m.), ☊ 6° W., curve 58°, 32°, 22°. According to our Table (p. 430), the longitude of the ☊ was shorter by 3° 27′, and hence the eclipse must have been nearly total in Campania. Petavius, of course, alluded to the eclipse A.D. 59, April 30, 23h., ☋ 3° E., obscuration 9 inches; but this eclipse stands in direct opposition to Pliny and Dio, and to Roman chronology. The date "pridie Kal. Majas" is, in the present editions of Pliny, apparently altered to suit Petavius's erratic chronology.

40. Philostratus (V. A. 45, 8 & 11, p. 180 & 184 St.) testifies that during the consulate of Telesinus an eclipse of the sun took place (γενομένης ἐκλείψεως τοῦ ἡλίου), consequently A.D. 67, May 31st, 3h., ☊ 3° W., curve 40°–28°; Europe, Africa, S.W. Asia. Since the longitude of the ☊ was shorter by about 3° 25′, the obscuration was great in Rome. The year of the eclipse is fixed by the Olympian games, for in the course of the same consulate, and the 12th year of Nero, the emperor went over to Greece to assist at the festival; the games, however, were postponed for one year, and were celebrated A.D. 68 (Philost. V. A. iv. 17, 18, 24; Sueton. Nero, 19; Pausan. x. 36, 4, etc.) Petavius referred the same consuls Telesinus and Paulinus to A.D. 66, but alas! during this year no eclipse at all was possible.

But it came to light on occasion of the observance of the jubilee of the martyrdom of St. Peter and St. Paul, notoriously solemnized in Rome A.D. 1867, that it was enacted too early by one year. For, in the first place, the Father of Church History, Eusebius, insists that both Apostles died during the 13th year of Nero's reign, and this 13th year extended from Oct. 13, A.D. 67 to the same day A.D. 68, and not, as Petavius, in consequence of insufficient chronological resources and erroneous conclusions, stated, from A.D. 66 to 67. (See p. 437.) This result is mathematically confirmed by the solar eclipse A.D. 67 (No. 40), and by the epochs of all Olympian games mentioned in Roman and Greek histories (p. 449). Petavius erroneously referred the usual celebration of the Olympian games to A.D. 65, accordingly their postponed celebration to A.D 67, and then the nonsense comes out that πέρυσι (the preceding year) signified two years earlier. As, then, both Apostles died in the "13th year of Nero, June 29, they must have been martyred A.D. 68, and not A.D. 67. Hieronymus, it is true, twice refers the same martyrdom to the following, the 14th year of Nero, A.D. 69, and not, as Eusebius does, to his era 2083, but 2084 after Abraham. Yet the statements of Eusebius and Hieronymus do not contradict each other; for Hieronymus commences the same era, as every historian knows, one year earlier than Eusebius does, and hence his 14th year of Nero was the same that Eusebius calls the 13th; in the second place, Clemens Romanus, who lived at the same time in Rome, testifies (Ad Corinth. i. 5) that both Apostles were put to death in that year in which Nero attended the postponed Olympian games, A.D. 68. This testimony is confirmed, furthermore, by the explicit reports in the "Martyrologium Pauli" (A.D. 396); for it relates that the Apostles suffered death on the "iii. Kal. Jul." (June 29th) "in the 69th year after Christ's birth." Christ, as we have seen, was born seven days previous to the year 0, the first of the original Christian era, two weeks prior to Herod's eclipse of the moon (No. 31, p. 454), observed in the same year 0; consequently the Apostles were put to death A.D. 68, this year being the 69th after Christ's birth. Further, the same Martyrologium adds that the martyrdom of the Apostles occurred "in the 36th year after the crucifixion of the Lord," which, as we have seen, took place A.D. 33, Mar. 19th, being the 14th day of Nisan (p. 414): therefore the Apostles died A.D. 68, this year being the 36th after the crucifixion. This result, finally, is positively confirmed by the eclipse A.D. 67, May 31, observed in the course of the consulate of Telesinus A.D. 67, because the Apostles died during the following consulate, the 13th year of Nero, and in A.D. 66 no solar eclipse was possible. These historical and astronomical certainties put it beyond any question that the jubilee of St. Paul's and St. Peter's martyrdom ought to have been solemnized A.D. 1868, and not in 1867. Perhaps, however, the next jubilee will take place A.D. 1968.

41 & 42. Dio Cass. (lxv. 8, p. 180; lxv. 11, p. 184 St.) and Zonaras (An. xi. 16, p. 574 D.) relate that, coss. Sulp. Galba and T. Vin Rufinus, two total eclipses of the moon (*αἱματώδης καὶ μέλαινα*) occurred, of which one happened "on Oct. 29th." These are the eclipses in A.D. 68, May 6, 12h., ☊ 2° E. (—3° 25′), and Oct. 29, 6h. 30m. a.m., ☋ 2° W. (—3° 25′); for in A.D. 70, to which the said consuls belong, no lunar eclipse at all occurred, and in A.D. 69, to which Petavius referred, both lunar eclipses were partial, and neither coincided with Oct. 29th. The consuls of A.D. 68, Capito and Rufus, have been confounded with the consuls A.D. 70, Galba and Rufinus, because Rufus and Rufinus were very similar names.

43 & 44. Pliny (H. N. ii. 13 & 10) narrates, "ut quindecim diebus utrumque sidus quereretur, Vespasianis patre et filio consulibus." The rare phenomenon of two great eclipses within fifteen days occurred, about that time, only A.D. 71, Mar. 4, 8h., ☋ 8° E., obscuration 4¼ inches; and March 19, 21h. 30m., ☊ 7° W., curve 16°, 39°, 66°. Since the longitude of the nodes was then 3° 25′ shorter, both eclipses were great ones, as Pliny says. The words "Vespasianis patre et filio consulibus" obviously mean that year in which Emperor Vespasian was, for the first time, associated with Titus in exercising the consulate. Accordingly, these consuls must of necessity be referred to A.D. 71, and not, as Petavius calculated, to A.D. 70; for Pliny was an eye-witness. Since these eclipses were irreconcilable with Petavius's chronology, according to which the consuls Vespasian II. and Titus I. ruled A.D. 70, Petavius would have us to read, "Vespasiano III. filio iterum consulibus"; and hence our philologers have been so kind as to transform Pliny's genuine words, as they read in old manuscripts, into "Vespasiano III., filio iterum consulibus"; or even into, "Vespasiano IV. filio iterum consulibus. But Vespasian cos. III. was the colleague of Nerva, and not of Titus. The other so-called emendation of Pliny, "Vespasiano IV. Tito II. coss." is the worst of all, because these consuls ruled, according to Petavius himself, A.D 72, during which year Pliny's eclipses were quite impossible. These two eclipses incontrovertibly demonstrate that all consuls and emperors from Claudius to Titus reigned one year later than hitherto has been believed; hence Jerusalem was destroyed A.D. 71, and not, as Petavius conjectured, A.D. 70.

Since the consuls Commodus Verus and Novius Priscus, as we have seen (p. 423), were A.D. 78 extraordinarii, and not ordinarii, to whom Petavius erroneously attributed an entire year, and since Vespasian reigned not ten but nine years only, it is natural to conclude that Titus commenced to reign in the same year (A.D. 80) which Petavius assigned him, and that all consuls and all Roman eclipses after Titus belong to the very same years during which the latter were observed, according to Petavius's Doctrina Temporum.

Roman Eclipses from Titus to Constantinus Magnus.

45. ⊙ +73, July 22, 22h., Bœotia. Plutarch (De facie in orbe lunæ, c. 13; vol. ix. p. 680 Reis) asserts that he really witnessed a total eclipse of the sun in Chæronea (38° 30′ N. Lat., 20° 46′ Long.), which commenced with noon—(*ταύτης ἔναγχος τῆς συνόδου, μνεσθέντες, ἣ πολλὰ μὲν ἄστρα πολλαχόθεν τοῦ οὐρανοῦ διέφηνεν, εὐθὺς ἐκ μεσημβρίας ἀρξαμένη κρᾶσιν δὲ, οἷον τὸ λυκαυγὲς, τῷ ἀέρι παρέσχεν.*) The computation will be found further on, Greek Eclipses, No. 26.

46. ⊙ +95, May 21st, 15h. 30m., ☋ 5° E., Ephesus (38° N., 25° 15′ E.), curve 16°, 47°, 50°. Philostratus (V. A. viii. 23, p. 365) narrates as follows: *τὸν τοῦ ἡλίου κύκλον περιελθὼν στέφανος, ἐοικὼς Ἴριδι, τὴν ἀκτῖνα ἠμαύρου,*—which phenomenon happened in the 14th year of Domitian, A.D. 95. Eusebius (Chr. ii. 203, ad Ol. 218, 4) mentions only *διοσημεῖαι πολλαί.* Lambert and Struyk took the phenomenon for an eclipse of the sun in Ephesus, A.D. 95, May 21, 15h. 30m., ☋ 5° E., curve 16°, 47°, 50°, obscuration 1 inch. The report, however, is very doubtful, and it probably means an iris around the sun; otherwise the eclipse agrees with our Table (p. 429).

47. ⊙ +98, March 21st, 3h, ☋ 10° E., Rome, curve 71°–73°, Europe. Aurel. Victor (Ep. xii. 12) reports that "eo die, quo (Nerva) obiit (Jan. 25th), solis defectio facta est." Since Nerva died on Jan. 25, and no eclipse, about that time, occurred on that day, it is evident that Aurelius Victor referred the death of Nerva to a wrong date. According to Petavius and his adherents, Nerva died A.D. 98, and hence they recurred to the aforesaid eclipse. It is, however, still a question whether Nerva died A.D. 98 or 99; for Petavius himself (Doct. Tem. xi. 20, p. 182) concedes that the year 98 is in conflict with Domitian's coins, and that some authors put the death of Domitian in 97 A.D. Since, then, Nerva died 16 months after Domitian, Nerva's death belongs to A.D. 99; and, in this case, the eclipse under consideration was that of A.D. 99, Sept. 2d, 22h. (+2h. 9m.) P. T., ☊ 2° 20′ E., curve 11°, 0°, *. According to our Table (p. 429), the ☊ lay 1° west of the sun, and hence the eclipse was plainly visible in Rome.

48. ☉ +118, Sept. 2, 22h. 30m., ☊ 6° W., Rome, curve 53°, 42°, 14°. The Chronographer of A.D. 354 (Anonymus Norisii), published by the R. Saxon Society of Science, Leips., 1850, p. 660, relates that "his consulibus" (Hadrian II. and Tib. Claud. Tusc. Salinator A.D. 118) "sol eclipsin passus est." The longitude of the ☊ was (p. 430) shorter by 3° 15′, and the conjunction happened later, about 2 p.m.

49. ☉ +200, Mar. 31, 21h. 30m., ☊ 4° E., Utica (Carthage), curve *, −15°, 7°. Tertullian (Apol. ad Scop. c. 3, p. 70) narrates: "nam et sol illo in conventu Uticensi extincto pæne lumine adeo portentum fuit, ut non potuerit ex ordinario deliquio hoc pati, potius in suo hypsomate et domicilio," etc. The Council of Utica took place in the course of the eight-year reign of Emperor Severus, A.D. 200; for which reason Petavius recurred to the aforesaid eclipse, although it was invisible in 36° 51′ N. Lat. According to our Table (p. 429), however, the ☊ lay only 1° E. of the sun. The eclipse in +199, Oct. 7th, 5h. 30m., happened after sunset, and that of A.D. 201, March 21st, 12h., was visible only in Eastern Asia.

50. ☉ +219, April 1st, 20h., ☊ 3° W., Rome, curve 1°, 26°, 48°. The eye-witness Dio Cassius (78, 30, p. 769) reports that u.c. 971, A.D. 219, *ἡλίου ἔκλιψις περιφανεστάτη. ὑπὸ τὰς ἡμέρας ἐκείνας ἐγένετο.* This small eclipse, however, was nearly a total one in Rome, because the ☊ lay about 6° W. of the sun, and the conjunction happened nearly two hours later (p. 429).

51. ☉ +237, April 12, 3h. 30m., ☊ 2° W., Rome, curve 44°–48°. Julius Capitolinus (Gord. iii. 23; vol. ii. p. 13, ed. Lugd.) bears witness that, within the first year of Gordian (A.D. 237), a total eclipse of the sun was observed ("eclipsis solis facta est, ut nox crederetur, neque sine luminibus accensis quidquam agi [legi ?] posset.") Scaliger. Petavius, and Calvisius, computed the aforementioned eclipse, but the obscuration of the sun in Rome amounted, on the southern part of the sun, to 10 inches only. Since the ☊, however, lay (p. 429) nearly 4° 38′ west of the sun, the eclipse must have been total, or nearly total, in Rome. This is a clear confirmation of the Table, p. 429. Struyk (Ruperti's Magaz. i. 353) maintains that, two years later, a similar eclipse occurred, which, according to ancient reports, happened a short time after the Olympian games, A.D. 239. Hence the latter eclipse would have been that of A.D. 239, Aug. 16, 2h., ☋ 12°, or rather 9° 20′ E., which eclipse was a partial one.

52. ☉ + 291, May 15th, 2h. 30m. ☊ 0° W., Rome, curve 30°–24°. Idatius (Scaliger's Thesaur. p. 30) reports that in the 7th year of Diocletian, coss. Tiberianus and Cassius Dio, A.D. 291, "tenebræ fuerunt inter diem." According to Petavius, the obscuration of the sun amounted to 8 inches south. The longitude of ☊ being shorter by 2° 39′, the obscuration was greater in Rome.

53. ☽ + 303, Sept. 11th, 7h. 30m., ☊ 5° E., Rome. Scaliger (Emend. temp., Proleg. xviii. ed. Col. 1629) cites a Martyrologium, according to which Bishop Felix suffered martyrdom in the 19th year of Diocletian, which was, according to Eusebius (Chron. ad 2319), A.D. 303; and in the following night a total eclipse of the moon happened (et ductus est ad passionis locum, cum etiam ipsa luna in sanguinem conversa est, die iii. Kal. Septembres). Calvisius had reference to the eclipse A.D. 304, Aug. 31, 9h., ☊ 3° W. (—2° 37′), which was not total, but nearly coincided with iii. Kal. Sept. Scaliger alluded to the eclipse A.D. 301, Nov. 3d, 2h. 45m. a.m., ☊ 9° W.; but the moon scarcely touched the shadow of the earth, and iii. Kal. Sept. is not Nov. 3d. The eclipse A.D. 303, Sept. 11, 7h. 30m., ☊ 5° E., amounted, according to the present theory of the moon, to 11¾ inches only, and hence the lunar orb could not "assume the hue of blood"; but, according to our Table (p. 429), the ☊ stood distant from the centre of the shadow of the earth by two degrees only. Accordingly, this eclipse was total indeed. For the rest, instead of "iii. Kal. Sept.," read iii. Id. Sept.

54. ⊙ +316, Dec. 30th, 19h. 30m., ☊ 2° W., Constantinople, curve 13°, —2°, 25°. Aurel. Victor (Cæs. xli. 1) reports that a short time after Diocletian's death, which happened A.D 316, Dec. 3d, a partial eclipse of the sun occurred in Constantinople (quod—defectu solis fœdato iisdem mensibus die patefactum est.) Calvisius had reference to the eclipse A.D. 316, July 5th, 17h., ☋ 0° E.. curve 20°–36°, 35°, 27°; obscuration in Constantinople 5 inches. This eclipse, however, did not "follow," but preceded. Diocletian's death, and, since the ☋ lay (p. 429) 2° 36′ west of the sun, no solar eclipse was visible in Constantinople. On occasion of the aforesaid eclipse, A.D. 316, Dec. 30, the corrected place of the ☊ was 4° 26′ W., and the obscuration of the sun, visible in Constantinople, was very great.

55. ⊙ +317, Dec. 20th, 1h., ☊ 11° W., Constantinople, curve Eur., Afr. Idatius (in Scaliger's Thes. p. 30, ed. Roncall. p. 10) reports that, coss. Val. Licinian. Licinus Aug. V. and Fl. Jul. Crispus Cæsar, A.D. 317, a solar eclipse occurred three hours prior to sunset in Constantinople (tenebræ fuerunt hora nona). Petavius referred this eclipse to A.D. 317, Dec. 20th, 1h. ☊ 11° west, obscuration 7 inches. Indeed, this eclipse happened in Constantinople three hours past noon (p. 429), but the obscuration was greater, the longitude of the ☊ being shorter by about 2° 36′. This result agrees with Idatius's words, "tenebræ fuerunt," and confirms our Table, p. 429.

56. ⊙ +324, August 6th, 2h., ☊ 4° W., Campania, curve 40–20°, Eur., Afr. Cedrenus (p. 285 Par.) recounts that, coss. Crispus and Constantinus III.., A.D. 324, a total eclipse of the sun occurred in the afternoon (ἡλίου ἔκλειψις τοιαύτη, ὡς ἀστέρας φανῆναι ἐν ἡμέρᾳ). Calvisius, agreeably to the present lunar theory, stated this eclipse to have been partial, for the reason that only seven inches of the southern limb of the sun were covered. According to our Table, p. 429, howéver, the longitude of the ☊ was shorter by about 2° 36′, and hence the obscuration of the sun must have been a total one in Campania about 4 o'clock p.m.

57. ⊙ +334, July 16th, 23h. 30m., ☋ 2° E., Rome(?), curve 42°, 40°, 5°. Firmicus (Astron. i. 2) informs us that "sol medio diei tempore—cuncta mortalibus fulgida splendoris sui denegat lumina, quod Optati et Paulini consulatu—mathematicorum sagax prædixit intentio." Petavius computed the eclipse A.D. 334, July 16th, 45m. past noon, Roman time, obscuration 11 inches. Since the longitude of the ☋ was shorter by 2° 35′, the eclipse was smaller in Rome, and total in Africa only. The eclipse in the preceding year, July 27. 21h. P. T., or, according to the Table on p. 429, 23h. 22m. in Rome, likewise took place about noon; but, the ☋ being 11°, i.e. about 8° E., the obscuration was great only in Northern Italy.

58. ⊙ +346, June 5th, 17h. 30m., ☊ 7° W., Constantinople, curve 30°, 65°, 64°. Theophanes (p. 31 ed. Goar) reports that, within the 10th year of Constantius (A.D. 346), on the 6th day of Dæsius (June 6th), and within the 3d hour of the day, a total, or nearly total, eclipse of the sun took place in Constantinople (*τῷ δ' αὐτῷ ἔτει ἔκλειψις ἡλίου ἐγένετο, ὥστε καὶ ἀστέρας φανῆναι ἐν τῷ οὐρανῷ, ἐν ὥρᾳ γ′ τῆς ἡμέρας, μηνὶ Δαισίου ϛ′*). The same we read in Cedrenus. Eusebius and Hieronymus (Chr. ii. p. 183) refer the same eclipse to the same 10th year of Constantius. The position of Constantinople presumed to be 31° 10′ Long. and 41° N. Lat., the sun rose there on June 5th about 4h. 40m.; consequently the 3d hour of the day commenced about 6h. 26m. local time, and, in consequence of the parallax, the eclipse began nearly two hours earlier. According to our Table (p. 429), however, the conjunction was nearly 1h. 34m. later, which agrees with Theophanes and Cedrenus. Even Petavius found that, according to his Lunar Tables, the eclipse happened one hour too early. This eclipse, moreover, was partial in Constantinople. (See No. 59.)

59. ⊙ +347, Oct. 20th, 3h., ☋ 14° E., Constantinople. Theophanes reports that in the course of the 11th year of Constantius, "on a Monday," a partial eclipse of the sun occurred (Theoph. p. 32 ed. Goar: *ὁ ἥλιος πάλιν αὐχμηρότερος γέγονεν ἐν ὥρᾳ β′ τῆς κυριακῆς ἡμέρας*). The obscuration amounted, as Petavius calculated, to 7 inches; but, according to our Table (p. 429), the longitude of ☋ was shorter by 2° 33′, and hence the obscuration was greater. But this eclipse happened on a Tuesday, and not on a Sunday. The only eclipse coinciding about that time with a Sunday was that of A.D. 345, June 16th, 1h., ☊ 1° E., or rather (p. 429) 1° 34′ W., which must have been a nearly total one in Constantinople; for the central shadow of the moon traversed at noon, as Pingré states, the 16th degree of north latitude, but, according to our correction, the former really touched the latitude of Constantinople. Hence it is evident that three consecutive eclipses, observed in Constantinople, have been confounded with each other: the first was that of A.D. 345, June 16th, 1h., on a Sunday; the following happened A.D. 346, June 6th, two hours after sunrise, on a Friday; and the third, A.D. 347, Oct. 20th, 3h. p.m., on a Tuesday. The first was the total one witnessed by Theophanes and Cedrenus.

60. ☉ +348, Oct. 8, 20h., ☋ 5° 17′ E., Constantinople, curve 52°, 23°, 1–2°. Hieronymus, as Petavius found in some manuscripts, mentions an eclipse (solis facta defectio) observed in the 12th year of Constantius, and Ol. 282, 1. The latter points to A.D. 347 (No. 59), the former to A.D. 348. The same eclipse Cassiodor (p. 220, ed. Rom.) refers to the consuls Fl. Philippus and Fl. Salius (his coss. solis facta defectio), and to the 12th year of Constantius. The obscuration amounted, according to Petavius, to 8 inches in Constantinople; but it must have been smaller, the ☋ lying 2° 33′ nearer to the sun.

61. ☉ +360, Aug. 27th, 16h., ☊ 3° W., Mesopotamia, curve 34–37°, 26°, 21°. Amm. Marcellinus (xx. 3, p. 203 Wagn.) says: "eodem tempore per Eoos tractus cœlum subtectum caligine cernebatur obscura, et a primo auroræ exortu ad usque meridiem intermitabant jugiter stellæ—primo attenuatum in lunæ corniculantis effigiem, deinde in speciem semestrem, postea in integrum restitutum." This eclipse Ammian refers to the coss. Constantius X. and Julianus III., A.D. 360. According to Petavius, 11 inches of the sun's disc were covered in Mesopotamia, but, according to a careful computation of the same eclipse, performed by means of Damoiseau's Tables and Airy's corrections of the latter (Zech's Preischriften über die wichtigeren Finsternisse der Griechen und Römer, 1855), the eclipse was over prior to sunrise in Mesopotamia. Both contradictions are removed by our Table, p. 429, for the ☊ lay 2° 32′ more west of the sun, and the conjunction happened nearly 1h. 32m. later. The report that the eclipse lasted six hours, means that the total shadow of the moon traversed different places of Asia successively. (See p. 448.)

62. ☉ +364, June 16, 1h., ☊ 6° W., Alexandria, Egypt; curve ✱, 60° (noon), 38°. Theon (Can. L vi. p. 277 & 282 ed. Bas., p. 161 Hal.) testifies that on the 23d day of Thoth (June 16), Ær.

Dioclet. 80 (A.D. 364), a solar eclipse occurred (γενομένης συνόδου—ἐκλειπτικῆς τυγχανούσης). The longitude of the ☊ was shorter by 2° 32′, and the obscuration commenced about 1 h. 32 m. later.

63. ☽ +364, Nov. 25th, 14h., ☋ 6° E., Alexandria. Theon (Can. vi. p. 90. 162) records that on the 6th day of Phamenoth (Nov. 25th), Ær. Dioclet. 81 (A.D. 364), a "total eclipse of the moon" was there seen. According to our Table, p. 429, the ☊ lay 2° 32′ nearer to the centre of the earth's shadow, and hence that "total" eclipse was a total one indeed.

64. ☉ +374, Nov. 19, 22h, 30m., ☊ 2° W., Alexandria, curve 7°, —9°, *. Theon (Can. vi. p. 74 Hal.) reports that a solar eclipse happened in Alexandria during Phamenoth, Ær. Diocl. 90, and in the 3d hour of the day (p.m.) Theon's eclipse, however, was invisible in Alexandria, provided the ☊ lay not farther from the sun by about 2° 32′ (p. 429). The eclipse commenced 1 h. 32 m. later (p. 429), which agrees with Theon.

65. ☉+378, Sept. 7th, 23h. 30m. ☊ 2° W., Alexandria, curve 25°, 19°, *. Theon (Can. vi. p. 74 H.) mentions a solar eclipse belonging to the year 94, Ær. Diocl. Since the ☊ lay farther from the sun by 2° 32′, the obscuration was greater in Alexandria (31° 13′ N.)

66. ☉ +393, Nov. 19, 23h. (+1h. 29m.), ☊ 10° W. (—2° 29′) Rome or Constantinople, curve 53°, 40°, 37–45°. Zosimus (Hist. iv. 58, 3) narrates that coss. Theodosius III. and Abundantius, A.D. 393, during the battle of Theodosius against Eugenius, a great eclipse of the sun occurred (ἡλίου ἔκλειψιν ἐν αὐτῷ τῷ καίρῳ τῆς μάχης συνέβη γενέσθαι τοιαύτην ὥστε νύκτα εἶναι μᾶλλον ἐπὶ πλείονα νομίζεσθαι χρόνον). Marcellin (Scal. p. 36; ed. Ronc. 271) says: "tunc quippe hora diei tertia tenebræ factæ sunt." The same is reported by Prosper Aquit. Chron. i. 672. The obscuration in Rome amounted, according to Petavius, to 10 inches on the northern side of the solar disc. Since the ☊, however, lay nearly 2° 29′ farther from the sun, the eclipse was smaller in Rome. The "third" hour probably means the third hour after noon, because the Romans were in the habit, in later times, of counting the hours both from midnight and from noon. (Comp. No. 64.) Hieronymus refers, perhaps, the same eclipse to Pentecost (June), and such a one occurred A.D. 392, June 6th,

18h., ☋ 1° E., curve 3°, 28°, 29°; which was also a small one because the ☋ lay 1° W. of the sun. (Comp. Calvisius's Opus Chron.)

The Actual History of the Greeks.

The history of the Greeks and the chronology of their eclipses depending, of course, upon the Olympiads, it is to be borne in mind that the Olympian games were celebrated two years later than hitherto was universally believed, namely, in all years B.C. which, being divided by 4, gives the remainder 1, and in all years of the Christian era which, being divided by 4, leaves the remainder 3. The proofs have been discussed in the premises (p. 437.) For the planetary configuration referring to the celebration of the first Olympian games, as well as all those mentioned in Roman history, place this statement beyond question, as the following 18 examples clearly show:

1. — 777, March 29, Plan. Conf. Schol. Pind. Ol. v. 10; Pausan. v. 14.
2. — 205, Coss. Cl. Nero and Salinator II. Livy, 27, 34.
3. — 41, Subsequent to Julius Cæsar's death. Cic. Epis. ad Att. 16, 7; 15, 5; 24.
4. — 37, Coss. Calvinus and Pollio. Joseph. Ant. xiv. 14,4; xv. 10, 1; B. J. i. 19, 13. (See p. 433.)
5. — 29, Coss. Ahenobarbus and Sosius, 13th year of Augustus. Plut. Ant. p. 942.
6. — 9, Coss. Messalla and Appianus, 33d year of Augustus. Joseph. B. J. i. 21, 8. 12.
7. + 19, Coss. Rufus and Flaccus, 3d year of Tiberius. Cramer An. p. 151.
8. + 43, Coss. Caligula IV. and Saturninus, 1st year of Claudius. Malala x. 320.
9. + 59, Coss. Nero III. & Messalla. Philostr. V. A. iv. 24, 17. 18. 34.
10. + 67, Coss. Telesinus & Paulinus, 12th year of Nero. Pausan. x. 36, 4.
11. + 95, Coss. Domitian XVII. and Clemens, 15th year of Domitian. Philostr. viii. 14-18.
12. + 127, in the 8th year of Hadrian. Pausan. Perieg. v. 21, 6; Ol. 226, 1.
13. + 163, in the 3d year of Aurelius and Verus. Pausan. x. 24, 2; Ol. 135, 1.
14. + 167, death of Peregrinus. Amm. xxix. 1, 39; Gell. N. A. viii. 3; Hieron. A. A. 2181.
15. + 211, Æræ Ant. 260. Malala xii. 372.
16. + 239, u.c. 991; Æræ Act. 267; Æræ Jul. 283; Censorin c. 5.
17. + 327, 331, 335, 363. Liban. iii. 123, 110.
18. + 395, interdicted in the 16th year of Theodosius. Cedren. p. 325 C.

Accordingly, the following epochs of Grecian history are incontrovertibly fixed in advance:

1. —777, the first year of Archon Æshylus. Euseb. Chron. ii. 318.
2. —477, battle near Thermopylæ Her. vii. 206; Arch. Calliades. Par. Marb. Ep. 52; Her. viii. 51.
3. —425, the 4th year of Peloponn. war, Arch. Diotimus. Thuc. iii. 8.
4. —417, the 12th year of Pelopon. war, Arch. Astyphilus. Thuc. v. 40.
5. —405, the 24th year of Pelop. war, Arch. Antigenes. Xen. H. i. 3, 1.
6. —401, the 28th yr. of Pelop. war, Arch. Pythodor II. Xen. H. ii. 3, 1.
7. —361, the 2d year of the Arcadian war, Arch. Arimnestus; battle near Olympia. Xen. H. vii. 4, 29.
8. —353, Alexander the Great born, Arch. Elpines. Plut. Al. 3.
9. —345, the 13th year of Philippus. Æsh. F. L. p. 29. Arch. Theophilus.
10. —321, Arch. Hegesias; Alexander the Great dies in the following year. Arr. vii. 28, 1.

All these epochs refer to the years in which the Olympian games were actually held, and by means of them it will be an easy matter to determine the true dates of all the eclipses mentioned in the history of the Greeks.

The following Chronological Table summarily shows the difference between Petavius's Greek history and that of the author, and, at the same time, it includes the true dates of all Greek eclipses. We add the epochs of the Persian kings, fixed by classic authorities. In the next place, the Olympian games confirm the results (p. 409). that the Peloponnesian war lasted, from the first naval expedition of the Athenians to the destruction of the Piræus, 28 full years, as Thucydides and Xenophon testify, and not, as Petavius "*post ingentem laborem*" made out, 27 years only; that, moreover, the history of the 21st year of the Peloponnesian war and the first chapters of Xenophon's Hellenica have been lost. For, the Olympian games being held in the 4th and 12th years of the Peloponnesian war (Thuc. iii. 8; v. 49), i.e. —425 and —409, do not agree with the Olympian games celebrated during the 23d and 27th years of the same war (Xen. Hell. ii. 3, 1, and i. 2, 1), i.e., according to Petavius, in —406 and —402, because the games would have been repeated after an interval of 3 years. Besides, the years —406 and —402 disagree with the epochs of all Olympian games mentioned in Roman history (p. 451). The aforesaid loss of one year of the Peloponnesian war is, moreover, placed beyond question by the Parian Marble, which, for the same period, counts one archon more than Petavius did; further, by the 28 ephori who ruled during the Peloponnesian war (Xen. Hell. ii. 3, 10, and Thuc. viii. 6), by the history of the kings of Bosporus (Diod. xii. 31, 36), by the ages of Sophocles, Plato, Socrates, Isocrates, and others, who, the missing year between Thucydides and Xenophon not being expleted, would have lived one year less than history reports. Add to this the celebration of the Isthmia, and Pythia, mentioned in ancient history. The Pythia, repeated, like Olympian games, every four years, were celebrated during the autumn in —419, the 10th year of the Peloponnesian war, Arch. Alcæus (Thuc. v. 1); consequently in a year which, being divided by 4, gives the remainder 3. Since the same Pythia were held (Xen. Hell. iv. 13, 14; v. 2, 29, etc.) in —391, —379, —371, —367, —327, —287, it is evident that one year must be inserted between Thucydides and Xenophon. Furthermore, Thucydides (viii. 10) tells us that the Isthmia æstiva were celebrated during the 20th year of the Peloponnesian war, i.e. 409, a year which, being divided by 4, gives the remainder 1. Since the same Isthmia took place in —389, Arch. Philocles, as Xenophon (Hel. iv. 5, 1) testifies, Petavius must have omitted one year intervening between Thucydides and Xenophon. This is confirmed by the same Isthmia celebrated in —385 (Xen. Hel. v. 1, 29), and those in —193, Coss. Purpurio and Marcellus ruling from the Idus Mart. 194 to the same in 193 (Livy 33, 32), as well as by the Isthmia hiberna A.D. 68, during the 12th year of Nero (Sueton. Nero 24; Philost. V. A. v. 41). The simple logical deduction, therefore, is that Petavius has antedated all events of Greek history down to Xenophon by one year; the following, however, by two years.

Olymp.	Seyf.	Petav.	Historical Events and Eclipses.
0	−777	−779	The first Olympian games. Pind. Ol. v. 10, x. 59; Paus. v. 14.
1, 1	773	775	The 2d year of Archon Æshylus.
38, 4	622	623	July 2. The 6th year of the Medo-Lydian war. Herod. i. 74.
	621	622	(1) ☉ T. on the Halys, May 17, 20h. 15m. Herod. i. 74, 103.
48, 4	582	583	July 2. Archon Damasias.

Olymp.	Seyf.	Petav.	Historical Events and Eclipses.
	—581	—582	(2) ⊙ T., Miletus, March 27th, 17h. 45m. Pliny ii. 12, 9; u.c. 170, Ol. 48, 4.
59, 4	538	539	(3) ⊙ Nov. 22d, 19h. Greece. Fasti Sic. p. 144, ad Ol. 59, 4.
61, 1	533	534	July 2. Daniel (ix. 24) predicts the birth of Christ in — 1.
	532	533	(4) ⊙ T., Nineveh (Mosul), Jan. 26, 15h. 45m. Xen. An. iii. 4, 7.
	526	527	Cyrus dies, Cambyses reigns, 7 yrs. after Nineveh's fall.
65, 1	517	518	July 2. Darius Hystaspes reigns. Par. Marb. Ep. 44.
	516	517	(5) ⊙ Mar. 28th, 2h. 45m. Fast. Sic. p. 146, ad Ol. [65, 1.
74, 3	479	480	July 2. Archon Themistocles.
	478	479	(6) ⊙ T., Sardes, Feb. 27, 15h. 30m. Her. vii. 3, 7; viii. 51; Arist. Or. 46, p. 241 D., and his Schol. p. 232 From.
75, 1	477	479	Olympian games during the battle at Thermopylæ. Her. vii. 206.
75, 2	476	477	(7) ⊙ Corinth, Aug. 1, 1h. 30m. Herod. ix. 10.
76, 4	470	471	July 2. Archon Chares. Par. Marb. Ep. 55.
	469	470	(8) ⊙ T., Thebes. Bœot., Mar. 20, 1h. 30m. Pindar, in Dion. Hal. p. 167 Syl.
78, 4	463	464	July 2. Archon Lysistratus.
			(9) ⊙ T., Athens, —465, Dec. 25th, 20h. Fasti Sic. Ol. 78, 4; Pliny H. N ii. 22.
79, 4	458	459	July 2. Archon Phrasiclides.
			(10) ⊙, Greece, —460, March 9, 23h. 30m. Euseb. Arm. ad Ol. 79, 4.
86, 4	430	431	July 2. Archon Pythodor. I. The Pelopon. war begins, according to Xenophon.
	429	430	(11) ⊙, μηνοειδής, Athens, Jan. 26th, 22h. Thuc. ii. 28; Cic. R. P. i. 16.
88, 1	425	427	The Olympian games celebrated. Thuc. iii. 8.
88, 4	422	423	July 2. Archon Stratocles.
			Artaxerxes Long. obit in χειμῶν. Xerxes II. & Sogdian reign. Thuc. iv. 50.
89, 1	421	422	(12) ☽, Athens, Aug. 8, 15h. Schol. Aristoph. Nubes v. 580.
			Darius Nothus reigns. Thuc. viii. 58. Arch. Isarchus.
	420	421	(13) ⊙, small in Athens, Jan. 18th, 2h. Aristoph. Nub. 580, and Scholiast.
			(14) ☽ T., Feb. 2, 6h., Athens. Aristoph. Nub. 580.
90, 1	417	419	The Olympian games celebrated. Thuc. v. 49.
91, 4	410	411	July 2. Archon Callias. Diodor. xiii. 34.
			(15) ☽ T., Sicily, July 8, 7h. 45m. Thuc. vii. 50.
92, 1	409	411	Isthmia celebrated in θέρους. Thuc. viii. 10.
			The 13th year of Darius Nothus. Thucyd. viii. 58. (See the year —421)
92, 2	408	409	July 2. Archon Glaucippus. (See p. 411.)
93, 2	404	406	July 2. Archon Callias II. Diod. xiii. 103; Xenoph. Hel. i. 6, 1.
	403	405	(16) ☽, Athens, Feb. 23, 6h. 30m. Xen. Hel. i. 6, 1.
93, 4	402	404	July 2. Archon Pythador II., during the last (28th) year of the Peloponnesian war.

Olymp.	Seyf.	Petav.	Historical Events and Eclipses.
	401	403	(17) ⊙, Athens, Jan. 17, 21h. 30m. Xen. ii. 3. 4.
			Darius Nothus obit. Diod. xii. 104. Artaxerxes Mnemon reigns.
			June—The Olympian games celebrated, Xen. ii. 3, 1.
96. 2	392	394	July 2. Archon Eubulides.
	391	393	(18) ⊙ (μηνοειδής), Bœotia, Jan. 26, 22h. 30m. Xen. H. iv. 3, 10.
104, 1	361	363	July 2. Archon. Timocrates.
			(19) ⊙ T., Thebes, Bœotia, May 12, 3h. 15m. Plut. Pel. 31, p. 389.
105, 1	357	359	July 2. Archon Callimedes.
	356	358	(20) ⊙, Syracuse, Feb. 28th, 23h. 15m. Plut. Dion, c. 19, p. 286 R.
105, 2	356	358	July 2. Archon Agathocles.
			(21) ☽ T., Sicily, Aug. 9th, 6h. 45m. Plut. Nic. 22: Dion. 24.
111, 4	330	332	July 2. Archon. Nicocrates.
			(22) ☽ T., Sept. 10th, 7h. 30m., referred to Arbela. Ptolemy Geog. i. 4.
112, 2	328	330	July 2. Archon Aristophanes. The last year of Darius Codomannus, succeeded by Alexander the Great.
			(23) ☽ P., near Arbela, Aug. 29, 12 h. Cic. Div. i. 55; Arr. iii. 7, 6.
116, 4	312	314	Archon Nicodorus. (See p. 412.)
117, 3	307	309	July 2. Archon Hieromnemon.
	306	308	(24) ⊙ T., near Syracuse, June 13, 21h. 25m. Justin. xxii. 6; Diod. xx. 5.
162, 4	126	128	(25) ☽, Athens, Oct. 14th, 13h. 30m. Diog. Laërt. iv. 9, 64.
212, 3	+73	+ 70	(26) ⊙ T., Chæronea, Bœotia, July 22d, 22h. Plut. vol. ix. p. 680 R.

It is true, the succession of the archons in general is less reliable than the epochs of the Olympian, Isthmian, and Pythian games mentioned in history. For, e.g. the scholiast of Aristophanes Aves, 997, places Apseudes before Pythador I. in —430; the scholiast of Æshines (p. 15 St., p. 740 R.) makes Nicephorus the predecessor of Themistocles; the Parian Marble counts, from Diphilus to Pythador I. one archon more than Diodorus does; the latter puts all archons mentioned by Xenophon later by one year, whilst the Parian Marble, in accordance with Xenophon, puts the archons Antigenes, Micon, and Laches, one year earlier; the same Diodor puts Apseudes before Pythador I., and he (xiii. 7) inserts between Chabrias and Cleocritus, in —411, Pisander, an archon not elsewhere mentioned; Pausanias names archon Charon four years prior to Diodor's date, and the latter postdates archon Phœnippus and the battle at Marathon by one year; Diodor, comparing his archons with the Roman consuls, was compelled to repeat five consular magistracies twice in order to harmonize his Greek history with the Roman. Besides this, in the present editions of Xenophon (Hell. i. 2, 1) the Olympian games are referred to the year —406, instead of —405, which is obviously a repeated blunder of an ancient copier of Xenophon. Furthermore, Thucydides calls the year preceding the first expedition of the Athenians against Sparta, namely, the year in which the Spartans destroyed Potidæa, the first year of the Peloponnesian war. This is evident from the fact that Thucydides (ii. 56) makes Pericles to have been a participant in the naval expeditions of the Athenians first "in the 2d year of the Peloponnesian war," and this year is astronomically fixed by the nearly total eclipse No. 11 of the Table. Xenophon, on the contrary, counted the years of the Peloponnesian war from that January during which the Attic fleet first started against the Peloponnesus. Hence it came to pass that both the last year of Thucydides and the first (now lost) year of Xenophon were originally termed the 23d year of the war. Nevertheless, none of these incongruities, as we shall see, affect at all the aforesaid dates of the eclipses observed during the Peloponnesian war. The inscriptions (p. 411) demonstrate that, in general, all archons down to —409 ruled one year (the following, two years) later.

Examination of the Eclipses of the Peloponnesian War.

11. The eye-witness Thucydides (ii. 28) reports that 3 yrs. and 5 mos. prior to the Olympian games in —425 (p. 471), consequently in the year —429, in the beginning of *θέρος*, therefore during January of —429, at noon (*μετὰ μεσημβρίαν*), a nearly total (*μηνοειδής*) eclipse of the sun happened in Athens. *Ὁ ἥλιος* (says he) *ἐξέλιπε μετὰ μεσημβρίαν, καὶ πάλιν ἀνεπληρώθη γενόμενος μηνοειδὴς, καὶ ἀστέρων τινῶν ἐκφανέντων.* Cicero (R. P. i. 16): adds, "cum tota se luna sub orbem solis subjecisset"; and Quinctilian (In. Or. i. 10. 47), "cum Pericles Athenienses solis obscuratione territos, redditis ejus causis, metu liberavit." Plutarch (Per. c. 35, p. 661 R.) narrates the same. The words *μετὰ* μεσημβρίαν signify, analagously to μεθ' ἡμέραν (during day), during noon. About that time, as Pingré's computations show, only one eclipse was possible in the early spring, and about noon, viz. that in —429, Jan. 26, 22h, P. T., ☊ 1° E., curve — 15°, — 30°, — 3°. According to our Table, p. 429, however, the longitude of the ☊ was shorter by about 5° 35′, and hence the obscuration amounted to about 11 inches in Athens. The conjunction took place nearly 3h. 37m. later, which agrees with Thucydides. Petavius, of course, had reference to the eclipse in —430, Aug. 3d, 5h. local time, obscuration 11.20 inches; but, unfortunately, this eclipse belonged to χειμών (p. 418), and not, as Thucydides testifies, to the early θέρος. Moreover, this eclipse was too late in the afternoon, and it happened, according to Petavius's chronology, one year too late; for Petavius referred the Olympian games to —427, and since the said eclipse, as reported by Thucydides, occurred 3 yrs. 5 mos. prior to the Olympian games, Petavius ought to have recurred to a similar eclipse in —431, during which year no similar eclipse was possible. Finally, it is well known that Buerg's Lunar Tables were, in spite of the Almagest, based upon 3200 Greenwich observations, and that the former, on occasion of the total eclipse in 1851, proved more correct than Burckhardt's and Damoiseau's Tables. By the aid of Buerg's Tables, Prof. Heiss (Ueber die Finsternisse des Peloponnesischen Kriegs, Köln, 1834) computed the same eclipse, but the obscuration of the sun was only 7.9 inches. In this case, as Thucydides testifies, nobody would have seen fixed stars.

12. Thucydides (iv. 2.) narrates that, in the course of the 9th year of the Peloponnesian war, the tanner Cleon was extraordinarily elected strategus; and the scholiast of Aristophanes (Nub. 581) says that about that time, Arch. Stratocles, a lunar eclipse occurred in August (ἐπειδὴ ἔκλειψις σελήνης τῷ προτέρῳ ἔτει ἐπὶ Στρατοκλέους Βοηδρομιῶνι, i.e. August; p. 23). This is the eclipse in —421, Aug. 8, 0h. 15m., ☋ 10° E., which confirms our Table, p. 429; for the longitude of the moon was 1° 57′ shorter (3h. 35m. later), and without this correction the said full moon would not have been visible in Athens. The obscuration of the moon must have coincided with sunset. Petavius recurred to the eclipse in —424, Oct. 23d, 6h. 30m., which clearly is contradicted by the consecution of the archons and the years of the

Peloponnesian war, as the two following eclipses evidence. The later scholiast perhaps viewed the eclipse during the rule of Arch. Isarchus, in −420.

13 & 14. The eye-witness Aristophanes (Nubes, 581) testifies that in the early spring of the following year, and a short time previous to Cleon's first orderly election as strategus, a very small eclipse of the sun and a total one of the moon were perceived in Athens. *Εἶτα* (says Aristophanes) *τὸν Παφλαγόνα ἡνίχ' ᾑρεῖσθαι στρατηγὸν, τὰς ὀφρῦς ξυνήγογεν κἀποιοῦμεν δεινὰ—ἡ σελήνη δ' ἐκλέλοιπε τὰς ὁδοὺς* (Herod. vii. 37), *ὁ δ' ἥλιος, τὴν θρυαλλίδ' εἰς ἑαυτὸν εὐθέως ξυνελκύσας, οὐ φανεῖν ἔφασκεν ὑμῖν, εἰ στρατηγήσει Κλεων· ἀλλ' ὁμῶς εἵλεσθαι τοῦτον.* The scholiast in Scaliger's "Synage" informs us that the same solar eclipse took place on the 16th day of Anthesterion (*'Ανθεστηριῶνος ἔκτῃ ἐπὶ δέκα*), that is, as we have seen (p. 408), on Jan. 18th. About that time there is but one year to be found within which a solar and lunar eclipse occurred during spring, at which time the strategi were elected; and it was only in −420, Jan. 18, 2h., ☋ 17° E., that a small eclipse of the sun happened on the 18th day of January. The total eclipse of the moon took place on Feb. 2d, 6h. p.m., ☊ 2° E. (−5° 32′). These two eclipses, then, mathematically demonstrate that Arch. Isarchus ruled during *θέρος* in −420, and his predecessor Stratocles in −421; that, moreover, Thucydides' reports (iv. 119) concern the year −420. It is strange, however, that Thucydides (iv. 52) refers the same solar eclipse to the preceding year, to −421, in which neither solar nor lunar eclipses were visible in Athens during the spring; for the solar eclipse on Feb. 26th, 23h., ☋ 5° W., described the curve −56°, −44°, −5°, and hence it was invisible in Athens. The lunar eclipse in −421, Feb. 12th, 22h. 30m. coincided with noon. It is, therefore, probable that Thucydides (iv. 52: *τοῦ ἐπιγιγνομένου θέρους εὐθὺς τοῦ ἡλίου ἐκλιπής τι ἐγένετο*), whilst writing his work twenty years later, confounded with each other, concerning the eclipse, the 9th and 10th years of the Peloponnesian war. Besides, the ascertained solar eclipse in −420, Jan. 18th, confirms our Table, p. 429; for the ☋ lay not 17°, but 12° only east of the sun, and without this correction no eclipse would have been possible at all. Petavius, as was natural, had recourse to the eclipse in −423, March 20th, 20h., ☋ 10° E., which contradicts the eye-witness

Aristophanes, because in −423, about Mar. 20, no lunar eclipse was possible. Moreover, supposing the Athenians had elected their strategi after March 20th, the warlike exploits of the Greeks would have commenced prior to the orderly elections of the strategi; for Thucydides and Xenophon narrate that usually all belligerent expeditions set out in January.

15. Thucydides (vii. 50, ἡ σελήνη ἐκλείπει), Plutarch (Nic. 33, p. 393 R.), Diodorus (xiii 12, p. 551 S.), Polybius (Exc. ix. 19, τῆς σελήνης ἐκλιπούσης δεισιδαιμονήσας ὥς τι δεινὸν προσημαινούσης ἐπέσχε τὴν ἀναζυγήν), report that at the end of θέρος a total elipse of the moon, soon after sunset, happened in Sicily. which caused the ruin of the Attic army in Sicily, viz. during the 20th year of the Peloponnesian war, Archon Callias, two years prior to the archonship of Glaucippus in −408, which year is mathematically fixed by the calendrical inscription, p. 411. Thucydides specifies 21 days from the eclipse to the capture of the army (see Clinton's F. H. to this event), and the latter Plutarch (Nic. 33, p. 393 R.) refers to "the 27th day of the Spartan month Carneius," consequently to the 29th of Metageitnion, the 31st day of July, Julian style (p. 408). Since, then, the eclipse happened 21 days prior to July 31, the same must have taken place on July 8th in −410, soon, as Thucydides says, after sunset. Indeed, in −410 only, July 8th, 7h. 45m., a total eclipse of the moon happened soon after sunset. No lunar eclipse coinciding twice, during a period of 19 years, with July 8th, the epoch of this eclipse is fixed with mathematical certainty. The obscuration of the moon, however, amounted, according to the present lunar theory, to 6.5 inches only, because the ☋ lay 7° E. of the centre of the earth's shadow; but, according to our Table, p. 429, the longitude of the ☋ was shorter by 5° 29′, and hence this eclipse was, as the authors report, a total one after sunset. Petavius, according to his erratic chronology, recurred to the eclipse in −412, Aug. 27, 10h. 15m., ☋ 4° W.; yet this eclipse belonged to χειμών, and it did not precede, but followed, the fall of Nicias, on July 31st, by 27 days.

16. Xenophon (Hell. i. 6, 1) reports that during the 26th year of the Peloponnesian war, Archon Callias, namely, a short time after the beginning of θέρος, and soon after sunset (ἡ σελήνη ἐξέλιπεν ἑσπέρας), a lunar eclipse occurred in Athens. This is apparently the eclipse in —403, Feb. 23d, 6h. 30m. ☋ 9° E., i.e. 4° E. (p. 429). Agreeably to the present lunar theory, 3¼ inches only were obscured. Petavius computed, as was to be expected, the eclipse in —405, April 15th, 10h. local time; but this eclipse is irreconcilable with Xenophon, who refers that eclipse to the first and not to the last months of θέρος, and, especially, to evening (ἑσπέρα). (Comp. p. 445.) The present editions of Xenophon put this eclipse in the 25th year of the Peloponnesian war, beginning, as Xenophon affirms, with the first expedition of the Athenians against Sparta in —429 (p. 471); but the particular passage (παρεληλυθότος ἤδη τοῦ χρόνου καὶ τῷ πολέμῳ τεττάρων), according to the Petavian chronology, contains an alteration of the original text, perpetrated by some ancient transcriber or modern editor.

17. Xenophon (Hell. ii. 3, 4) attests that in the spring, during θέρος of the last (28th) year of the Peloponnesian war, Archon Pythodor II., an eclipse of the sun occurred in Athens (κατὰ τοῦτον τὸν καιρὸν περὶ ἡλίου ἔκλειψιν). This is the eclipse in —401, Jan. 17th, 21h. 30m., ☋ 10° E. (—5° 26′), curve 37°, 32°, 60°, which commenced 3h. 31m. later (p. 429). Petavius mistook Xenophon's eclipse for that in —403, Sept. 2d, 21h. 30m., ☊ 6° W., curve 57°, 38°, 2°; but, unhappily for him, this eclipse belonged to χειμών, and not to θέρος. The same eclipse, moreover, confirms Thucydides and Xenophon, who unanimously bear witness that the Peloponnesian war lasted fully 28 years; for, from the eclipse in —429 (No. 11) to this eclipse in —401, the last year of the Peloponnesian war, 28 years really transpired. Petavius, on the contrary, referring the first eclipse of the war to —430 and the last to —403, made out, of course, that the war lasted only 27 years, and that "bonus Xenophon erravit."

18. Xenophon (iv. 3, 10) narrates that within θέρος of the 1st year of the Corinthian war, Arch. Eubulides (—392 to 391), a great eclipse of the sun (μηνοειδής) was seen on the northern bounds of Bœotia (38° 40′ N. Lat.) The same we read in Plutarch (Ages. 17, vol. viii. p. 654 R) On the occasion of the ecliptic new moon in —391, Jan. 26th, 22h. 30m., ☊ 9° W., the shadow of the moon touched only 33°, 23°, 47°. Since, however, the longitude of the ☊ was shorter by 5° 24′ (p. 429), the obscuration must have been very great in Bœotia. Petavius, of course, computed the two-years earlier eclipse in —393. Aug. 13th, 23h., ☊ 2° east, curve 24°, 29°, 0°; but, alas! this eclipse happened in *χειμών* and not in *θέρος*, and it was, moreover, too small (nine inches according to La Hire's Tables) and not *μηνοειδής*.

19. Xenophon (Hell. vii. 4, 29–32) reports that the battle near Olympia was fought during both the Olympian games and the archonship of Timocrates, accordingly in the month of June of —361. Nearly 10 months after this battle, consequently in —360, during the spring, Pelopidas died in the city of Thebes, Bœotia, as Plutarch (Pel. 31, p. 389 R.) narrates, whilst a great eclipse of the sun took place (*σκότος ἐν ἡμέρᾳ τὴν πόλιν ἔσχεν*). The same we read in Diodor (xv. 81, p. 65 W.) This is obviously the eclipse in —360, May 12th, 3h. 15m., ☊ 1° W., curve 2°, 28°, 21°; but the obscuration was very small in Bœotia (38° 20′ N., 21° 5′ E.), according to the prevalent lunar theory. Thus, our correction (p. 429), according to which the ☊ lay nearly 6° west of the sun, and the conjunction happened 3h. 25m. later, is confirmed. In —351 no solar eclipse was visible in Greece. Petavius. who put the Olympian games two years earlier, and the archons of this time earlier by three years, recurred to the eclipse in —363, July 12, 22h. 15m., ☊ 6° W., curve 41°, 54°, 17°; but the obscuration of the sun amounted to 4 inches only, and it is contradicted by Plutarch, by the epochs of the Olympian games, and by the succession of the archons.

20. Plutarch (Dion 19, p. 286 R.) narrates that during Plato's third sojourn in Sicily (Ol. 105, 3), a remarkable eclipse of the sun, predicted by Helicon, occurred in Syracuse (37° 2′ N., 12° 56° E.) Petavius, commencing the Olympiad 105, 3, with July in —357, computed the eclipse in —356, Feb. 28, 23h. 13m., ☊ 4° W., curve 11°, 26°, 41°; but the obscuration amounted in Sicily to 4 inches only. Other authors refer the same eclipse to Ol. 104, 3, commencing with July 2d in —361, and in this case Helicon's eclipse would have been the same mentioned by Xenophon (No. 19). But Petavius correctly demonstrates that Plato's third visit to Sicily belongs to —357. According to our Table, p. 429, the longitude of the ☊ was shorter by 5° 14′ in —356, Feb. 28th, 23h. 30m. P. T., to the effect that the sun was probably totally obscured in Syracuse.

21. Diodor (xvi. 9), Plutarch (Nic. 23, p. 394 R., *καθ' ὃν χρόνον ἤμελλεν ἄρας ἐκ Ζακύνθου πλεῖν ἐπὶ Διονύσιον ἐκλιπούσης τῆς σελήνης οὐδὲν διαταραχθεὶς ἀνήχθη*), Plutarch (Dion. 24, *μετὰ τὰς σπονδὰς καὶ τὰς νενομισμένας κατευχὰς ἐξέλιπεν ἡ σελήνη*), and Quinctilian (In. or. i. 10, 48, "Dion cum ad destruendam Dionysii tyrannidem venit, not est tali casu deterritus), report that in Ol. 105, 4, in the course of the archonship of Agathocles, a total eclipse of the moon happened in Sicily, soon after sunset. This eclipse must have been total, because it is paralleled with that of Nicias (No. 15) and called a "terrible" one. About that time only one lunar eclipse was possible soon after sunset, viz. that in —356, Aug, 9, 6h. 45m. P. T., ☋ 10° E., obscuration 2½ inches (Pingré), or 4 inches (Calvisius). Since, however, the longitude of the ☋ was nearly 5° 14′ (p. 429) shorter, this eclipse was total indeed. Diodor refers the eclipse to the same year, because Ol. 105, 4, commenced, according to his Olympiads, with July 2d in —356. Even Calvisius recurred to the same eclipse, because all the following eclipses disagreed with the ancient reports. Agathocles ruled two years later; but in —354 no similar eclipse occurred, as Pingré demonstrates.

22 & 23. The ancient authors erroneously refer two different eclipses of the moon to the same battle near Arbela, for they refer those eclipses to different Greek months and hours. Cicero and Arian, who are the most reliable authorities, place the battle in —328, Sept. 10, and the eclipse preceding the latter in Aug. 29, 12h. P. T.; for Cicero (Div. i. 53) says, "si luna paullo ante solis ortum defecisset et in signo Leonis, fore ut armis Darius et Persæ, prælio vincerentur." Arrian (Exp. Al. iii. 7, 6, & 15, 7) reports that the battle, 11 days after the eclipse, was fought both in the month of Pyanepsion, i.e. in September (p. 408), and during the archonship of Aristophanes; moreover, that the eclipse was a partial one (*τῆς σελήνης τὸ πολὺ ἐκλιπὲς ἐγένετο*). About that time only one lunar eclipse coincided with sunrise near Arbela (41° 40′ E.), viz. that in —328, Aug. 29, 12h., i.e. 3h. 44m. after midnight, Arbela time, and, according to our Table (p. 429–30), about three hours later, 6h. 50m. local time. In consequence of the parallax, the obscuration became visible at Arbela nearly two hours earlier. Since Plutarch (Al. 31), however, reports that the Persian army, 11 days after the eclipse, came in sight of Alexander, and since he may have marched eastwardly, during these 11 days, 40 geographical miles, the difference of time is to be diminished by about 3 hours. The ☊ lay 9°, according to our Table nearly (p. 429) 14° W. This eclipse agrees with the reporters. First, it was indeed a small one; it occurred a short time before sunrise; the sun stood then among the eastern stars of Leo, near Virgo; the eclipse happened during Boëdromion (Aug., p. 408), as Arrian teaches. Further, since the archons of this time ruled, as we have seen, two years later, Aristophanes belongs to —328. Finally, a few months prior to the battle near Arbela, Alexandria was founded, and this event Solinus (32 & 42) refers to the consuls Luc. Pap. Cursor and C. Pœtilius in —328, and to Ol. 112, [1,] that is again to —328 (p. 432).

The two-years earlier eclipse in —330, Sept. 20th, erroneously referred to the battle at Arbela, is mentioned by the following authors: Pliny (H. N. ii. 70=72) says, "nobili apud Arbelam Magni Alexandri victoria luna defecisse noctis secunda hora prodita est, eaque in Sicilia oriens." Ptolemy (Geogr. i. 4) puts the same eclipse in the 5th hour (*ἐν Ἀρβήλοις πέμπτης ὥρας φανῆναι, ἐν δὲ Καρχηδόνι δευτέρας*). Plutarch (Alex. 31) refers this eclipse to Boëdromion, and to the beginning of the *mysteria* in Athens (*περὶ τὴν τῶν μυστερίων τῶν Ἀθήνησιν ἀρχήν*). Curtius (Hist. Alex. iv. 10) reports: "prima fere vigilia luna deficiens primum nitorem sideris sui condidit, deinde sanguinis colore suffusum lumen omne fœdavit." Plutarch, referring the eclipse to the beginning of the mysteria celebrated according to lunar months, it is evident that Boëdromion means the lunar month which corresponded with September, because in the course of the preceding year a lunar month had been intercalated. This total eclipse of the moon, then, belongs to —330, Sept. 20th, 7h. 30m., ☊ 4° E.; according to Petavius, 5h. 47m., or 6h. 31m. The sun then rising in Arbela 3h. 40m. P. T., this eclipse agrees with our Table, p. 429–30: for the opposition took place 3h. 19m. later; consequently the eclipse was perceived a short time prior to midnight in Arbela, which agrees with Ptolemy. Besides it is easily explained how it came to pass that the later authors antedated by two years the battle near Arbela; for in later times, as we have seen, the practice of counting the Olympiads from 775, instead of 773, prevailed.

24. Justinus (xxii. 6) and Diodor (xx. 5, p. 409 S.) relate that during *θέρος* of Ol. 117, 3, consequently in the summer of —306, the 7th year of King Agathocles of Sicily, whilst Hieromnemon was archon in Athens, a total eclipse of the sun occurred between Syracuse and Carthage. This eclipse happening one day after the fleet left Syracuse, the locality and the time of this really total eclipse of the sun are sufficiently fixed (*τῇ δ' ὑστεραίᾳ τηλικαύτην ἔκλειψιν ἡλίου συνέβη γενέσθαι, ὥστε ὁλοχερῶς φανῆναι νύκτα, θεωρουμένων τῶν ἀστέρων πανταχοῦ*). Petavius recurred, of course, to the eclipse in —309, Aug. 14th, 20h. 15m., ☊ 4° W., curve 42°, 35°, —4°, obscuration 10 inches; but, alas! this eclipse occurred in *χειμών* and not in *θέρος*, and the archons of this time ruled two, even three, years later than Petavius believed. About that time, viz. in *θέρος*, only one total eclipse of the sun was possible near Syracuse, i.e. that in —306, June 13, 22h, 45m., ☊ 0° 43′ E., curve 0°, 21°, —3°. According to our Table, p. 429, the ☊ lay 4° W. of the sun, and hence the obscuration of the sun was total near Syracuse. The calendrical inscription (p. 412) referring to Archon Nicodorus mathematically demonstrates that the archons of this time ruled two, even three, years later than Petavius made out. Compare No. 19, p. 478, and the eclipses, discussed further on, referring to —197 and —196 (Babylonian eclipses Nos. 11, 12, 13).

25. Diogenes Laërt. (iv. 9, 64) reports that, according to Apollodor (Ol. 162, 4), the death of Carneades was followed by an eclipse of the moon (*ἔκλειψις σελήνης*) in Athens. On occasion of the ecliptic full moon in —126, Oct. 14, 13h. 30m., ☊ 9° W., which the Olympiads point to, 6 inches were obscured. This eclipse, however, being too small, and Apollonius living in later times, we may presume the Olympiads to have been counted from —775, and in this case Apollonius and Diogenes Laërtius would have had in view the two-years earlier eclipse in 128, Nov. 5th, 13h. 30m., ☊ 7° E., which was, according to our Table (p. 429.) a total one, because the longitude of the ☊ was 4° 12′ shorter.

26. Plutarch (De fac. i. o. l. chap. 13, vol. ix., p. 680 R.; see the passage p. 461), being born A.D. 45 (Clinton F. R. p. 85) in Chæronea, Bœotia, became when nearly 20 years old a pupil of Ammonius in Athens (Plutarch De *εἰ*, p. 385), and returned,

several years after, to Chæronea (38° 30′ N.), where he had the good fortune to see a total eclipse of the sun, of which an exact description is to be found in the before-mentioned passage (p. 461). "During the eclipse," he says, "which I lately observed, many stars in all directions of the sky became visible, and while it (the eclipse) commenced exactly at noon (ἐκ μεσημβρίας ἀρξαμένη), the air assumed a hue like that of twilight." Really total eclipses of the sun, it is well known, return to the same places of our globe only after centuries, and it happens very seldom that solar eclipses commence with noon; wherefore Plutarch, during his life-time, could not have seen in Bœotia two such obscurations of the sun as he describes. Pingré's computations of ancient eclipses show that, about that time, only the following eclipses coincided with noon in Bœotia whilst Plutarch lived there:

A.D. 71, March 19, 21h. 30m., ☊ 8° W., curve 16°, 39°, 66°.
" 73, July 22, 22h., ☋ 4° E., curve 63-64°, 61°, 24°.
" 75, Jan. 5, 1h. 30m., ☊ 6° W., curve 16-42°.
" 76, May 21, noon, ☋ 12° E., curve Northern Europe & Northern Asia.
" 78, April 29, 22th. 30m, ☋ 2° W., Southern India.
" 81, Feb, 27, noon, ☋ 2° E., curve *, 20°, S.W. Asia.

None of these eclipses could have been really total in Bœotia, or other regions of Greece except that in A.D. 73, July 22, 22h. P.T., Plutarch at that time being aged 26 years. Prof. Hind ("Nature," New York, July 25th, 1872) computed, by means of Hansen's Tables, all the eclipses visible during the last half of the first century of our era and during the first part of the second century, but none of them corresponded with Plutarch; and this fact alone will suffice to convince every astronomer that the present theory of the moon's motions is incorrect. According to our Table, p. 429, the ☋ lay, A.D. 73, July 22, about 3° 24′ nearer to the sun, and hence the central shadow of the moon traversed, about noon, nearly the 38th degree of N. Lat., and not, as Pingré found, the 61st degree. The conjunction happened 2h. 12m. later, which agrees with Plutarch, who testifies that the eclipse "commenced at noon." All these 26 Greek eclipses confirm the result, obtained by the Roman eclipses, that the longitudes of the moon and her Nodes were, in earlier times, shorter than our Lunar Tables, based upon the Almagest, induce.

Some earlier Solar and Lunar Eclipses of the Greeks.

2. This eclipse, predicted to the Milesians by Thales, and referred to sunrise by Herodotus (i. 74), has already been alluded to (p. 440). It is not the same which Herodotus refers to the battle on the Halys; for the latter, likewise predicted by Thales, happened several hours later, as we now shall see.

1 & 4. The dates of these two eclipses depend on the stages of Cyrus's life. Herodotus (iii. 27) reports that Cambyses, the son of Cyrus, conquered Egypt in the course of the 5th year of his reign, and that in the following year a new Apis period of 25 years commenced. These periods began, as we have seen (p. 405), together with the Canicular periods, in —2780, —1320, and A.D. 140; and the renewals of Apis periods occurred, subsequent to —1320, in all years which, being divided by 25, give the remainder 20, e.g. in —520, —495, —320, and so on. Since, then, an Apis period recommenced in the 6th year after Cyrus's death, viz. in —520, it is apparent that Cyrus must have died in —526, and not, as Ptolemy's Historical Canon erroneously presumed, in —528. Even Eusebius refers the death of Cyrus to Ol. 62, 3, that is, to —526. This result is confirmed by Daniel, Cyrus's contemporary, and by the "turnus" of the Hebrew priests down to the birth of John the Baptist and that of Christ. Xenophon (Cyr. vii. 4, 16) bears witness that Cyrus, subsequent to the capture of Babylon, reigned nine years, and Herodotus (viii. 7) reports that Cyrus, seven years prior to his death, destroyed Nineveh and the Median supremacy in Asia, in consequence of which Cyrus permitted the Hebrews to return to Palestine and to rebuild the temple. Daniel (ix. 25) says: "Know therefore and understand, that from the going forth of the commandment to restore and to build Jerusalem unto Messiah the Prince, shall be seven weeks and threescore and two weeks," etc. Likewise, Daniel reckons 33 years from the birth of Christ to the crucifixion. The seventy weeks of Daniel have been explained in the author's Chronologia Sacra (p. 107, 112), and in "Gettysburg Review," 1861, p. 341. Daniel, in one word, reckons 532 years from the destruction of Nineveh to Christ's birth, which happened, as we have seen (p. 454), seven days prior to the beginning of the year 0, the first of the original Dionysian era. Moreover, the same year —532 results from the "turnus" of the 24 classes of the

Hebrew priests, as has been demonstrated in the author's Chronologia Sacra, 1846, p. 97 John the Baptist having been born six months before Christ, and on the longest day (June 24), had been announced to Zacharias, a priest of the 8th class (course), viz. that of Abia, whilst the same was in the temple about September 20th, in the year — 2. Now, the Hebrews, having returned to Jerusalem, inaugurated the new altar on the day of the autumnal equinox (Ezra iii. 8), and during this week the first of the reorganized 24 classes of the priests had to serve the sanctuary. Hence, an easy computation establishes the fact that from the inauguration of the new altar down to the annunciation of the Baptist neither more nor less than 1151 turnus and 7 weeks transpired. Consequently the end of the Babylonian captivity, and the destruction of Nineveh, with which the reign of Darius Medus alias Cyaxares II. expired, and the monarchy of Cyrus commenced, belongs to — 532; and this year was, as we have seen, the seventh prior to Cyrus's death in — 526. To this very year, then, the solar eclipse belongs which preceded the conquest of Nineveh, called Laryssa (Heb. *rasas*, the ruins), the present Mosul (36° 31′ N., 43° 30′ E.), as Xenophon (Anab. iii. 4, 7) testifies. He reports that the king of Persia (Cyrus), when taking the supremacy from the Medians, besieged Nineveh (Laryssa) for a long time, but in vain, till, one day, the sun disappeared (*ἥλιον νεφέλη προσκαλύψουσα ἠφάνισκε μέχρι ἐξέλιπον οἱ ἄνθρωποι και οὕτως ἑάλω*). This is, then, the eclipse in — 532, Jan. 26th, 15h. 45m. P. T., ☋ 20° E.: curve, touched by the shadow of the moon, 34°, 36°, 64°. According to our Table (p. 429), the longitude of the ☋ was shorter by nearly 6° 5′, and hence the eclipse must have been a large one in Nineveh. The conjunction happened, according to our Table, nearly one hour before noon, local time. On this occasion it comes to light that Layard referred the destruction of Nineveh too early by 74 years. Prof. Airy referred Xenophon's eclipse to — 558, May 19, 2h. 15m. Paris time; but in this case the Babylonian captivity would have lasted 47 years only, and not, as the Hebrew chroniclers testify, 70 full years.

We come now to the famous total eclipse (No. 4) observed on the Halys in the course of the battle between the Medians and Lydians. Herodotus (i. 74) reports that in the sixth year of the war between the Medians and Lydians, during the battle on the southern Halys near Lydia, that is, about 39° N. Lat., 36° E., a total eclipse of the sun occurred (συνεστεώσης τῆς μάχης τὴν ἡμέραν ἐξαπίνης νύκτα γενέσθαι). In consequence of this unexpected phenomenon the battle immediately ceased, and the kings Cyaxares and Alyattes resolved to intermarry their adult children. From this marriage Mandane, the mother of Cyrus, originated in the following year. In another place Herodotus (i. 103) repeats that this eclipse was a total one, and that it took place in the course of the battle (ὅτε νὺξ ἡ ἡμέρη ἐγένετο σφι μαχομενοῖσι), and that Thales had predicted it. The same is reported by Clemens Alex. (Strom. i. 130, 5), Cicero (De div. i. 50), Themistius (Orat. xxvi., p. 317 Dind.), even in the Shanameh, as Hammer (Wiener Jahrbücher ix. p. 13) vouches. This eclipse has been very often confounded with that mentioned by Pliny, Eudemus, Eusebius, Hieronymus, and referred by the same authors to Ol. 48, 4, and u.c. 170, i.e. to —581 (No. 2), because both eclipses had been predicted by Thales. Oltmanns, however, correctly distinguished two eclipses mentioned by Herodotus, and he referred the older one, that on the Halys, to —609, Sept. 30; but this eclipse is inconsistent with history, as we shall see directly. The date of the eclipse on the Halys is fixed by the following data:—Cyrus died, as we have seen, in —526, six years prior to the renewal of the Apis period in —520, viz.. as Cicero (De div. i. 33) avers, "70 years old"; consequently Cyrus was born in —596. Further, he destroyed Nineveh, as Xenophon (Cyrop. viii. 7, 1), the seventy weeks of Daniel, and the "turnus" of the Hebrew priests, corroborate, seven years prior to his death, i.e. in —532; and two years earlier, i.e. nine years prior to his departure (Cyrop. vii. 4, 16), he took Babylon, and at that time, as Daniel (vi. 1), Cyrus's contemporary, testifies, he was 62 years old. Consequently Cyrus was really born in —596. Now, Herodotus (i. 107) narrates that Mandane, the daughter of Astyages, the son of Alyattes, at the time of marrying the father of Cyrus, was a marriageable virgin (ἐοῦσα ἤδη ἀνδρὸς ὡραίη); and in that heroic age, mirrored in the monuments of Nineveh, being at present 2470 years old, no girl could be called a marriageable virgin before reaching her 20th year. Accordingly, the eclipse during the battle on the Halys must have taken place twenty or more years prior to Cyrus's birth in —596, that is, about the year

—621. About that time only one total eclipse was possible near the southern Halys, viz. that in −621, May 17th, 20h. 15m., ☊ 2° 46′ E., curve −25°, 2°, −6°. According to our Table (p. 429), however, the ☊ lay 4° W. of the sun, and hence the obscuration of the sun near the 39° N. Lat. must have been total. The eclipse happened on the Halys, as Pingré states, about noon, but, according to our Table (p. 429–30), 4h. 14m. later, which agrees with Herodotus, who reports the eclipse to have taken place in the course of the battle (σφι μαχομένοισι). Oltmanns, it is true, had reference to the eclipse in −609, Sept. 29th, 21h. P. T., ☊ 4° W., curve +, 55°, 22°; but this eclipse was not total on the Halys, and the battle-field would have been nearly the middle of the Black Sea. Moreover, according to this eclipse, Mandane would have been born in −608, and, since Cyrus was born in −596, Mandane, aged eleven years, would have been married to Cyrus's father. Who is able to believe that, 2470 years ago, girls of 11 years were "marriageable virgins"? Prof. Hind, however, as well as Prof. Airy, took the eclipse in −583, May 17th, 20h., for that on the Halys witnessed by Herodotus; but this eclipse was total only between Sardes, Iconium, Tarsus, Issus, Ancyra, and not on the Halys. By the way, since Mandane, according to this eclipse, was born in −582, whilst Cyrus was born in −596, the wonderful discovery is made that Cyrus was born fourteen years prior to his mother.

3. The Fasti Siculi (Chronicon Pashale, p. 144 Par.) refer a solar eclipse, probably observed in Greece, to Ol. 59, 4 (ἡλίου ἔκλειψις ἐγένετο). In the year —538, Nov. 22d, 19h., ☊ 8° W., curve 12°, −26°, −25°, the longitude of the ☊ was shorter by 6° 6′ (p. 429); consequently the obscuration of the sun must have been great in Greece. Two years earlier no solar eclipse occurred.

5. The same Fasti (p. 146) refer a solar eclipse (ἔκλειψις ἡλίου ἐγένετο) to Ol. 65, 1. In —519, Nov. 22d, 17h., ☊ 7° W., curve 52°, 17°, 16°; the conjunction happened 3h. 54m. later, and the longitude of the ☊ was shorter by about 6° (p. 429), and hence this obscuration of the sun in Greece must have been great. Two years earlier no eclipse of the sun occurred in Greece. Hence it is evident that the Fasti Siculi counted the Olympiads from −773 correctly.

6. We proceed now to the famous total eclipse of Xerxes, observed near Sardes (Smyrna), about sunrise, in the early spring. Herodotus (vii. 37), who was born about the same time, reports as follows: *ὁ ἥλιος ἐκλιπὼν τὴν ἐκ τοῦ οὐρανοῦ ἕδραν ἀφανὴς ἦν, οὔτ' ἐπινεφελέων ἐόντων, αἰθρίης τε τὰ μάλιστα· Ἀντὶ ἡμέρας τε νὺξ ἐγένετο.* Aristides (Or. 46, p. 241 Din.) calls the same eclipse a total one (*ἡ τοῦ ἡλίου συμπᾶσα ἔκλειψις*), and the scholiast to Aristides (p. 222 Fr.) likewise refers the obscuration to sunrise (*ἐξ ἀνατολῆς*), and to the vicinity of the Hellespont. Herodotus (viii 51), the Parian Marble (Ep. 52), Dionysius (ix. 17, 38), and Diodor (xi. 1) put the eclipse a few months prior to Archon Calliades (June, 478), and Thucydides (i. 18) counts ten years from the battle at Marathon, of which the date (—488, Aug. 6) is fixed with mathematical certainty (p. 408–410) down to the eclipse of Xerxes. Moreover, a short time after this eclipse the battle at Salamis (according to Plutarch) on the 16th day of Munychion (March 19) was fought in —477; and from Xerxes' eclipse to the Olympian games in —477, during which the battle at Thermopylæ took place, Herodotus (vii. 206) counts about 18 months. Even Plutarch (Ages. ii. 1) and Nepos (Ages. 4) also specify 1 year 6 months from Xerxes' passage over the Hellespont to the Olympian games. Thus the date of the eclipse near Smyrna is both mathematically and historically ascertained. About that time, during spring, only one eclipse coincided with sunrise in Smyrna (29° 26′ E., 38° 28′ N.), viz. that in —478, Feb. 27th, 15h. 30m. P. T., ☋ 17° E., curve touching 39°, 57°, 1°. According to our Table (p. 429), however, the conjunction occurred 3h. 46m. later, i.e. about 7h. 10m. a.m. Paris time, i.e. 9h. Smyrna time. The parallax makes the obscuration of the sun nearly two hours earlier (7h. local time), and about the same moment the sun rose on Feb. 27th in Smyrna. The ☋, moreover, lay (p. 429) 5° 49′ nearer to the sun, i.e. 12° E., and hence the eclipse must have been total near Smyrna. Finally, in the preceding and following years no other eclipse coincided, as Pingré's computations demonstrate, with sunrise. Petavius being unable to produce, about that time, a total eclipse of the sun coinciding with sunrise, did not hesitate, in spite of all ancient authorities, to declare this eclipse to have been "a supernatural phenomenon." Hind recurred to the eclipse in —477, Feb. 17th, 11h. 10m. a.m.,

which was, however, a partial one near Sardes (☋ 9° E.); it did not at all coincide with sunrise, and, besides, it clearly disagrees with ancient history and chronology.

7. Herodotus (ix. 10: *ὁ ἥλιος ἀμαυρώθη ἐν τῷ οὐρανῷ*) bears witness that two years after Xerxes' eclipse, one year after the celebration of the Olympian games (June, —477)), arch. Calliades (—476), a partial eclipse of the sun happened near Corinth, one year subsequent to the battle at Salamis (—477, March 19th). This is the ecliptic new moon in —476, August 1st, 1h. 30m. (+3h 46m.), ☊ 0° E., (—5° 49′), curve 14°, 15°, —21°. Petavius had recourse to the eclipse in —479, Oct. 2d, 1h., ☊ 9° west, obscuration seven inches; but this eclipse preceded Xerxes' arrival in Greece, and it is in conflict with the epochs of the Olympian games.

9 & 10. The Fasti Siculi (p. 162: *ὁ ἥλιος ἐξέλιπεν*) refer a solar eclipse to Ol. 78, 4, i.e. to —460, Mar. 9, 23h. 30m., ☋ 16° E., curve touching 46°, 68°, +. According to our Table (p. 429), the longitude of the ☋ was shorter by 5° 44′, and hence the obscuration of the sun was nearly total in Greece. In —461 and —462 and —463 no solar eclipse was visible in Greece. Eusebius (ad Ol. 78, 4, Armen. p. 338) and Hieronymus likewise mention an eclipse referring to Ol. 78, 4, which is, no doubt, the one aforesaid. It is, however, to be mentioned, that Philostratus (i. 11) reports Anaxagoras, living from —497 to —421, who was the instructor of Pericles, the ruler of Attica from —478 to —428, to have predicted, like Thales, a solar eclipse in Athens whilst he (Anaxagoras) was "32 years old." Consequently, Anaxagoras may have predicted the eclipse in —465 (497—32=465), and in the course of this same year an eclipse occurred on Dec. 25th, 20h., ☊ 6° W., curve 37°, 11°, 27°. Philostratus (i. 2), moreover, relates (see Pingré's Cometography i. 256) that during the eclipse predicted by Anaxagoras a comet was discovered near the sun, which would have been impossible on occasion of a partial obscuration of the sun like that obtained by Halley's Tables. According to the Table on p. 429, the longitude of the ☊ was in —460 shorter by 5° 46′, and hence the obscuration must have been total, or nearly total, in Athens. Even Pliny (H. N. ii. 59) and Plutarch's Lysias report that, Ol. 78, 2, a comet was visible during 75 days.

8. Pindar, being born in —575, deceased in —436, aged 76 years, and he flourished from —480 to 440 in Thebes, Thessalia (38° 20′ N., 21° E.), where he had the opportunity to see a really total eclipse of the sun. A fragment of the hymn by which he immortalized this rare phenomenon is to be found in Dionysius Hal. (p. 167, 18 Sylb., vol. vi., p. 972 R.), which reads thus: *ἀκτὶς ἀελίου, τι—ἄστρον ὑπέρτατον ἐν ἁμέρᾳ κλεπτόμενον λιποῦσ' ἔθηκας ἀμάχανον ἰσχὺν ποταμὸν ἀνδράσι καὶ σαφανείας ὁδόν κ. τ. λ.* (See G. Hermanni De Pindari ad solem deficientem versibus, Lips., 1845.) The fact being known that during a period of 80 or more years only one total eclipse of the sun can occur on the same place of our globe, there is no doubt that Pindar's eclipse was that in —469, March 20th, 1h. 30m., ☊ 0° E., curve —24°, —11°, +10°. According to our Table (p. 429), however, the ☊ lay about 5° 46′ west of the sun, wherefore the obscuration of the sun must have been total in Thebes, Thessalia.

27. To these 26 Greek and 66 Roman eclipses, discussed in the premises, 2 very old ones may be added which concur in verifying that the present theory of the moon's motions needs some fundamental corrections. First, it is notorious that the Chinese authors mention an infinite number of eclipses, but the majority of them are not chronologically fixed. The date of the following, only, is determined by a planetary configuration:—The Chinese annals, it is universally known, contain an uninterrupted series of Chinese regents down to this day. Their dynasties go back, like the Egyptian dynasties specified in Manetho's Sothis, further in the so-called "Vetus Chronicon," by the Tables of Abydos and Karnak, by Herodotus, Eratosthenes, and Diodor of Sicily, to about the "Dispersion of the nations in Peleg's days," 666 years after the deluge; in other words, to about the commencement of the first Canicular period, beginning with July 19 in the year —2780, which epoch is mathematically fixed by sixteen astronomical monuments. (See the author's "Berichtigungen der alten Geschichte und Zeitrechnung," Leipz., 1855, p. 103.) According to Chinese historians, as will be seen in Mailla's "Histoire de la Chine" (vol. i. p. 1, vol. ii. p. 1), the history of China commenced in —3332, and the first regent of the presumed first Chinese dynasty reigned since the year —2598. This chronology has been repeatedly attacked for two reasons. In the first place, many modern historians maintained it to be improbable in the extreme that the Chinese recorded the names and years of their sovereigns and dynasties as early as 3332, or, at least, 2598 B.C. This argument, however, falls short; for the Egyptians have likewise recorded, from Menes (2780 B C) down to the Roman emperors, the years of their kings and dynasties, and this chronology in general has been confirmed by a great number of planetary configurations. (See the author's "Astronomia Ægypt." and "Berichtigungen," p. 137.) Similar historical traditions, moreover, going back to the dispersion of the nations, to the deluge (3446 B.C.) and even to the antediluvian patriarchs, are to be found among other nations of antiquity, especially the Chaldeans, Parsees, Indians, Phœnicians, etc. Hence it is not at all improbable that the Chinese dynasties are in general as reliable as the Egyptian.

The second and more important objection is that the Chinese dynasties do not agree with the chronology in the present Hebrew text of the Old Testament. The question, however, is whether the present Masoretic Hebrew Testament, or else the Hebrew Bibles of the Israelites in Ethiopia, examined by Bishop Gobat in Jerusalem, which reckon 6,000 and not 4,000 years from the creation to Christ, and if the texts of the Septuagint interpreters who translated, about 280 B.C. the Hebrew Testaments obtained from Jerusalem, which manuscripts likewise once reckoned 6,000 years from Adam to Christ, contain the true chronology. This question has, from the Fathers of the Church down to this day, been ventilated by numberless savans, and they all, with few exceptions, arrived at the result that the Septuagint, apart from some clerical errors, has preserved the true chronology. Apart from Josephus, a faithful and orthodox Israelite, and all Fathers of the Church, we mention the following vindicators of the Septuagint:—Julian of Toledo (A.D. 680), P. Burgensis, Pagninus, Bredambachius, Porchetus, Hieronymus a S. Fide, Galatius, F. de Escatante, Leo a Castro, Huntæus, Alf. Samero, Gretserus, Dieghus, Peyva ab Andrada, Bellarminus, Baronius, Fr. Vatablus, Joh. Lorinus, Gilb. Genebrardus, Joh. Isaac, Adam a Conzen, Sim. de Muis, Joh. d'Espeires, Huetius, Phil. Quadagnolus, Calvinus, Drusius, Casaubonus, Junius, Am. Polanus, Mencerus, Andr. Rivetus, Chamierus, Sixt. Amama, Buxtorf, Hottinger, Pokok, Walton, Bochart, Perizonius, Fréret. Many other learned men of the same conviction will be found mentioned in Fabricii "Bibliotheca Antiquaria." Even P. Mailla, the author of the "Histoire de la Chine" (vol. i. p. clix.), wrote to Fréret, one of the most distinguished chronologers and members of the French Academy at that time, as follows: "Vous êtes pleinement convaincu, me dites vous, qu'il faut préférer la chronologie des Septante; il est en effait evident qu'aucun des quarante et plus sentiments des chronologists Hebraisants ne seroit s'accorder avec la chronologie des Chinois, sans parler de celle des autres peuples." The chronology of the Septuagint, moreover, has been verified by many new methods, especially by planetary configurations and other astronomical observations going back to —1951, —1578, —3446, —3725, —5870. (See the author's "Summary of Recent Discoveries," etc., New York, 1857, pp. 114–60; "Die wahre Zeitrechnung des Alten Testaments." St. Louis, Mo. 1857, pp. 22–69.) Hence, seeing that the corrected Greek text of the Old Testament refers the deluge to —3446, it would be preposterous to condemn Chinese history which commences with the year 3332, and refers the first emperor of the first dynasty to —2598, whilst the Egyptians, according to numerous astronomical monuments, put their first king, Menes (Thinites), residing at This, i.e. Tanis (Heb. *Koan*), in —2780, viz. in the 666th year after the Deluge, and in Peleg's days.

Now, the aforesaid Chinese history and chronology—which is, by the way, excepting a few ciphers corrupted by transcribers, the same in all Chinese annals—state that King Tchouen-Hio, the 2d regent of the 1st Chinese dynasty, reigned 78 years, namely, from —2513 to —2435. And in the Universal History of China we find a passage, translated by P. de Mailla (Histoire de la Chine, Paris, 1777, vol. i. p. cliv.), as follows: "*Imperator Tchouen-Hio fecit Calendarium, ut principio veris Luna esset prima. Hoc anno primæ Lunæ primâ die processerat ver. Quinque planetæ convenere in cœlo, transmissa constellatione 'Che' (Aquarii).*" "Lorsque l'empereur Tchouen-Hio fit le Calendrier, il établit le commencement de l'anné au commencement du printemps. Cette année le premier jour de la première Lune etait entrée dans le primtemps. Cinque planètes s'assemblèrent au ciel, on avait passé la constellation 'Che' (Aquarius)." The sun standing, in our age, on the day of the vernal equinox, near the middle of the constellation Pisces. the sun was, one month prior to the vernal equinox, as the Chinese say, in conjunction with the first stars of Pisces about the year —2460; and, indeed, in this very year the conjunction of five planets, referred to, actually took place, as the following approximate computation, according to Lalande's Tables, demonstrates:

Longitudes of the Planets in —2460. March 12, Julian style.

	Heliocentrically.	Geocentrically.
The Sun..........		.... $10^s\ 30° = 11^s\ 0°$
The Moon........		.... $10\ \ 30 = 11\ \ 0$
Mercury..........	$5^s\ 27°\ 33'$	.... 10 24
Venus............	11 27 28	.... 10 29
Jupiter............	11 16 13	.... 10 24
[Mars........	$7^s\ 26°\ 42' = 9^s\ 1°$]	
[Saturn......	$6\ \ 22\ \ 15 = 6\ \ 26$]	

On the vernal equinoctial day in —2460, April 11th, 7h. 36m. Pekin time, the longitude of the sun was $11^s\ 29°\ 23'$, and that of the moon $0^s\ 17°\ 7'$; hence the crescent (luna prima) was visible on the vernal equinoctial day, which Thouen-Hio made the beginning of the year, after sunset, namely, 30 days subsequent to that conjunction of five planets.

Such a conjunction of the said planets, whilst the sun stood between the constellations Aquarius and Pisces, occurs but once within 164,000 years: for the sun stands again in conjunction with the moon, on the corresponding day of the year, first after 19 years, with Mercury not until after 26 years, with Venus not until after 4 years, with Jupiter not until after 83 years; consequently a similar conjunction of the same planets returns after $19 \times 26 \times 4 \times 83$ years. This observation, then, of the year —2460 proves that the history of China, according to which Tchuen-Hio, the 2d regent of the 1st Chinese dynasty reigned from —2513 to —2435, cannot be very wrong, because the planetary configuration referred by the Chinese annals to this king occurred in —2460 only.

The same annals report that Emperor Thong-khang, the 4th of the 2d dynasty, reigned from 2158 to 2145 B.C., and about that time a total eclipse of the sun occurred in Pekin, as the Chou-king, a compilation of the oldest religious books of the Chinese, testifies. This Chou-king contains the following passage, according to P. Gaubil's translation in "Histoire de l'Astronomie Chinoise," Par., 1732, vol. ii. p. 140: "Thong-khang venoit de monter sur le thrône. Au premier jour de la dernière lune d'Autumne le soleil et la lune dans leur conjunction n'étant pas d'accord" (i.e. they conflicted with each other) "dans Fang; l'Aveucle a frappé le tambour, les Mandarins sont montés à cheval, et le peuple s'accourut," etc. The first day of autumn was the autumnal equinoctial day, as we have seen; for Tchouen-Hio ordered the spring and the year to commence with the vernal equinox, thirty days after the aforesaid planetary configuration. The date of the eclipse under consideration is confirmed by the Chou-king itself, because the latter reports that on that day the sun and the moon stood in "Fong," which is, as Gaubil states, the second star south of the bright star in the front of Scorpio, and about the year —2200 the sun stood, on the day of the autumal equinox, near the first stars of Scorpio. Moreover, the Chinese astronomers themselves, as well as Gaubil, referred that eclipse to the day of the autumnal equinox. It is natural, however, that neither the Chinese, with their imperfect theory of the moon, nor the European astronomers in China, being destitute of a correct Lunar Table, succeeded in authenticating this very important eclipse, which must have been a total one, because it caused such great excitement in the capital. The Chinese astronomers, from A.D. 620 to 908, who, moreover, were not yet acquainted with the secular acceleration of the moon, nor even with the *Anomalia media*, came to the conclusion that the eclipse of the Chou-king referred to —2127, which decision is obviously wrong; for the year does not agree at all with the Chinese annals, according to which Thong-khang reigned from —2158 to —2145, or some years earlier. Besides this, on the autumnal equinoctial day of — 2127 the ☊ lay 13° west of the sun, and hence the obscuration was not visible in Pekin. Gaubil insisted upon it, that the same eclipse was that in —2154, Oct. 12th, 6h. 57m. a.m. Pekin time; ☉ and ☽ in Libra 0° 23′ 19″, ☊ in Virgo 25° 24′ 27″, i.e. 4° 58′ 52″ west of the sun, latitude of the moon 26′ 10″, obscuration in Pekin 51′. Unfortunately, however, this eclipse preceded sunrise in Pekin (114° 7′ E. of Paris, 39° 54′ N.), and even in Gan-y-hein, where the sun rose 20 minutes earlier; for Gaubil states that the Tartarian translation of the Chou-king narrates that the same eclipse took place in Gan-y-hein at 8 o'clock;

that is, obviously, after sunrise, and not 8 hours after midnight. He accordingly computed the said eclipse by means of eight different Tables, those of La Hire, Riccoli, Longomontanus, Wing, Philolaus, Rudolph, Carlin, Flamstedt; and yet the eclipse preceded sunrise, according to all Tables, both in Pekin and Gan-y-hein. And why? Because all these Tables were based on Ptolemy's eclipses in the Almagest. Since, then, during a period of 912 years only one total eclipse of the sun happened on the same day in Pekin, we come to the eclipse in —2192, Oct. 10th, 18h. Par. T., i.e. 1h. 36m. p.m., in Pekin (114° 7′ E. of Paris); for all nations of antiquity commenced the civil day with sunrise, for which reason the "8th hour" commenced about 2 o'clock p.m. Since, moreover, the eclipse of the Chou-king happened in Gan-y-hein, where the sun rose 20 minutes earlier than in Pekin, it follows that the said eclipse was seen in Pekin about two hours past noon, on Oct. 11th, in —2192, which day was, as the Chinese report, the day of the autumnal equinox. On that day (—2192, Oct. 10, 18h. Par. T.) the longitude of the sun was nearly $6^s\ 0°\ 46'$, that of the moon $6^s\ 6°\ 41'$, that of the ☊ $6^s\ 10°\ 22°$. According to our Table, p. 429, the longitude of the ☊ was shorter by 17° 15′, and hence the ☊ lay 7° 40′, likely 6° only, west of the sun. According to the same Table, the moon's longitude was $6^s\ 0°\ 35'$, because it must be shortened by 6° 6′; but a more exact computation of the moon's place will decide the question how far our coëfficients concerning the secular accelerations of the moon, and her Apsides and Nodes, are to be diminished. Besides, this eclipse is well qualified to determine more exactly the secular acceleration of our globe. Finally, it is not to be wondered at that our eclipse happened 34 years earlier than the present chronology of the Chinese emperors requires; for, in copying ancient manuscripts, the ciphers were most of all subject to corruptions, as the copies of Manetho's dynasties in Eusebius, Africanus, and in the Armenian translation of Eusebius, demonstrate. (See the author's "Theologische Schriften der alten Æg.," 1855, p. 104.) By the way, all students of Chinese literature maintain that Fohi, "during whose life the columns of the heavens broke down," is the Chinese Noah; and the Chinese annals, as we have seen, refer him to —3332, whilst the deluge, according to the corrected Septuagint and the planetary configuration represented in the Noachian alphabet, ended in —3446. The date of our eclipse, it is evident, harmonizes Chinese chronology with the Septuagint, apart from 80 years (3446 = 3332 + 34 + 80). The time will come when all other Chinese eclipses will be once more chronologically fixed, as well as the Greek and Roman ones.

28. The oldest eclipse mentioned in history is, no doubt, that observed in Tanis about the time of Menes' arrival in Egypt, and about the beginning of the first Canicular and the first Apis periods, namely, the lunar eclipse in — 2780, May 23, 15h. P. T., ☊ 12° E. It is known that the Apis-bull was a living emblem of the moon, as Jablonskius (Panth. Æg. iv. 4) and my Astronomia Ægyptiaca (p. 100) have demonstrated. Horapollo (ii. 4, i. 10), and the fact that the so-called Isis Table, the Nativity of Trajan, signifies the sun by the Mnevis-bull and the moon by the Apis-bull, put beyond question that Apis represented the moon. This is, moreover, confirmed by the Apis periods of 25 Egyptian years; for the longitude of the moon is exactly the same after 25 vague years of 365 days, i.e. after 25 Julian years, minus 6 days and 6 hours; and this singular phenomenon gave rise to the Apis periods, i.e. Moon periods of 25 Egyptian years, so often mentioned in Egyptian, Greek, and Roman histories. For instance, in — 2780, July 19, which was the first newyears day of the Egyptians, on the 1st day of the month called Thoth, the moon and the sun stood distant from each other 180°; it was the day of the full moon: and 25 years later, viz. in — 2755, the full of the moon again coincided with the 1st day of Thoth, the newyears day. The Apis, however, signified the moon not in general only, but also especially an obscuration of the moon, a lunar eclipse about the beginning of the first Apis period in — 2780; for the Apis must always be a black bull with a white crescent-like figure on his side, as archæology reports. It would have been absurd to represent the candent full moon by a black bull with a crescent-shaped white sickle. Even the myth that Menes was devoured by a crocodile, points us to a lunar eclipse about the time of Menes' arrival in Egypt; for Menes simply signifies the moon, like the Greek *Μήν*, the Hebrew *meni*, the Arabic *mana*, our moon, *men-sis*, and the like; and even the Coptic name of poppy, viz. *ne-man*, signifies the flower of the moon, the German *Mohn.*

Hence the name of King Menes was syllabically expressed by the figure of the crescent, e.g. in Burton's "Excerpta hieroglyphica." Pl. XV. representing the planetary configuration of Menes in —2780, July 16, the day of the summer solstice. The mythical description of a lunar eclipse by the devouring of the moon by a crocodile, is analogous to that of the Chinese, according to whom, the sun and the moon, at the time of eclipse, are being devoured by a dragon.

The time of Menes' eclipse is astronomically fixed; for the Vetus Chronicon, preserved by Syncellus, expressly reports that Menes and the following dynasties reigned "since the beginning of the Canicular period" in —2780, and, accordingly, that the first fifteen dynasties ruled simultaneously in different provinces of Egypt. The Table of Abydos, furthermore, specifies 38 kings successively reigning from Menes to the last king of the 18th dynasty, viz. Ramses, who ruled, according to the nativities of several kings of the same dynasty, about —1647 B.C., and Eratosthenes counted from Menes down to the end of the same dynasty 1076 (+57) years. The Table of Karnak, in accordance therewith, enumerates in juxtaposition, on one side, the kings from Menes to the middle of the 18th dynasty who ruled suecessively, and on the other side it specifies the coëtaneous dynasties. All these ancient reports concur in demonstrating that Menes settled in Egypt in the course of the year —2780. The matter has been discussed *in extenso* in the author's "Theologische Schriften der alten Ægypter," Leipzig, 1855, p. 102. This result, finally, is mathematically confirmed by the so often mentioned astronomical monuments referring Menes' arrival in Egypt to the 16th day of July, in the year —2780. According to these monuments, one of which is represented in the author's "Berichtigungen," Pl. I., and another in Burton's "Excerpta hieroglyphica," Pl. XV., the places of the planets were on that day as follows: the sun in Cancer 0°, Saturn in Sagittarius 4°, Mars in Sagittarius 6°, Jupiter in Aries 13°, Venus in Cancer 15°, Mercury in Cancer 2°, the moon in Scorpio 3°. The said day was, therefore, the day of the summer solstice, and it is odd only that Menes commenced the Egyptian year not with the summer solstice, a cardinal day, but, three or four days later, with the 19th or 20th day of July. The prevailing opinion is that the Canicular periods commenced with July

20th, but Ideler's Chronology, vol. ii. p. 594, cites Hephæstion, according to whom that period commenced one day earlier, and the latter has been confirmed by the Tanis stone. How, then, came it to pass that Menes made July 19th the first day of the year? The reason is, no doubt, that he intended to commence the year and the Canicular period with the beginning of a new week; for July 19th in − 2780 was a Saturday, and this day was the first day of the original week, as the series of the ancient planets, arranged according to their apparent velocities, evidences. Take of the natural series of the planets always the fourth, and you will have the succession of the days of the week as follows:

♄	♃	♂	☉	♀	☿	☽
1	6	4	2	7	5	3

Moreover, our week was already known to Menes, because the sacred records of the Egyptians, written, as history reports, in Menes' days, mention the week. (See the author's "Summary of Recent Discoveries," p. 65.)

The conclusion, therefore, is that the image of the Apis-bull, his black skin and white sickle, signified a partial obscuration of the moon about the time of Menes' arrival in Egypt, and this is the lunar eclipse in − 2780, May 23, 15h. P. T. Long. ☉ $1^s\ 8^\circ\ 4'$: Long. ☽ $7^s\ 15^\circ\ 18'$, i.e., according to our Table, p. 429, nearly $7^s\ 6^\circ\ 18'$; Long. ☊ $1^s\ 20^\circ\ 48'$, i.e. according to p. 429, ☋ $9^\circ\ 9'$ W. of the centre of the earth's shadow, which caused a partial obscuration of the moon.

The actual History of the Persians, Medians, and Babylonians.

No man will gainsay that the Babylonian and other lunar eclipses specified in the Almagest have taken place in the same years of the kings and archons to whom they were linked in the catalogue of eclipses which, as Ptolemy says, came once into his hands. The question, however, is whether Ptolemy, in whose days (140 A.D.) chronology was in its very infancy, and who was still destitute of correct Lunar and Chronological Tables, correctly referred his first 15 lunar eclipses to their real dates, or not. This question principally depends on the question whether Ptolemy's Historical Canon, by means of which he determined the dates of the said eclipses, is true or erroneous. Since many of the Babylonian

Median, Persian, Greek, Egyptian, and Roman regents, successively enumerated in Ptolemy's Historical Canon, occur in Biblical, Greek, and Roman histories; and since the principal epochs of the latter have been, in the premises, fixed by a multitude of infallible historical and astronomical certainties, it will be an easy matter to decide the question to what years the 19 eclipses in the Almagest really belong. In advance we put in juxtaposition the successive regents according both to Ptolemy's Historical Canon and his Nabonassarian Era on one side, and on the other their epochs according to other chronological resources, especially the Greek ones (pp. 470–72). It is to be remembered that the basis of Ptolemy's Narbonassian Era is the vague year of the Egyptians, which every four years commences earlier by one Julian day, and that Ptolemy in general referred, as Ideler says, the last months of a king subsequent to the newyears day to the reigning-time of his successor. Fréret, on the contrary, maintained that Ptolemy referred the first months of the Babylonian kings preceding the newyears day to the reigning-years of his predecessor.

REGENTS.	Ptolemy.		Correctly.
Nabonassar	— 746	Feb. 26	— 743
Mardokempad's first year	— 720	Feb. 20	— 717
(1) ☽ Ec. March 19.			
Mardokempad's 2d year	— 719		— 716
(2) ☽ Ec. March 8.			
(3) ☽ Ec. September 1.			
Nabopolassar	— 624	Jan. 27	— 621
(4) ☽ Ec. during his 5th year.			
Nabokolassar (Nebuchadnezzar)	— 603	Jan. 21	— 601
Babylonian captivity, 2 Kings xxv. 1.			
Nabonnad (Belshazzar)	— 554	Jan. 9	— 552
Cyrus	— 537	Jan. 5	— 535
Cambyses	— 528	Jan. 3	— 526
(5) ☽ Ec. during his 7th year.			
Darius (Hystaspes)	— 520	Jan. 1	— 518
(6) ☽ Ec. during his 20th year.			
(7) ☽ Ec. during his 31st year.			
Xerxes	— 485	Dec. 23	— 484
Artaxerxes (Longimanus)	— 464	Dec. 17	— 462
Darius (Nothus)	— 423	Dec. 7	— 422
Artaxerxes (Mnemon)	— 404	Dec. 2	— 402
(8) ☽ Ec. 381, December 12.			
(9) ☽ Ec. 380, June 6.			
(10) ☽ Ec. 380, December 1.			
Ochus	— 358	Nov. 21	— 356
Arses (Arogus)	— 337	Nov. 16	— 335

REGENTS.	Ptolemy.		Correctly.
Darius (Codomannus)	— 335	Nov. 15	— 332
Alexander (Magnus)	— 331	Nov. 14	— 328
Philippus Aridæus (Ptolemæus Soter I.)	— 323	Nov. 12	— 320
Alexander II. (Cassandra)	— 316	Nov. 10	— 314
Ptolemæus Lagi (Soter I.)	— 304	Nov. 7	— 303
Pt. Philadelphus	— 284	Nov. 2	— 283
Pt. Evergeta I.	— 246	Oct. 24	— 245
Pt. Philopator	— 221	Oct. 18	— 220
Pt. Epiphanes	— 204	Oct. 13	— 203
(11) ☽ Ec. — 199, September 12.			
(12) ☽ Ec. — 197, July 23.			
(13) ☽ Ec. — 196, January 16.			
Pt. Philometor	— 180	Oct. 7	— 179
(14) ☽ Ec during 7th year of Philometor.			
Pt. Evergeta II.	— 145	Sept. 29	— 144
(15) ☽ Ec. — 138, June 1.			
Pt. Soter II.	— 116	Sept. 21	— 115
Pt. Dionysus (Alexander II.)	— 80	Sept. 12	— 79
Cleopatra	— 51	Sept. 5	— 50
Augustus	— 31	Aug. 29	— 28
Tiberius	+ 14	Aug. 20	+ 16
Caligula	+ 36	Aug. 14	+ 38
Claudius	+ 40	Aug. 13	+ 42
Nero	+ 54	Aug. 10	+ 55
Vespasian	+ 68	Aug. 6	+ 69
Titus	+ 78	Aug. 4	+ 78
Domitian	+ 81	Aug. 3	+ 81
Nerva	+ 96	July 30	+ 96
Trajan	+ 97	July 30	+ 97
Hadrian	+ 116	July 25	+ 116
(16) ☽ Ec. + 125, November 5.			
(17) ☽ Ec. + 133, May 6.			
(18) ☽ Ec. + 134, October 20.			
(19) ☽ Ec. + 136, March 5.			
Antoninus Pius	+ 138	July 20	+ 139

Examination of Ptolemy's Historical Canon.

1. History reports that Antonine, in the 2d year of his reign, visited Egypt, and that, at the same time, a new Canicular period commenced. Since Hadrian died, according to Spartianus, A.D. 139, July 10, Antonine's 2d year commenced with the same day A.D. 140, and consequently the new Canicular period belongs to A.D. 140, the 2d year of Antoninus Pius. Ideler, on the contrary, referring the beginning of the Canicular period to the preceding year (A.D. 139), had recourse to the hypothesis that Antonine obtained his first Tribunitia potestas one year prior to Hadrian's death. Yet no emperor was invested with that office previous to the day of his predecessor's death, and the planetary configurations, the Apis periods, the Triacontaëteris, mentioned in the premises (p. 405), place beyond question that the Canicular periods commenced in -2780, -1320, +140, and not, as Ptolemy, Petavius, and Ideler imagined, one year earlier.

2. Ptolemy counts from Caligula to Titus two years too much, because he knew not that the consuls A.D. 47 and 78 were Extraordinarii, as the inscriptions and coins have demonstrated (p. 422).

3. In consequence of this gross blunder, Ptolemy referred the death of Augustus to A.D. 14 instead of 16, for the latter year is confirmed by many infallible arguments, both historical and astronomical (p. 455). Hence the battle near Actium, fought during the 14th year of Augustus, happened in -28, and not, as Ptolemy stated, in -30, which result is confirmed by Josephus (An. xv. 5, 2); for he refers this battle to the 7th year of Herod, who reigned from Sept. 11th in -35, as we have seen (p. 454), accordingly to -28. Moreover, since the reign of Augustus commenced with Cæsar's death, three months prior to the Olympian games, i.e., as a multitude of historical and mathematical developments have brought to light (p. 448), in -41, and not in -43, it is evident that Ptolemy must have likewise antedated by two years all events of Greek history connected with the Olympiads; for the Olympian games were celebrated, and the archons, closely connected with the Olympiads, ruled two years later than Ptolemy conjectured. Hence Ptolemy's eclipses, referred to the archons Phanostratus and Evander, and to the Calippian periods, must of necessity be postdated by two years.

4. According to the Olympian games, the Apis periods, and several eclipses, Alexander the Great died in -320, and yet Ptolemy's Historical Canon refers this event to -323, three years too early. On this occasion even Ideler, the boldest advocate of Ptolemy's chronology, concedes Ptolemy's statements to be sometimes wrong. Alexander's death in -320 is, in the first place, confirmed by the renewal of an Apis period in -320; for Diodor (i. 76, 84 p. 25 B.) and the Almagest itself (Ideler Chron. i. 182) report that one year after Alexander's death, i.e. in the first year of Ptolemæus Lagi (Soter I.) the Apis period was renewed, which was also the case in -320 (p. 405). Further, Diodor (xviii. 8) and Dinarch (Dem. 81, p. 108, 28) bear witness that Alexander died in the year subsequent to the Olympian games which were repeated in –321 (p. 451). Consequently Alexander died three years later than Ptolemy supposed.

5. Ptolemy's Canon refers the foundation of Alexandria and the battle near Arbela, fought some months prior to Darius Codomannus's death, to –331 and –330, respectively. But Curtius (iv. 5, 11) testifies that Alexandria was founded some months after the Isthmia æstiva which were celebrated in –329 (p. 432, ad u.c. 558; comp. p. 471, Ol. 92. The eclipse, eleven days prior to the battle at Arbela, observed in –328 (p. 472), demonstrates that Darius Codomannus died in –328, and not, as Ptolemy made out, in –331, or –330.

6. Darius Nothus died, as Diodor (xiii. 104, 108) recounts, a short time (μακρόν) after the end of the Peloponnesian war, viz. in χειμών, –401 (p. 471); Ptolemy, on the contrary, refers the death of the same king to –403, again two years too early.

7. Since Darius Nothus reigned, according to Ptolemy's Historical Canon, 19 years, he should have commenced to reign in –422, as Ptolemy states. But, alas! Thucydides (viii. 58) narrates that the Lacedæmonians, about the end of the 20th year of the Peloponnesian war, namely, "80 days after the summer sol_stice," confederated with the same king, viz. in the course of his 13th year (τρίτῳ καὶ δεκάτῳ ἔτει Δαρείου βασιλεύοντος). Consequently, since the 20th year of the Peloponnesian war commenced (p. 471) with the year –409, Darius Nothus must have reigned in –422, and not, as Ptolemy misjudged, in 423. Moreover. Clinton's Fasti Hellenici (p. 315) affirm that Ptolemy omits the reigns of Xerxes II. and Sogdianus; that, consequently, Darius Nothus ruled one year less, or that he ruled simultaneously with both the said kings.

8. Thucydides (iv. 50) informs us that Artaxerxes Longimanus died during χειμών of the 7th year of the Peloponnesian war, commencing with the year 422 (p. 471), and yet Ptolemy's Canon refers the death of the same king to –423; that is also one year too early.

9. Herodotus (vii. 1, 3, 4) reports that Darius Hystaspes died four years after the battle at Marathon, and that in the same year Xerxes commenced to reign. The battle at Marathon in –488, Aug. 6th, being incontrovertibly fixed by the Solar Calendar of

the Greeks, and by the astronomical full moon four days prior to the 6th day of August (pp. 408, 409, 487), it is apparent that Xerxes must have reigned since –484 and after August 6th. The Parian Marble (Ep. 48), which counts the years down to Archon Diognetus (July in –261), refers the battle at Marathon to the same year (227 + 261 = 488). Hence the same authentic monument counts 223 years from Xerxes to Diognetus, to the effect again that Xerxes reigned not in –485, but in –484. (See Boeckh's Corpus Inscript., vol. ii., p. 294.) Ptolemy's Historical Canon, on the contrary, refers Darius Hystaspes' death and Xerxes' reign to –485. Eusebius likewise puts Xerxes in Ol. 73, 4, i.e. in –484; the Armenian translation reads "Ol. 74, 1," which makes no difference.

10. Herodotus (vii. 20), who was born about the same time in —481, and "53 years prior to the beginning of the Peloponnesian war" (Gell. xv. 23. Suidas ad v.), reports that Xerxes marched out against Greece in the 5th year of his reign, consequently in —479. His arrival at Sardes in —478 is mathematically fixed by the total eclipse of the sun in the early spring of —478, Feb. 27 (p. 487). In the following year, —477, the battle near Thermopylæ was fought during the Olympian games (Her. vii. 206), and the Parian Marble (Ep. 51) counts from this event to Diognetus 216 years; wherefore the said battle belongs to —477. This date is confirmed by Thucydides (i. 18), who counts ten years from the battle at Marathon (Aug. 6, —488) to Xerxes' arrival in Greece, and by Eratosthenes, who counts 48 years from Xerxes' crossing the Hellespont to the beginning of the Peloponnesian war in —429. Ptolemy's Canon, on the contrary, refers the first year of Xerxes to —485, i.e. again one year too early.

11. It is universally known that the Babylonian captivity commenced in the 11th year of King Zedekiah, the 1st of Nebuchadnezzar (Jer. xxxix. 1; 2 Kings xxv. 8; 2 Chron. xxxvi. 17); that the same bondage lasted full 70 years (2 Chron. xxxvi. 22, "fulfil threescore and ten years"), and ended in the 1st year of Cyrus (2 Chron. xxxvi. 22; Ezra i. 1). Now, Ptolemy's Canon puts Nebuchadnezzar in —603 and Cyrus in —537; accordingly, the captivity lasted 66 years only. Indeed, this is the chronology of Petavius, who made out that the Babylonian captivity "lasted only 66" and not 70 years with some months. But, who is capable of believing that the Prophets, who lived at the same time, and the sacred chroniclers were mistaken? The simple conclusion, therefore, is that Ptolemy's Canon is again erroneous. Cyrus, as we have seen (p. 483), permitted the Jews to rebuild Jerusalem subsequent to the conquest of Nineveh in —532, seven years prior to his death, and that year is incontrovertibly determined by the solar eclipse in —532, by the Apis periods, by the *turnus* of the priests, and by the seventy weeks of Daniel. Consequently, Ptolemy ought to have put Cyrus's monarchy in —532, and not in —537, i.e. he put it at least four years too early. How came it to pass that Ptolemy committed this error of four years? First, Ptolemy antedated in general, as we have seen, all his kings by two years, and, moreover, he forgot to mention Cyrus's predecessor, viz. Darius Medus, whom Josephus expressly inserts with two years between Cyrus and Nabonad (Belshazzar).

12. Ptolemy (Almagest iii. 6, p. 204 Hal.) says éxpressly that from the 1st year of Nabonassar (—746, Feb. 26) down to Alexander's death (—323, Nov. 12th) 424 vague years elapsed. The account is true, for —746, Feb. 26, —424, Nov. 12, gives 322 Julian years and 8 months. But the question, however, is whether Alexander actually died in —323, or not. Alexander's death in —320, on the 6th day of Thargelion (April 6th), is, as we have seen, placed beyond any question, because he died one year after the celebration of the Olympian games (Diodor xviii. 8; Dinarch, in Dem. 81, p. 100, 28; Joseph. c. A. I. 22; Ant. viii. 28; Ælian. V. A. ii. 25; Laërt. vi. 79), and in the 1st year of an Apis period (Diod. i. 84. p. 25 Bip.), and eight years subsequent to the lunar eclipse preceding the battle at Arbela in —328, and, as history says, 33 years after his birth, which happened during the Olympian games in —353 (Plut. Alex. 3; Cic. de Div. i. 23; Euseb. ad Ol. 106, 1). The natural inference, therefore, is that Ptolemy likewise antedated the reigning-time of Mardokempad by three years, because he had antedated Alexander by three years.

13. Finally, so far as Ptolemy's chronology of the Lagides is concerned, at least three errors are apparent. First, Alexander having died in —320, and not —323, Ptolemæus Lagi must have reigned three years later than formerly was believed. Further, Cicero (Legg. agr. ii. 17) testifies that King Ptolemæus Alexander died during his own consulate, and, since the latter's reign began in —62, and not in —63 (p. 432), the said king reigned one year later than Ptolemy stated. Consequently, Soter II., the predecessor of Dionysus, who ruled 30 years, must have died in —79. and not in —80. Finally, since Cleopatra assisted at the Olympian games in —29 (p. 451), and not in —31, and since the battle near Actium happened in —28, and not in —30, it is evident that Cleopatra's history must likewise be postdated by nearly two years.

These arguments, apart from many others, remaining *in petto*, will suffice to convince every sane historian that the whole of Ptolemy's Historical Canon down to Titus is wrong; that, therefore, all eclipses linked to Ptolemy's kings and other historical epochs must of necessity be referred to later dates. It is singular, indeed, that a world-renowned astronomer like Ptolemy should commit such gross errors as his Chronological Canon contains; but *errare humanum est*, and it is known that he does not at all belong to the class of reliable ancient authors; for Biot, a savant whose wisdom and discernment inspired, a long time since, all the scientific world with veneration, pronounced as follows:—"Since I examined Ptolemy's catalogue of fixed stars, I have lost the last remainder of respect concerning the Alexandrian astronomer."

It is, moreover, not the first time that Ptolemy's Historical Canon has appeared to be erroneous, for many historians before us have likewise given judgment against Ptolemy. We mention only the following authors: *Masson's* Histoire critique de la république des lettres, Paris, 1714, T. i. p. 22; *another author*, in the same work, T. v., p. 114; *Lobbi's* Introductio Chron. ii. 38; the *anonymous author* of the Dissertatio de Canone astronomico, p. 149; *Koch's* Entsiegelter Daniel, p. 131; *Drumel's* Proben einer verbesserten Harmonie der heiligen und Profanscriebenten, Frankfurt, 1746; *Johan Kepler's* Eclogæ Chronologicæ; *Megerlin's* Commentar. Chronolog. in Tabulam mathematico-hist.; *Conring's* Canonem mathem. Nabonassaræum non mereri fidem (Grævii Syntagmata); *Harduin's* Chronologia V. T. Amstel., 1709; *Artopæus's* Dissertatio de summis imperiis; *Ravius's* Chronologia infallibilis; *Wagner's* Institutiones historicæ; Ideler's Chronol. ii. 122, etc. Others maintained Ptolemy's Canon to be incorrect, except the years to which eclipses are linked, and to this class of opponents *Scaliger*, *Dodwell*, *Des Vignoles*, and *Fréret*, who put Ptolemy's newyears days in the 1st year of each Babylonian king, are to be numbered.

The real dates of the Eclipses in the Almagest.

11, 12 & 13. Ptolemy (Alm. iv. 10, p. 279) says that in the 54th and 55th years of the second Calippian period three lunar eclipses happened, of which the latter two belonged to the same Calippian year (τῷ αὐτῷ νε' ἔτει). These eclipses the Almagest refers to — 200, Sept. 22d; to — 199, Mar. 19th, and to — 199, Sept. 12th. Since, however, the Greek year commenced with the 1st day of Hecatombæon, June 2d (p. 408), it is evident that Ptolemy's eclipses in — 199, March 19th, and in — 199, Sept. 12th, refer to two different Calippian years, and not to the same Greek year (αὐτὸν ἔτος): for the eclipse in — 199, March 19th, belonged to the 53d year of the Calippian period, whilst the eclipse on Sept. 12th in — 199 appertained to the 54th year of the same period. Moreover, the first Calippian period was, as is well known, a continuation of Meton's lunar cyclus of 19 years, which had commenced not in — 429, as Ptolemy imagined, but in — 428, with May 15th (p. 408), viz. during Apseudes' archonship; and the archons of the times of Calippus ruled, in consequence of the lost year between Thucydides and Xenophon (p. 469), two years later than Ptolemy calculated. Consequently, the aforesaid 3 eclipses are to be postdated as follows:—The first of them happened in — 199, Sept. 12, 13h. 30m., ☋ 3° W., which year belonged to the 54th year of the Calippian period; the 2d refers to — 197, July 23d, 11h. 45m., ♌ 11° E.; the 3d to — 196, Jan. 16th, 5h. 30m., ☋ 5° E. According to our Table (p. 429), the longitudes of the Nodes were at that time nearly 4° 31′ shorter, and the oppositions happened about 3 hours later. Indeed, the latter eclipses appertained, as Ptolemy's ancient historiographer said, to the same Greek year, because July 23d in — 197 and Jan. 16th in — 196 belonged to the very same Calippian year. Hence these three eclipses alone demonstrate that Ptolemy's chronology of ancient eclipses is wrong.

15. Ptolemy (Alm. vi. 5, p. 390) mentions a lunar eclipse observed in Rhodus during the 37th year of the third Calippian period, which he referred to — 140, Jan. 27th, 9h., ☋ 11° W., obscuration 2¾ inches. But, the Calippian years and archons coming down by two years, that eclipse happened in —138, June 1st, 10h. 15m., ☋ 2° W., i.e., according to our Table (p. 429), 6° W.

8, 9 & 10. Ptolemy (Alm. iv. 10, pp. 275, 277, 278) cites three eclipses observed during the archonships of Phanostratus and Evander, and he referred to Phanostratus both the eclipses in —382, Dec. 23, 5h. 45m., ☋ 10° E., obscuration 2 inches, and in —381, June 18th, 6h. 45m., ☊ 7° 45′ E., obscuration 5½ inches: but to Evander the eclipse in —381, Dec. 12, 9h. 30m., ☋ 2° E., as Pingré states. Inasmuch, however, as the Olympiads and archons of this time come down by two years (p. 470), the latter eclipse should be referred to —379, May 27th, 12h., ☊ 8° W., obscuration 4 inches, but the ☊ lay too far west of the centre of the earth's shadow (p. 429). On the other hand, it is apparent that Ptolemy's eclipse in —382, Dec. 23, 17h. 45m. P. T., which he referred to the archonship of Phanostratus, is erroneous, because it happened, as we shall see below, subsequent to sunrise both in Babylon and Greece. Ptolemy's eclipses occurred one year later than he imagined, viz. in —381, Dec. 12th, 9h. 30m. P. T., ☋ 2° E., or rather 3° W. (p. 429); further, in —380, June 6th, 7h. 45m. P. T., ☊ 3° E., i.e. 2° W.; and in —380. Dec. 1st, 0h. 30m., that is, 4h. 25m. in Babylon, and, according to our Table, p. 429, nearly at 8 o'clock p.m. local time; ☋ 1° W.

5. The years in which Cambyses and Darius Hystaspes commenced to reign are, as we have seen, historically and mathematically fixed (p. 483); for Cyrus died in —526, seven years after the conquest of Nineveh, and this epoch is put beyond the reach of controversy by the eclipse in —532, by the *turnus* of the Hebrew priests, and by Daniel. Accordingly, Cambyses must have reigned since —526, and this year is confirmed by the renewal of an Apis period in the 6th year of his reign, viz. in —520 (p. 405). Consequently, the lunar eclipse observed in the 7th year of Cambyses (Alm. v. 14, p. 341) belongs to the year —519, Nov. 8th, 2h. p.m. P. T., ☋ 8° E., obscuration 2½ inches. Babylon time being earlier by 2h. 45m., and the opposition beginning later by nearly 4 hours, this eclipse happened in Babylon about 8 o'clock p.m. The ☋ lying 6° nearer to the sun (p. 429), this eclipse was a total one in Babylon. Ptolemy, on the contrary, not knowing in what years the Apis periods were renewed, referred the eclipse observed in the course of the 7th year of Cambyses to —522, July 16th, 9h. 30m. P. T., ☋ 6° E., obscuration 6 inches. Consequently, Ptolemy again antedated Cambyses by two years, or three, the day of Cyrus's death being unknown.

6. Ptolemy (Alm. iv. 8, p. 269) refers the lunar eclipse observed within the 20th year of Darius Hystaspes to —501, Nov. 19, 10h. P. T. Since, however, Cambyses died two years later than Ptolemy supposed, Darius Hystaspes must likewise have reigned and deceased later by two years. This is confirmed by Herodotus, who narrates that Darius died four years after the battle at Marathon, viz. in —484, as we have seen (p. 410). Therefore, the real eclipse of the 20th year of Darius belongs to —499, May 4th, 10h. 15m. p.m. P.T., ☊ 4° W. According to our Table, p. 429, the opposition took place about 4h. 50m. after midnight in Babylon, and the ☊ lay 10° W.

7. Ptolemy (Alm. iv. 5, p. 267) reports that in the course of the 31st year of the same Darius a lunar eclipse was observed, which he refers to —490, April 25, 8h. 45. P. T., ☊ 11° E., obscuration 1 inch. But, Darius reigning two years later (p. 501), his 31st year commenced in —488, or, since the day of Cambyses' death is unknown, in —489. Besides, in —488 no lunar eclipse was visible in Babylon. Hence, the eclipse referred to happened in —489, Oct. 8th, 4h. 30m. p.m. P. T., ☋ 1° W., i.e., according to our Table, p. 429, 1 hour before midnight in Babylon, ☋ 7° W. of the centre of the earth's shadow.

4. Ptolemy having learned that in the 5th year of Nabopolassar a lunar eclipse happened in Babylon, referred it (Alm. v. 14, p. 340) to —620, April 21st, 14h. 45m. P. T., ☊ 9° E., obscuration 1¾ inches. But, since all the following kings reigned two years later, Nabopolassar must likewise have ruled in —622, and not in —624; and hence the eclipse of the 5th year of Nabopolassar belongs to —619, Oct. 6th, 12h. ☋ 0° E., and, according to our Table, p. 429, this total obscuration of the moon took place in Babylonia about one hour prior to sunrise. The eclipse in —620, April 21st, 14h. 15m., happened after sunrise in Babylon.

1. Since Alexander the Great died in —320, three years later than Ptolemy states, and since the latter (Almag. vi. 6, p. 204) expressly reports that from the 1st year of Nabonassar down to

Alexander's death "424 years elapsed," we have to presume that the first kings of the Nabonassarian era reigned not two years, as was the case with Nabopolassar and his successors, but even three years later. Hence the lunar eclipse in the first year of Mardokempad which Ptolemy refers to —720, March 19th, 8h. P.T., ☋ 1° W., is to be referred to —717, Jan. 16th, 4h. P. T., ☋ 5° E. The longitude of the Nodes was (p. 429) shorter by 7° 3′, and this total obscuration of the moon took place about 3 hours 30 minutes after midnight in Babylon.

2. The following eclipse in the 2d year of Mardokempad, which Ptolemy refers to —719, March 8th, 10h. P. T., ☋ 9° W., obscuration ¾ of an inch, belongs to —716, Nov. 26th, 0h. P. T., for the longitude of the ☉ was 7^s 28°, that of the moon 1^s 28°, that of the ☋ 8^s 19°. The opposition in Babylon took place 2h. 46m., and according to our Table, p. 429, nearly 4 hours 33 minutes later, i.e. about 7 o'clock p.m. local time. The longitude of the ☋ was shorter (p. 429) by about 7° 3′. Since, however, the Lunar Ecliptic Limit is commonly 12°, and not 13°, this eclipse is to be computed more exactly. The longitude of the Apsides was then, according to our Table, p. 429, shorter by about 3° 21′.

3. The other ecliptic full moon of the 2d year of Mardokempad, which Ptolemy refers to —719, Sept. 1st, 7h. 30m. P. T., ☋ 9° W., obscuration 5 inches; happened in —715, May 21, 5h. P. T.; long. ☉ 1^s 21° 49′; Long ☽ 7^s 21° 43′; long. ☊ 2^s 9° 59′. The opposition in Babylon took place a few minutes after midnight, and the ☊ lay (p. 429) 10° 41′ E. of the sun.

14. Ptolemy (Alm. vi. 5, p. 389) mentions a lunar eclipse observed in the 7th year of Ptolemæus Philometor, which eclipse he refers to —173, April 30th, 12h. 45m, P. T., ☊ 9° W., obscuration 7 inches. Since Ptolemæus Soter, however, ruled three years later than Ptolemy's Historical Canon states, and since Ptolemæus Alexander and Cleopatra died, respectively, one and two years later, as we have seen (p. 503), it is probable that Philometor likewise reigned one or two years later, and that, accordingly, Ptolemy's eclipse happened in —171, Sept. 2d, 11h. 30m. P. T., ☋ 5° 59′ E., obscuration 11½ inches. The full moon in —173, April 30th, was not ecliptic (p. 429), and in —172 no lunar eclipse occurred.

16–19. Finally, we come to the four Alexandrian eclipses observed by Ptolemy himself, provided the latter really lived at the same time. These ecliptic full moons he referred to A.D. 125, April 5th, 7h., ☊ 10° E., obscuration 1¼ inches; to 133, May 6th, 9h. 15m., ☋ 5° E., obscuration 12¾ inches; to 134, Oct. 20th, 9h. 15m., ☊ 5° W., obscuration 10 inches: to 136, March 5th, 14h., ☋ 9° E., obscuration 5 inches. The times and magnitudes of these four eclipses, however, disagree very much with Hansen's Tables, as will be seen further on. Moreover, since Ptolemy observed these eclipses with the naked eye, and without chronometers and micrometers, it is evident that his statements concerning the times and magnitudes of said eclipses are not sufficiently accurate for establishing a correct theory of the secular accelerations of our satellite, her Nodes and Apsides. According to our Table, p. 429, the eclipses A.D. 125, 133, and 136, were some inches greater than Ptolemy states. The eclipse of A.D. 134, ☊ 5° W., obscuration 10 inches, was smaller, because the ☊ lay 3° 11′ farther from the centre of the earth's shadow. Besides, none of these eclipses took place, according to our corrections, after sunrise.

Corollaries.

The following are, in short, the results of the preceding researches:

1. By means of new historical and astronomical methods, both totally unknown to Petavius and his adherents down to Clinton and Fischer, it came to light that all the dates of ancient history down to 80 A.D. are to be postdated, and the respective eclipses mentioned by Roman, Greek, and Babylonian authorities have been observed later, respectively, by one or two, and even three years than was formerly believed correct. Some of them greatly differ from those that have been determined by the instrumentality of modern Lunar Tables.

2. If we compute the hundred and some ancient eclipses, fixed in the premises, by means of our Lunar Tables, the majority of the former remain irreconcilable with the reports of ancient eye-witnesses; for all total eclipses of the sun mentioned in Greek, Roman, and other histories would have been partial, sometimes even invisible ones. The same is the case with several total eclipses of the moon witnessed by ancient authors. Moreover, all the eclipses which, according to history, coincided with sunrise, or with fixed hours of the civil day, preceded sunrise and the attested hours according to the usual Lunar Tables. Finally, a number of very small eclipses of the sun and the moon, witnessed by coëval authors, would have been fictitious ones if our Lunar Tables were right.

3. If we, on the other hand, compute the hundred and some ancient eclipses by applying the approximate corrections specified on pp. 429–30, none of the ancient eclipses drop out of existence; all total eclipses were total ones, all partial ones agree with the statements of the Tables, and the alleged hours of ancient eclipses prove more or less true.

4. The secular accelerations of the moon, her Nodes, her Apsides, and probably other elements of the moon's motions, are to be determined by means of the classic eclipses, and not by those in Ptolemy's Almagest. It is impossible to bring both classes of eclipses into harmony; either the former or the latter must be given up. *Tertium non datur.*

Objections concerning the New Theory of the Moon's secular accelerations.

The proposition that the principal motions of the moon are to be fixed by means of the classic eclipses, and not by those in the Almagest, is so paradoxical that there is no doubt all kinds of objections will be raised, which deserve to be canvassed in advance.

1. The nineteen eclipses of the moon, of which the times and magnitudes are so nicely specified in the Almagest, it will be objected, agree with all Lunar Tables constructed since Ptolemy; consequently, it will be said, the eclipses cited in the Almagest must have been the same which the ancients observed, and hence any other theory of the moon's motions differing from the Almagest is nonsense. But, alas and alack! this logical deduction is a gross *conclusio in circulo*, a vicious circle, and I cannot altogether conceive how it came to pass that so many learned astronomers and historians were blinded by the chimera. To state the case clearly: the Babylonian eclipses in the Almagest are the principal basis, the *terminus a* *quo*, of all former Lunar Tables; the latter were artificially harmonized with the former; Hansen, and all other authors of Lunar Tables, put, for the epoch —800, the moon, the Apogee, and the Nodes of the moon in the same degrees of the Zodiac presumed by Ptolemy, in order to obtain the same eclipses specified in the Almagest. Therefore, whenever we recalculate Ptolemy's eclipses, our Tables will necessarily, as a matter of course, represent them in conformity to the Almagest. Instead of referring the Babylonian eclipses to the same years, days, and hours, as Ptolemy did, the previous question ought to have been answered, whether or not Ptolemy's Historical Canon is true, and whether or not all other, or at least the most decisive Greek and Roman eclipses, agree with Ptolemy's theory of the moon's motions. Let us take an example for illustration. The learned Kircher, 200 years ago, translated entire Obelisks containing the usual 600 hieroglyphs: he assigned, distinctively, to each figure a word, ideologically expressed, and thus the first Hieroglyphic Dictionary was produced. Many years after, another Egyptologist translates the same inscriptions by the aid of Kircher's Dictionary, when lo! the same words and contents come out. Consequently, says he, Kircher's Hieroglyphic System must be right. In this vicious circle the entire evidence is involved. The previous critical inquiry ought to have been whether other hieroglyphic inscriptions, being interpreted by the said theory, yield a logical sense, or not. And thus, in reference to the moon's theory, adopted in all lunar Tables, the principal inquiry ought to have been, whether the theory of our satellite, derived from the Almagest, agrees with the Greek and Roman eclipses, or not. This *conclusio in circulo*, then, proves nothing.

2. It is a matter of indifference to what years, and days, and hours, the Greek, Roman, and other ancient historians referred their eclipses: the dates of ancient eclipses are to be determined *a priori* by means of the Lunar Tables alone. This was the position of Ptolemy and of his numberless followers, and yet it will meet with the approbation of no scrupulous historian. *History has its inviolable rights.* The historians of the Greeks, Romans, Hebrews, etc., were honest and intelligent men, being both able and willing to tell the truth; and hence their reports, founded on actual personal observation, or on the testimony of

earlier eye-witnesses, must be respected so long as their traditions are not clearly demonstrated to be impossibilities. This is and will be the stand-point of all present and future historians, especially in reference to the chronology of the ecliptic new and full moons witnessed by Greek and Roman authors. History is not to be constructed *a priori.*

3. The correctness of the Babylonian eclipses, as described in Ptolemy's Almagest, is placed beyond question by careful calculations according to the most perfect Lunar Tables in existence, viz. those of Hansen. This assertion, however, is likewise untenable. The Almagest specifies, as is known, in nearly all instances in what hours and minutes each of its 19 eclipses commenced, in what time they reached the middle, and came to a close; moreover, how many inches and minutes the moon's disc was obscured. Supposing these minute measurements to have been the result of Babylonian observations, those astronomers must, at least since the year −720, have been in the possession of instruments capable of measuring the minutes of hours, and parts of inches of the moon's diameter. In this case, of course, the specified times and magnitudes of the Babylonian eclipses would agree with each other. Now, if we compute the Babylonian eclipses by means of the most accredited Lunar Tables — those of Hansen — what is the result? One of them (No. 3) turns out to have been invisible; another one (No. 15) happened one hour and fifteen minutes later than Ptolemy states; another obscuration of the moon (No. 6) amounted to *one* inch and fourteen minutes instead of *three* inches, as the Almagest says. Let us come nearer to the subject. Prof. Hartwich has taken upon himself to recalculate Ptolemy's 19 eclipses by means of Hansen's Tables (Schumacher's Astronom. Nachrichten, 1860, No. 1241, p. 257), and the result was that Ptolemy's statements differ very much from the computations. For,

No. 2. Obscuration 0.206 ($2\frac{1}{2}$ inches) instead of 0.250 (3 inches).
No. 4. Obscuration 0,071 ($\frac{7}{8}$ inch) instead of 0.250 (3 inches).
No. 6. Obscuration 0.113 ($1\frac{3}{8}$ inches) instead of 0.250 (3 inches).
No. 7. Obscuration 0.022 ($\frac{1}{4}$ inch) instead of 0.167 (2 inches).
No. 14. Obscuration 0.671 ($8\frac{1}{3}$ inches) instead of 0.583 (7 inches), etc.

As to the times of Ptolemy's eclipses, the following incongruities came to light:

No. 9. Duration 2h. 5m. instead of 3h.
No. 15. Beginning 8h. 41m. instead of 9h. 56m.
No. 17. Middle 10h. 41m. instead of 11h. 8m.
No. 19. Middle 15h. 29m. instead of 16h. 13m., and so forth.

What astronomer would have committed so many and such gross mistakes!

The worst of all, however, is that the eclipse No. 2, so well described in the Almagest, concerning its time and magnitude, and which Ptolemy referred to the year —719, Sept. 1st, 6h. 0m., terminated, according to Hansen's Tables, prior to the rising of the moon in Babylonia. "This difficulty," says Prof. Hartwich, "we would overcome by lessening the longitude of the moon in —719; but, alas! in this case the ecliptic full moon (No. 8) —282, Dec. 22d, 18h. 53m., in the Almagest would drop out of existence." What then? Besides, the ☊ lay 16° W. of the earth's shadow on occasion of the aforesaid eclipse.

These mathematical facts will, as it appears to me, suffice to destroy the whole of the reliability of the Almagest thus far, as well as the groundwork of the present theory of the moon. Otherwise, I take the liberty to request the reader to answer the following questions: With what instruments may the Babylonian astronomers have seen an *invisible* eclipse, so *minutely* described in the Almagest? How could they notice an obscuration of the moon amounting to *one-quarter* of an inch only, i.e. to 37″? How could they take an eclipse of ¼ of an inch for an eclipse of 3 inches?

Moreover, the unfavorable statements of Hansen's Tables are confirmed by other ones. Ideler (Abhandlungen der Berlin. Academie d. W. 1814–15, p. 221), having computed anew the seven older Babylonian eclipses, discovered that the magnitude of one of them was only 1 inch 30 minutes, and not 3 inches, as the Almagest narrates, and so on. The same Tables brought to light errors of 1h. 4m., of 49m., of 35m., of 30m., of 15m., and so forth. In short, Ptolemy's eclipses could never have been observed by astronomers.

Finally, it is well known that Buerg, disregarding the Almagest, based his Lunar Tables upon 3200 Greenwich observations, and by means of these Tables Ideler recalculated the same seven eclipses. The result, however, was that 3 of the said 7 eclipses could not have been seen in Babylonia at all. And yet, on occasion of the total eclipse in 1851, it turned out that Buerg's Tables were more correct than those of Burckhardt and Damoiseau, based on the Almagest.

In one word, the Babylonian eclipses are by no means confirmed by Hansen's and other Tables. It is Ptolemy who, A.D. 140, determined the times and magnitudes of the Babylonian eclipses, having referred them to wrong years.

4. The present theory of the moon's motions, especially Hansen's Lunar Tables, principally derived from the Babylonian eclipses, have been ratified by eminent astronomers. It is true, Prof. Airy determined the dates of three famous eclipses of the sun by means of Hansen's Tables. (See Phil. Transac. of the R. Astron. Soc. of London, vol. 8, p. 92; Monthly Not. of the London Astr. Soc. 1857, pp. 233-355.) First, he referred the total eclipse of the sun of Agathocles, Arch. Hieromnemon (p. 472, No. 24), to —309, Aug. 14th, 21h. 15m., ☊ 4° W.; but, unfortunately, this eclipse belonged to χειμών, and not, as history reports, to θέρος (p. 418), and the archons of this time ruled, as we have seen, two years later. Consequently, this eclipse ought to have been referred to —306, June 13, 22h., ☊ 0° 45′, correctly 4° W. of the sun. Accordingly, this eclipse does not confirm, but confutes, the present theory of the moon. — The second eclipse by which Prof. Airy intended to assure the present lunar theory, especially Hansen's Tables, is that observed on occasion of the expugnation of Nineveh and the destruction of the Medo-Babylonian supremacy in Asia, which eclipse he referred to —556, May 19th, 2h. 15m. P. T.; but this eclipse is refuted by a great many of the most reliably ascertained historical events, as we have seen (p. 483). For instance, the Babylonian Captivity, it is universally known, commenced in —601, the first year of Nebuchadnezzar (p. 498), and hence, had Cyrus destroyed Nineveh in —556, the captivity would have lasted 45 years only. Who is able to believe that the coëval Prophets and chroniclers did not know the duration of the Babylonian captivity, which lasted, as they narrate, seventy years and some months? And yet Airy persists that about that time, and during a period of forty years, only one total eclipse of the sun was, according to the present lunar theory and Hansen's Tables, possible in Nineveh, viz. that in —556. The date of this eclipse, moreover, is refuted by the Apis periods, by the *turnus* of the priests, by Daniel, by the reports concerning the years in which Cyrus was born, in which he conquered Babylon and Nineveh, and died, as we have seen (p. 483). Finally, a short time since, Airy himself conceded the untenableness of Hansen's Tables, for our newspapers report the following item: "In his last report, Prof. Airy devotes a few words to the great work he has been engaged in, namely, the preparation for the formation of Lunar Tables, *according to a new treatment of the theory* by which he hopes to be able to give greater accuracy to the final results by means of operations which are entirely numerical throughout the work. Considerable progress has been made in these numerical developments, and he expects, at least, to put *his theory* in such a state that there will be no danger of its entire loss in the event of his death." In one word, Prof. Airy himself discovered Hansen's theory to be incorrect.—The third and last eclipse computed by Airy for vindicating the usual lunar motions and Hansen's Tables is that in —584, May 28th, 4h. 15m. P. T., ☊ 2° W., which he referred to the battle-field on the Halys (Her. i. 74). As this eclipse, however, was, according to Hansen's Tables, not total on the Halys, Airy was compelled to place the battle-field between Smyrna, Tarsus, Ancyra, Iconium, and Issus. Moreover, since Cyrus was born, as we have seen (p. 485), in —596; and since Mandane, the mother of Cyrus, was born one year after the battle on the Halys, viz. in —620, the strange event came to pass that Cyrus was wonderfully born thirteen years prior to his mother.

We proceed now to the 16 eclipses in "Nature," 1872, July 25, p. 251, carefully computed by Prof. Hind, by which the present theory of the moon and Hansen's Table appeared to be mathematically justified.

No. 1 relies on a cuneiform inscription, explained by Rawlinson. I do not know either how far the study of the cuneiform literature of the Assyrians has since my "Alphabeta genuina," Lipsiæ, 1840, p. 133, advanced, or what reasons led Hind to refer this presumed eclipse to —762, June 15. At that time no chronological eras existed except those of single kings; consequently the hypothetic eclipse must concern a certain year of a certain Assyrian king whose name is not determined by Rawlinson.

Moreover, the kings of that time, as we have seen (p. 507), reigning three years later than Ptolemy made the world believe, this eclipse would belong to —759. I fear, moreover, that the date of this eclipse was not fixed at all in the inscription, and that its epoch was made out only by the aid of Hansen's Tables. Pursuant to my approximate corrections of the latter, the longitude of the Lunar nodes was, about that time, shorter by 7° 14′. By the way, this solar eclipse is not all the "*terminus a quo* for researches on the historical eclipses"; for the eclipse observed during the building of Rome is of the same age, and, being fixed both by a planetary configuration and subsequent ascertained eclipses, it is much more reliably ascertained than that of Rawlinson. Moreover, the Chinese eclipse of —2192, likewise fixed by a planetary configuration, is 1300 years older than that in —762. (See page 494)

No. 2. I believe with Hind that the retrogression of the shadow on the dial of Ahaz signifies a solar eclipse. Hind refers it to —688, Jan. 10th, 22h. 15m., P. T.; but, since Hezekiah died in —696, and since 2 Kings xx. 6, reports the phenomenon to have taken place fifteen years prior to the king's death, it is apparent that Hind's eclipse cannot be the true one. (See the author's "Summary," Appendix, the year —696.) Consequently, the eclipse under consideration may have been that in —715, June 5, 21h. P. T., whilst the corrected place of the ☊ was nearly 5° W. of the sun. (See the eclipse p. 439, No. 3.) The proper eclipse in —710, March 13th, 23h., happened likely after sunset in Jerusalem.

No. 3. The total eclipse of the sun predicted to the Milesians by Thales, Hind took for the same which terminated the war between the Medians and Lydians, and hence he referred the eclipse to —584, May 28th, 4h. 15m. P. T., ☊ 2° W. This statement, however, stands in opposition to all ancient reports and established facts; for, in the first place, Herodotus (i. 74) expressly states that this eclipse predicted by Thales coincided with sunrise (εἶδον νύκτα ἀντὶ ἡμέρας γενομένην), whilst Hind's eclipse took place in the afternoon (4 hours p.m.) Even Eusebius, who notoriously begins the Olympian years with the preceding local newyears day, puts the Thalesian eclipse in Ol. 48, 3, i.e. in —581, and not in —584. Further, Pliny (H. N. ii. 12, 9) refers this eclipse to Ol. 48, 4, and at the same time to u.c. 170. Now, then, the Olympiads beginning two years earlier than was formerly believed (p. 79. 98), Ol. 48, 4, extended from June, —582, to the same in —581. And, moreover, the first year post urbem conditam commencing with the Julian month of January in —751, the year u.c. 170 began with January in —581. Thus the time of the famous Thalesian eclipse predicted to the Milesians is incontrovertibly fixed; it must have taken place between January and June in the year —581, namely, during sunrise, as Herodotus says. Indeed it was the ecliptic full moon in —581, March 27th, 17h. 45m. P. T., to which Pliny and Eusebius point us. According to the present theory of the moon's motions, however, this eclipse preceded sunrise in Miletus by nearly two hours; and it was there not total at all, because the ☊ lay 2° E. of the sun. But, according to the Table on p. 429, this eclipse commenced 4h. 9m. later, and the longitude of the ☊ was about 6° 23′ shorter; it lay nearly 4° W. of the sun. How came it to pass that chronologers, being acquainted both with the æra urbis conditæ and the Olympiads, referred the year u.c. 170 and Ol. 48, 4, to the year —584? But it is much stranger still that Hind's predecessors confounded the Milesian eclipse with that on the Halys, and terminating the Lydo-Median war; for Cambyses, the son of Cyrus, reigned, as we have repeatedly seen, since —526, because in his sixth year, i.e. in —520, a new Apis period commenced: accordingly, Cyrus must have died in —526. Further, in —532, the Jews, having returned to Jerusalem, rebuilt the Altar six years and some months prior to Cyrus's death (Cyrop. viii. 7, 1), which is confirmed by the *turnus* of the Hebrew priests. Two years earlier, in —535, Cyrus conquered Babylon (Cyrop. vii. 4, 16), and Daniel, his contemporary (Dan. vi. 1), testifies that in the same year Cyrus was 62 years old; consequently the latter must have been born in —596, and this date is confirmed by Cicero (De div. i. 33), who reports that Cyrus died 70 years old. Now, then, seeing that Cyrus died in —526, being 70 years of age, it follows that he must have been born in —596. Moreover, since Cyrus conquered Babylon 9 years prior to his death, as history reports, viz. in —535, "whilst he was 62 years old," we obtain once more the very same birth-year —596. Thus Cyrus's natal year is put beyond any question. Now, Mandane, Cyrus's mother, was born, as before asserted, one year after the battle on the Halys, during which a total obscuration of the sun happened there; and this Mandane was, at the time of marrying Cyrus's father, an adult virgin of about 25 years; consequently, the eclipse on the Halys and that predicted to the Milesians by Thales must have been two separate occurrences. If we refer the eclipse in —584 to the battle on the Halys, Cyrus, being born in —596, would have been born 13 years prior to his mother. The eclipse terminating the battle on the Halys near Lydia was that in —621, May 17, 20h. 25m. P. T., which happened, as Herodotus says, "some hours after the beginning of the battle," and not with sunrise, ☊ 2° E. of the sun; but according to our Table, p. 429, 4° W. of the sun. Consequently Mandane was born in —620; and one year prior to Cyrus's birth, in —595, she was 25 years of age. About that time no other eclipse of the sun could have been total on the southern Halys; consequently Hind's eclipse of —584 clearly refutes the present theory of the moon's motions.

No. 4. The notable total eclipse of the sun near Sardis, in sight of the whole army of Xerxes, coincided with sunrise (Her. viii. 51, vii. 37), for *ἀντὶ ἡμέρας νὺξ ἐγένετο*. It was, moreover, a total one (*ὁ ἥλιος ἀφανὴς ἦν*), and happened in the early spring, 1 year and 6 months prior to the Olympian games. The latter being celebrated, subsequent to the occupation of Attica by Xerxes, during June in —477, the epoch of this eclipse is evidently fixed. In the year —478, Feb. 17th, 15h. 30m. P. T., the ☋ lay 17°, but according to my Table, p. 429, only 12° east of the sun, and the conjunction happened almost four hours later. Petavius referred Xerxes' departure from Sardis to —480, but Hind, nevertheless, had recourse to the eclipse in —477, Feb. 16th, 23h. 10m. This eclipse, however, did not coincide with sunrise, as Herodotus, born in the same year, asserts, and it was not at all a total one near Sardis, but partial and "annular," and it disagrees apparently with the epochs of the Olympian games. Besides, the solar eclipse of Cleombrotus, mentioned by Hind, and observed near Corinth one year after the same Olympian games (Herod. ix. 10) subsequent to the battle at Salamis, was that in —476, Aug. 1st, 1h. 30m., P. T., ☊ 5° west of the sun (p. 488). Hind, on the contrary, computed the eclipse in —479, Oct. 2d, 1h. P. T., ☊ 9° W., which eclipse does not correspond with all other reports. It preceded both Xerxes' passage over the Hellespont and the battle near Thermopylæ.

No. 5. The eclipse in the seventh year of Agathocles, Archon Hieromnemon, noticed during θέρος between Syracuse and Carthage, was, according to Hind, that in —309, Aug. 17, 21h. 15m., ☊ 4° W., i.e. the same to which Airy recurred. Since, however, this eclipse belonged to χειμών, and not to θέρος, finishing with July 2d (p. 408), and since all the archons ruled from two to three years later (p. 412), it is apparent that Hind likewise referred the eclipse of Agathocles to a wrong year. The said eclipse belongs to —306, June 13th, 22h. P. T., ☊ 0° 43′; according to our Table, p. 429, 4° 15′ W.

No. 6. The total eclipse of the sun subsequent to J. Cæsar's passage over the "frozen" Rubicon, Hind refers to —50, March 7th, 0h. 50m.; yet this eclipse was annular, and it is contradicted by all ancient reports. First, during March no river in Italy is "*covered with ice.*" Moreover, Petronius testifies that during Cæsar's march against Rome a total eclipse of the moon also took place, which was, as Pingré shows, impossible in that year —50. Further, the same historians—Petronius, Lucanus, Dio Cassius (p. 448)—put these two eclipses, happening within fifteen days, in the year u.c. 705, that is to say, in —47, and not in —50: for Rome was founded in —752, and not in —755 (p. 439). Indeed, it was only in —47 that two total eclipses were possible, in the course of January, south of the Rubicon, viz. the solar eclipse on Jan. 3, 21h. 30m. P. T., ☋ 15° E., according to our Table (p. 429) 11° E. of the sun, and the total lunar eclipse on Jan. 18, 9h. 30m. P. T., ☊ 0°, correctly 3° W. of the sun. These two so important eclipses regulate, as we have seen, the whole of the Greek and Roman histories, and they are preëminently adapted to correct the present lunar theory. The dates of these eclipses, moreover, are confirmed by the eclipses observed about the time of Cæsar's assassination, March 15th. The Fasti Capitolini, Josephus, and other authors, record that Cæsar, subsequent to his crossing the Rubicon, ruled six years; he must, therefore, have died in —41. In the same year, on March 27th, 11h. 45m. P. T., a solar eclipse (☊ 7°, corr. 10° W.) occurred in Asia, because the conjunction happened 2h. 30m. later. The lunar eclipse took place in —41, March 13th, 1h. 45m. P. T., that is, 2h. 30m. later, ☊ 7°–3° 50′

E. (p. 429). Both eclipses were invisible in Italy, but the writers who mention these two eclipses only intended to record the singular phenomenon that two eclipses had occurred about the day of Cæsar's assassination, but visible in the eastern Roman provinces only. The same year is fixed by the recurrence of the Olympian games (p. 448).

No. 7. Hind correctly determines the date of Herod's lunar eclipse, witnessed by Josephus (Ant. xvii. 6, 4), which happened in the year 0, Jan. 9th, 12h., ☊ 0° W.; for Christ was born 16 days earlier, and Herod died a few months later. Thus the error of Ideler, who puts the same eclipse four years earlier, comes to light. Ideler's eclipse, moreover, was invisible (p. 454), and Christ was not born four years prior to the accepted date of his nativity.

No. 8. The total eclipse of the sun observed at Nicæa in Bithynia (40° 30′ N. Lat., 27° 30′ Long.), which Phlegon and other ancient authors refer to the 19th year of Tiberius, and to Ol. 202, 2, and to midday, was that of A.D. 33, Sept. 11th, 22h. 30m. P. T.; for, since Augustus died A.D. 16, on the 19th day of the month of August, the 1st year of Tiberius commenced on the very same day, and his 19th year began A.D. 34, according to Roman usage. But the Egyptians and oriental nations, as is known, reckoned the reigns of the emperors from the previous local newyears day, and hence the 19th year of Tiberius commenced in Asia Minor A.D. 33. Some authors put the same eclipse in Ol. 202, 4, instead of, as we have seen, Ol. 202, 2, because some ancient chronologers were in the habit of beginning the Olympiads two years earlier. The said ecliptic conjunction took place A.D. 33, on Sept. 11th, 22h. 30m. P. T., but, according to the Table on p. 429, 2h. 18m. later. The ☋ lay, according to Lalande, 8° E., and the curve described by the moon's shadow was, according to Pingré, 78°, 63°, 33°. Since, however, the longitude of the ☋ was shorter (p. 429) by 3° 32′, it will be found both that the obscuration was total, and that the eclipse commenced really with noon in Bithynia. Hind, on the contrary, referred Phlegon's eclipse to A.D. 29, Nov. 24th, 11h. 10m. a.m. Jerusalem time; but the obscuration of the sun was not total there, and was very partial in Bithynia; it did not, moreover, begin with "the sixth hour of the day"; it also remains irreconcilable with Roman history and with the 19th year of Tiberius.

On this occasion Hind mentions a lunar eclipse, observed A.D. 33, April 3d, 3h., in Jerusalem, ☊ 7° W., obscuration $7\frac{1}{4}$ inches; but no ancient author cites it. Calvisius's "Opus Chronologicum" only mentions, as something noteworthy, that about the time of Christ's crucifixion, which, according to ancient tradition, preceded the full of the moon by one day, an obscuration of the moon had taken place. The 14th day of Nisan, the day of the crucifixion, was always the 19th day of March, Julian style (p. 414).

No. 9. The really total eclipse of the sun in Chæronea, witnessed by Plutarch (p. 482), commenced with noon (ἐκ μεσημβρίας ἀρξαμένη), and happened A.D. 73, July 22d, 22h. P. T.; for about that time only one eclipse of the sun, viz. the one just mentioned, coincided with noon, ☋ 7° E.; curve 63°–64°, 61°, 24°. It must have been total in Chæronea (38° 30′ N. Lat., 20° 46′ Long.), because the longitude of the ☋ was shorter by nearly 3° 24′. Hind examined, by means of Hansen's Tables, all eclipses of the second half of the first century, as well as the ecliptic new moons of the first part of the second century, but failed, of course, to discover Plutarch's really total eclipse. Hence the inference is self-evident.

No. 10. Eye-witnesses have certified that A.D. 418, July 19th, 7 hrs. after sunrise in Constantinople, a total eclipse of the sun happened there, and a comet was discovered during the eclipse. Hansen's Tables, on the contrary, state this eclipse to have been partial in Constantinople; it was only total several miles south of Constantinople. Since, however, the western distance of the ☊ from the sun amounted to 5°, and not to 4°, the totality of this eclipse in Constantinople is saved. This important eclipse will contribute to establish the true secular acceleration of the moon's Nodes.

No. 11. Hind alleges a total eclipse of the sun, observed in Medina A.D. 671, Dec. 6th, 22h. 3m.—which was, however, annular according to Hansen's Tables—and the obscuration of the sun amounted to $\frac{85}{100}$ only, ☊ 6° W. The longitude of the ☊ being shorter by 1° 31′ (p. 429), and that of the perigee shorter by 4°, I conjecture that this eclipse was total in Medina.

No. 12. It is reported that A.D. 840, May 5th, 1h. 15m., a total eclipse of the sun was seen in Worms (Lat. 49° 38′), and yet its totality was visible, according to Hansen's Tables, but 100 miles south of Worms. As, however, the ☋ lay not 6° but 5° east of the sun, it is evident that the obscuration of the sun must have been smaller in Worms, probably total in Strasburg. The correction of the time (+46m.) and the parallax alter this result a little. According to Pingré, the central shadow of the moon described the following curve: 43°, 45°, 49° – 37°.

No. 13. English and Holland chroniclers (Calvisius's Opus Chr.) narrate that A.D. 1133, Aug. 2d, about noon, a total eclipse of the sun happened both in London and Bruegge. Hansen's Tables state that the central line of the shadow traversed Northumberland, because the longitude of the ☋ (8° E. of the sun) was too great. Pingré's curve is 55°, 50°, 13°. Since the ☋, however, lay about 36′ nearer to the sun (p. 429), its total obscuration was nearer Bruegge by many miles. In recalculating this eclipse, the correction of the place of the apogee (–5′) is to be taken into account.

Nos. 14, 15, and 16, finally, refer to certain days of A.D. 1433, 1598, and 1652; and the magnitudes of these solar eclipses, computed by Hind, remain nearly the same. For my approximate corrections of the secular accelerations of the moon, her Nodes and Apsides, are not very important for epochs of such modern dates. Besides, the localities of the related solar eclipses, sometimes copied in the chronicles of that time, are not always accurate and reliable.

Summarily, the objection that the present theory of the moon, especially Hansen's Tables, has been confirmed by Hind's Ancient Eclipses, misses the mark; for, in the first place, the majority of the computed eclipses are irreconcilable with history, fixed by mathematical facts. Prof. Airy, moreover, being at present about to establish, as he himself says, another theory of the moon's motions, I do not doubt that Prof. Hind is now equally convinced that the usual theory concerning the accelerations of the moon, her Nodes and Apsides, deduced from the eclipses in the Almagest, is no longer tenable in face of the really observed eclipses of the Greeks and Romans; otherwise, Prof. Hind would certainly have disavowed, either publicly or privately, the contents of my missive of Feb. 11, 1873; for, *amicus Plato, magis amica veritas.*

5. The most important objection is, no doubt, the following:—

The present theory of the moon's motions is deduced from the unalterable law of gravitation; consequently all other lunar theories essentially differing from the present are to be rejected. To this argument of professed astronomers I have, of course, to respectfully submit. And yet, as a reminder, I venture to offer the following facts. Granted that Damoiseau's Tables, Airy's corrections inclusive, are based upon the immutable law of gravitation, including the influence of the planets,—how comes it to pass that these Tables disagreed so much with the observation of the total eclipse in 1851? How comes it that all the total eclipses of the sun, verified by Greek and Roman historians, are partial when computed by Damoiseau and Hansen's Tables? that, according to the same Tables, many ascertained ancient eclipses were invisible, that the latter preceded sunrise and the attested hours of the day? How is the phenomenon to be explained that the numberless Lunar Tables, constructed successively from Ptolemy to Hansen, differ so much from each other concerning the mean motions and the secular accelerations of the moon, her Apsides and Nodes; that, moreover, all these Tables, some years after their construction, proved useless? I refer to the statements of the Tabulæ Prudenicæ, of Rudolph, Marinus, Pagan, La Hire, Cassini, Clairaut, Halley, Mayer, Mason, Lalande, La Place, Wurm, Buerg, Voiron, Burckhardt, Bouvoir, Euler, Damoiseau, Hansteen, Airy, Hansen, which I compared with each other. How is it that Buerg's Tables, based on 3200 Greenwich observations, agree much better with the eclipse in 1851 than those of Burckhardt? that Prof. Airy, being down to 1875 fully convinced of the correctness of Hansen's theory, is just now occupied with a *new theory* of the moon's motions?

It is not yet known what will result from the researches of this distinguished astronomer. Should he, by a closer examination of the planetary attractions, arrive at the result that in −2300 the longitude of the moon was shorter by about 6°, that of the Nodes shorter by about 18°, that of the perigee nearly 8° shorter than the usual Tables state, then he will be under the necessity of abandoning the eclipses in the Almagest, as I have done, since 1846, in different places. On the other hand, should it be impracticable, in this way, to explain the greatly accelerating motions of the moon, as specified in our Table, p. 429, which is *approximately* deduced from the authenticity of classic eclipses, then it is to be borne in mind that the possibility of expounding the fact is not yet exhausted. The exploration of nature has not yet reached the end. In the first place, it is well known that the comets accelerate, and this phenomenon is put to account of the resistance of the ether. Humboldt (Kosm. p. 406, Philad. ed.) presumes this fluidity to move round the sun from west to east, and points us to the zodiacal light and to the evaporating tails of the comets. That ethereal substance, of whatsoever nature it may be, opposes the motion of all heavenly bodies of our system ; and hence, the moon, more and more retarded, and consequently attracted, by the earth, must gradually perform shorter revolutions. In this way, perhaps, the aforesaid accelerating motions of the moon can be explained.

The following results of the preceding researches are true :

1. All eclipses in the Almagest, apart from the four later, occured in other years than was formerly accepted *bona fide*. Their times and other minutiæ are the result of Ptolemy's erroneous computations. Consequently, any theory of the lunar motions deduced from Ptolemy's Babylonian eclipses must necessarily be incorrect.

The chronology of the other eclipses discussed in the premises is true, because it is both based upon the reports of intelligent and honest eye-witnesses, and confirmed by infallible mathematical facts.

3. No Lunar Tables are to be considered correct as long as they disagree with the most reliably ascertained eclipses of the ancients, and as long as the former turn all total eclipses of the classics into partial or annular ones, many small eclipses into invisible ones, and according to which all eclipses coinciding with sunrise, and those of which the hours are fixed by ancient authorities, preceded sunrise and the attested times.

Catalogue of all Classic and other Eclipses discussed in the premises.

The following eclipses refer to astronomical and not to historical years before Christ.

The added hours and minutes of the eclipses are according to Paris time, wherever no local time is mentioned.

☉ signifies a solar eclipse, of which the magnitude and hours have not been fixed by ancient classic authors.

☽ signifies a lunar eclipse, of which the magnitude and hours are not specified by ancient classic authors.

☉ ∗ and ☽ ∗ signify a solar or lunar eclipse reported to have been total.

☉☽ a solar eclipse which has been nearly total (μηνοειδής) according to ancient classic authors.

☉ ◡ and ☽ ◡ eclipses of the sun and the moon reported to have been small ones.

☉ ☉ solar eclipses coinciding with sunrise according to ancient classic authorities.

‖ and ☽ ‖ solar and lunar eclipses, of which the hours have been specified by the same authors.

The ciphers below ☉ and ☽ signify the pages in the premises where the respective eclipses have been discussed.

The ciphers below the times of the eclipses mean the approximate corrections of the Lunar Table, p. 429-30.

The ciphe1s below ☊ and ☋ refer to the approximate corrections of the Lunar Table, p. 429-30.

E. (east), W. (west) of the centres of the sun's shadow respectively.

NO.	ECLIPSES.	LOCALITIES.	TIMES.	☊ ☋
1	☽ ◡	Tanis. Northern	— 2780, May 23, 15h. Par. T.	☊ 12° E.
	495	Egypt	+ 14h. ±	— 21° ±
2	☉ ∗ ‖	Gan-y-hein and	— 2192, Oct. 10, 7h.	☊ 10° E.
	492	Pekin, China	+ 11h.	— 17° 15′
3	☉ ∗ ‖	Rome. Latium.	— 771, Nov. 19, 0h. 45m.	☋ 14° E.
	438		+ 4h. 43m.	— 7° 17′
4	☉ ◡ ‖	Rome and Teos,	— 752, May 25, 16h.	☊ 8° E.
	439	Asia Minor	+ 4h. 40m	— 7° 11′
5	☽	Babylon	— 717, Jan. 16, 4h.	☋ 5° E.
	507		+ 4h. 33m.	— 7° 3′
6	☽	Babylon	— 716, Nov. 26, 0h.	☋ 14° E.
	508		+ 4h. 33m.	— 7° 3′
7	☽	Babylon.	— 715, May 21, 5h.	☊ 19° E.
	508		+ 4h. 33m.	— 7° 3′
8	☉ ∗ ‖	Rome	— 715, June 5, 21h. 15m.	☊ 2° E.
	439		+ 4h. 33m.	— 7° 3′
9	☉	Jerusalem	— 715, June 5, 21h. 15m.	☊ 2° E.
	516		?—710, Mar. 13, 23h.	☊ 4° W.
			+ 4h. 33m.	— 7° 3′
10	☉ ∗ ?	Rome	— 642, Jan. 11, 18h.	☊ 1° E.
	440		+ 4h. 18m.	— 6° 38′

NO.	ECLIPSES.	LOCALITIES.	TIMES.	☊ ☋
11	⊙ ✱ 485	Southern Halys, Asia Minor	— 621, May 17, 20h. 15m. + 4h. 14m.	☊ 2°46′ E. — 6° 32′
12	☽ 507	Babylon	— 619, Oct. 6, 12h. + 4h. 14m.	☋ 0° E. — 6° 32′
13	⊙ ✱ ⊙ 441, 515, 516	Miletus, Asia Minor	— 581, March 27, 17h. 45m. + 4h. 9m.	☊ 2° E. — 6° 23°
14	⊙ 486	Greece	— 538, Nov. 22, 19h. + 3h. 57m.	☊ 8° W. — 6° 6′
15	⊙ ✱ ? 484, 514	Laryssa (Nine- veh), Mosul.	— 532, Jan. 26, 15h. 45m. + 3h. 57m.	☋ 20° E. — 6° 5′
16	☽ 506	Babylon	— 519, Nov. 8, 2h. + 3h. 54m.	☋ 8° E. — 6°
17	⊙ 486	Greece	— 519, Nov. 22, 17h. + 3h. 54m.	☊ 7° W. — 6°
18	☽ 507	Babylon	— 499, May 4, 10h. 15m. + 3h. 50m.	☊ 4° W. — 5° 55′
19	☽ 507	Babylon	— 489, Oct. 8, 4h. 30m. + 3h. 49m.	☋ 1° W. — 5° 52′
20	⊙ ✱ ⊙ 486, 518	Smyrna	— 478, Feb. 27, 15h. 30m. + 3h. 46m.	☋ 17° E. — 5° 49′
21	⊙ ◡ 488	Corinth	— 476, Aug. 1, 1h. 30m. + 3h. 46m.	☊ 0° E. — 5° 49′
22	⊙ ✱ 489	Thebes, Thes- salia	— 469, March 20, 1h. 30m. + 3h. 45m.	☊ 1° E. — 5° 47′
23	⊙ ✱ 488	Athens	— 465, Dec. 25, 20h + 3h. 44m.	☊ 6° W. — 5° 46′
24	⊙ 488	Greece	— 460, March 9, 23h. 30m. + 3h. 43m.	☋ 16° E. — 5° 44′
25	⊙ ☽ 473	Athens	— 429, Jan. 26, 22h. + 3h. 37m.	☊ 1° E. — 5° 35′
26	☽ 474	Athens	— 421, Aug. 8, 0h. 15m. + 3h. 35m.	☋ 10° E. — 5° 33′
27	⊙ ◡ 475	Athens	— 420, Jan. 18, 2h. + 3h. 35m.	☋ 17° E. — 5° 32′
28	☽ ✱ 475	Athens	— 420, Feb. 2, 6h. + 3h. 35m.	☊ 2° E. — 5° 32′
29	☽ ✱ 476	Sicily	— 410, July 8, 7h. 45m. + 3h. 33m.	☊ 7° E. — 5° 29′
30	☽ 476	Athens	— 403, Feb. 23, 6h. 30m. + 3h. 31m.	☋ 9° E. — 5° 27′
31	⊙ 476	Athens	— 401, Jan. 17, 21h. 30m. + 3h. 31m.	☋ 10° E. — 5° 26′
32	⊙ ✱ 441	Rome	— 400, July 1, 17h. 45m. + 3h. 31m.	☊ 1°45′ E. — 5° 26′
33	⊙ ☽ 447	Bœotia, N.	— 391, Jan. 26, 22h. 30m. + 3h. 29m	☊ 9° W. — 5° 24′
34	☽ 506	Babylon	— 381, Dec. 12, 9h. 30m. + 3h. 28m.	☋ 2° W. — 5° 20′
35	☽ 506	Babylon	— 380, June 6h. 7h. 45m. + 3h. 28m.	☊ 3° E. — 5° 20′
36	☽ 506	Babylon	— 380, Dec. 1, 0h. 30m. + 3h. 28m.	☋ 1° W. — 5° 20′
37	⊙ (great) 478	Thebes, Bœotia	— 360, May 12, 3h. 15m. + 3h. 25m.	☊ 1° W. — 5° 14′
38	⊙ 478	Syracuse, Sicily	— 356, Feb. 28, 23h. 30m. + 3h. 24m.	☊ 4° W. — 5° 14′

NO.	ECLIPSES.	LOCALITIES.	TIMES.	☊ ☋
39	☽ ✳ ...... 479........	Sicily	— 356, Aug. 9, 6h. 45m..... + 3h. 24m.....	☋ 10° E. — 5° 14′
40	⊙ ✳ ⊙.... 441........	Rome	— 340, Sept. 25, 18h........ + 3h. 20m..	☋ 10° E. — 5° 9′
41	☽ ✳ ‖ .... 480........	Arbela and Sicily	— 330, Sept. 20, 7h. 30m.... + 3h. 19m....	☊ 4° E. — 5° 6′
42	☽ ◡ ‖ ..... 480........	Arbela and Carthage........	— 328, Aug. 29, 12h......... + 3h. 18m...	☊ 9° W. — 5° 5′
43	⊙ ✳ 481, 514, 519	S.E. of Syracuse, Sicily ..	— 306, June 13, 22h. 45m... + 3h. 14m...	☊ 0°45′ E. — 5° 0′
44	⊙ .... 442........	Rome	— 293, March 23, 23h....... + 3h. 13m..	☋ 12° E. — 4° 55′
45	☽ .... 442........	Mysia, Asia Minor	— 217, March 9, 4h......... + 3h. 58m....	☋ 3° W. — 4° 34′
46	⊙ ◡ ...... 442........	Sardinia.......	— 216, Feb. 11, 2h. 30m..... + 2h. 58m.....	☋ 5° E. — 4° 34′
47	⊙ ✳ ...... 443........	Zama, Africa ..	— 201, Oct. 18, 23h. 30m.... + 2h. 56m....	☊ 2° W. — 4° 31′
48	⊙ ◡ ...... 443........	Cumæ, near Rome	— 199, March 3, 22h........ + 2h. 56m...	☋ 13° E. — 4° 31′
49	☽ .... 505........	Greece	— 199, Sept. 12, 13h. 30m... + 2h. 55m...	☋ 3° W. — 4° 30′
50	☽ .... 505........	Greece	— 197, July 23, 11h. 45m.... + 2h. 55m....	☋ 11° E. — 4° 30′
51	⊙ ◡ ..... 444........	Rome	— 197, Aug. 6, 15h. 30m.... + 2h. 55m....	☊ 3° W. — 4° 30′
52	☽ .... 505........	Greece	— 196, Jan. 16, 5h. 30m..... + 2h. 55m.....	☋ 5° E. — 4° 30′
53	⊙ (great) ‖ 444........	Rome	— 187, July 16, 20h......... + 2h. 54m....	☋ 4° E. — 4° 27′
54	⊙ (great) ‖ 444........	Rome	— 186, Jan. 10, 23h. 30m.... — 2h. 54m....	☊ 3° W. — 4° 27′
55	☽ .... 508........	Egypt.........	— 171, Sept. 2, 11h. 30m.... — 2h. 50m....	☋ 5°59 E. — 4° 24′
56	☽ ✳ ...... 445........	Apollonia, Greece	— 167, June 21, 7h. 45m.... — 2h. 50m....	☋ 3° E. — 4° 24′
57	☽ ‖ .... 445........	Pydna, Macedonia.	— 166, June 10, 13h. 30m... + 2h. 50m...	☋ 5° W. — 4° 24′
58	☽ .... 505........	Rhodus........	— 138, June 1, 10h. 15m..... + 2h. 45m.....	☋ 2° W. — 4° 15′
59	☽ .... 481........	Athens	— 126, Oct. 14. 13h. 30m.... + 2h. 44m....	☊ 9° W. — 4° 12′
60	⊙ (great) ‖ 445..... ..	Rome	— 102, Dec. 2, 19h.......... + 2h. 40m.....	☋ 15 E. — 4° 6′
61	☽ ✳ ...... 446........	Rome	— 62, Oct. 27, 7h. 30m...... + 2h. 34m......	☊ 5°37′ E. — 3° 57′
62	⊙ (great) ‖ 447........	Rome	— 60, March 27, 4h. 15m.... + 2h. 34m.....	☊ 0° W. — 3° 57′
63	⊙ ✳ ...... 447, 519 ...	N. of Rome....	— 47, Jan. 3, 21h. 30m...... + 2h. 30m......	☋ 15° E. — 3° 53′
64	☽ ✳ ...... 448........	Rome	— 47, Jan. 18, 9h. 30m...... + 2h. 30m......	☊ 0° W. — 3° 53′
65	☽ ✳ ...... 448........	Asia	— 41, March 13, 1h. 45m.... + 2h. 30m... ..	☊ 7° E. — 3° 50′
66	⊙ ✳ ...... 448........	Asia	— 41, March 27, 11h. 45m... + 2h. 30m....	☊ 7° W — 3° 50′

NO.	ECLIPSES.	LOCALITIES.	TIMES.	☊ ☋
67	☉ ⊌ 453	Rome	− 40, Aug. 10, 16h. 15m + 2h. 29m	☋ 14° E. − 3° 50′
68	☉ (great) 453	Rome	− 39, July 30, 18h. 15m + 2h. 29m	☋ 6° E. − 3° 50′
69	☉ 454	Rome	− 37, Jan. 13, 21h. 30m + 2h. 28m	☊ 9° W. − 3° 50′
70	☉ 454	Rome	− 34, Oct. 31, 22h + 2h. 27m	☊ 7° W. − 3° 49′
71	☉ 454	Rome	− 28, Jan. 4, 19h + 2h. 26m	☋ 10° E. − 3° 48′
72	☽ 454	Jerusalem	+ 0, Jan. 9, 11h. 30m + 2h. 24m	☊ 0° W. − 3° 42′
73	☉ ⊌ 455	Rome	+ 7, Feb. 5, 23h + 2h. 23m	☋ 15° E. − 3° 39′
74	☉ 455	Egypt?	+ 16, Aug. 20, 17h + 2h. 22m	☋ 2° E. − 3° 37′
75	☽ ✱ 455	Laybach, Tyrol	+ 17, Jan. 30, 8h + 2h. 22m	☊ 8° E. − 3° 37′
76	☉ ✱ ‖ 456, 520	Nicæa, Bithynia	+ 33, Sept. 11, 22h. 30m + 2h. 18m	☋ 8° E. − 3° 32′
77	☉ 456	Rome	+ 45, July 31, 22h + 2h. 16m	☊ 0° W. − 3° 30′
78	☽ 457	Rome	+ 47, June 25, 15h. 30m + 2h. 15m	☊ 1° E. − 3° 29′
79	☽ 457	Rome.	+ 48, June 14, 6h + 2h. 15m	☊ 7° W. − 3° 29′
80	☉ ✱ ‖ 457	Naples and Armenia	+ 60, Oct. 12, 19h + 2h. 13m	☊ 6° W. − 3° 27′
81	☉ 458	Rome	+ 67, May 31, 3h + 2h. 13m	☊ 3° W. − 3° 25′
82	☽ 460	Rome	+ 68, May 5, 12h + 2h. 13m	☊ 2° E. − 3° 25′
83	☽ ✱ 460	Rome?	+ 68, Oct. 28, 18h. 30m + 2h. 13m	☊ 2° W. − 3° 25′
84	☽ 460	Rome	+ 71, March 4, 8h + 2h. 12m	☋ 8° E. − 3° 25′
85	☉ 640	Rome	+ 71, March 19, 21h. 30m + 2h. 12m	☊ 7° W. − 3° 25′
86	☉ ✱ ‖ 482, 461, 521	Chæronea, Bœtia	+ 73, July 22, 22h + 2h. 12m.	☋ 7° E. − 3° 24′
87	☉ ? 461	Ephesus, Asia Minor	+ 95, May 21, 15h. 30m + 2h. 10m	☋ 5° E. − 3° 20′
88	☉ 461	Rome	+ 99, Sept. 2, 22h + 2h. 9m	☊ 2° E. − 3° 19′
89	☉ 461	Rome	+ 118, Sept. 2, 22h. 30m + 2h. 6m.	☊ 6° W. − 3° 15′
90	☽ 509	Alexandria, Egypt	+ 125, April 5, 7h + 2h. 5m	☊ 10° E. − 3° 13′
91	☽ 509	Alexandria, Egypt	+ 133, May 6, 9h. 15m + 2h. 4m	☋ 5° E. − 3° 11′
92	☽ 509	Alexandria, Egypt	+ 134, Oct. 20; 9h. 15m + 2h. 4m	☊ 5° W. − 3° 11′
93	☽ 509	Alexandria, Egypt	+ 136, March 5, 14h + 2h. 4m	☋ 9° E. − 3° 11′
94	☉ ✱ ? 461	Utica, near Carthage	+ 200, March 31, 21h. 30m + 1h. 55m	☊ 4° E. − 2° 58′

NO.	ECLIPSES.	LOCALITIES.	TIMES.	☊ ☋
95	⊙ ✱ 462	Rome	+ 237, April 12, 3h. 30m + 1h. 49m	☊ 2° W. — 2° 50′
96	⊙ 462	Rome	+ 239, Aug. 16, 22h + 1h. 48m	☋ 12° E. — 2° 49′
97	⊙ (great) 463	Rome	+ 291, May 15, 2h. 30m + 1h. 43m	☊ 0° W. — 2° 39′
98	☽ ✱ 463	Rome	+ 303, Sept. 11, 7h. 30m + 1h. 42m	☊ 5° E. — 2° 37′
99	⊙ 464	Constantinople.	+ 316, Dec. 30, 19h. 30m + 1h. 39m	☊ 2° W. — 2° 36′
100	⊙ ‖ 464	Constantinople.	+ 317, Dec. 20, 1h + 1h. 39m	☊ 11° W. — 2° 36′
101	⊙ ✱ ‖ 464	Campania, Italy	+ 324, Aug. 6, 2h + 1h. 37m	☊ 4° W. — 2° 36′
102	⊙ ‖ 464	Rome or Sicily.	+ 334, July 16, 23h. 30m + 1h. 35m	☊ 2° E. — 2° 35′
103	⊙ ✱ ‖ 465	Constantinople.	+ 345, June 16, 1h + 1h. 34m	☊ 1° E. — 2° 34′
104	⊙ ‖ 465	Constantinople.	+ 346, June 5, 17h. 30m + 1h. 34m	☊ 7° W. — 2° 33′
105	⊙ 465	Constantinople.	+ 347, Oct. 20, 3h + 1h. 33m	☋ 14° E. — 2° 33′
106	⊙ 466	Constantinople.	+ 348, Oct. 8, 20h + 1h. 33m	☋ 5° 17′ E. — 2° 33′
107	⊙ ✱ ⊙ 466	Mesopotamia	+ 360, Aug. 27, 16h + 1h. 32m	☊ 3° W. — 2° 32′
108	⊙ 466	Alexandria, Egypt	+ 364, June 16, 1h + 1h. 32m	☊ 6° W. — 2° 32′
109	☽ ✱ 467	Alexandria, Egypt	+ 364, Nov. 25, 14h + 1h. 32m	☋ 6° E. — 2° 32′
110	⊙ ‖ 467	Alexandria, Egypt	+ 374, Nov. 19, 22h. 30m + 1h. 31m	☊ 2° W. — 2° 32′
111	⊙ 467	Alexandria, Egypt	+ 378, Sept. 7, 23h. 30m + 1h. 31m	☊ 2° W. — 2° 31′
112	⊙ ‖ 458	Rome or Con- stantinople	+ 393, Nov. 19, 23h + 1h. 29m	☊ 10° W. — 2° 29′
113	⊙ ✱ ‖ 521	Constantinople.	+ 418, July 18, 19h + 1h. 26m	☊ 4° W. — 2° 23′
114	⊙ ✱ 521	Medina, Arabia	+ 671, Dec. 6, 22h. 3m + 1h. 0m	☊ 6° W. — 1° 31′
115	⊙ ✱ 521	Worms? Stras- burg	+ 840, May 5, 1h. 15m + 46m	☋ 6° E. — 1° 7′
116	⊙ ✱ 522	London and Bruegge	+ 1133, Aug. 2, noon + 22m	☋ 8° E. — 36′

To these 116 eclipses the following total obscurations of the sun, mentioned in later chronicles, and collected in "Calvisius's Opus Chronologicum," may be added, because they will probably confirm or amend our approximate corrections of the present theory of the secular accelerations of the moon's motions. Pingré's curves are enclosed in brackets.

NO.	ECLIPSES.	LOCALITIES.	TIMES.	☊ ☋
117	☉ *	Constantinople	+ 693, Oct. 3, 23h. [47°, 24°, 9° — 16°] .. + 58m	☊ 6° W. — 1° 29′
118	☉ *	Toledo, Spain	+ 718, June 3, 1h. [38° — 22°]. ..... + 53m	☊ 2° W. — 1° 25′
119	☉ * [A.]	Girwic, England..	+ 733, Aug. 21, 22h [55°, 47°, 15°] ..... + 53 m.	☊ 5° W. — 1° 2′′
120	☉ *	Edessa, Syria.....	+ 812, May 14, 0h. [28°, 30°, 34°—23°] . + 48m.	☊ 2° W. — 1° 14′
121	☉ * (?)..	Paris.......	+ 878, Oct. 29, 1h. [57°, 55°, 48°—51°].. + 42m.	☊ 16° W. — 1° 3
122	☉ *	Stiklastad, Norway..	+ 1030, Aug. 31, 2h. [73° — 27°]......... + 29m. .... (Schumacher's Astron. N. 1849, p. 46.)	☊ 10° W. — 46′
123	☉ *	Paris	+ 1230, May 12. 17h. [52°, 87°, 90°] ... + 17m.	☋ 16° E. — 27′
124	☉ *	Lesina and Mirabeau.	+ 1239, June 1, 23h. [36°, 42°, 43°—25°]. + 17m.	☊ 3° W. — 26′
125	☉ *	Rheims and Erfurt .	+ 1241, Oct. 6, 0h. [56°, 47°, 30°] . ..... + 27m	☋ 10° E. — 26′
126	☉ * [A.]	Constantinople	+ 1255, Dec. 30, 2h. [31°, 32°, 51°]...... + 16m.	☋ 9° E. — 25′
127	☉ *	Constantinople .	+ 1406, June 14, 18h [41°, 69°, 58°] + 10m.	☊ 7° W. — 14′
128	☉ * ...	Constantinople .	+ 1433, June 17, 5h [63°—32°] .... + 8m.	☋ 7° E. — 12′
129	☉ * 59	Danzig, Germany.	+ 1851, July 28, 2h. 30m. [70°—39°] .... + 24′′±	Long. ☊ — 37′ ±

Specification of the most important Ancient Eclipses.

Solar eclipses reported to have been total in certain places: Nos. 2, 3, 8, 10(?), 11, 13, 15, 20, 22, 23, 32, 40, 43, 47, 63, 66, 76, 80, 86, 94, 95, 101, 103, 107, 113, 114, 115, 116–128.

Solar eclipses reported to have been nearly total (μηνοειδεῖς): Nos. 25, 33.

Solar eclipses reported to have been great ones: Nos. 37, 53, 54, 60, 62, 68.

Solar eclipses reported to have been small ones: Nos. 4, 21, 27, 46, 48, 51, 56, 67, 73.

Lunar eclipses reported to have been total: Nos. 28, 29, 39, 41, 61, 64, 65, 75, 83, 98, 109.

Lunar eclipses reported to have been small ones: Nos. 1, 42.

Solar eclipses reported to have coincided with sunrise: Nos. 13, 20, 40, 107.

Solar eclipses referred by the ancients to certain hours: Nos. 2, 3, 4, 8, 53, 54, 60, 62, 76, 80, 86, 100, 101, 102, 104, 110, 112, 113.

Lunar eclipses referred by the ancients to certain hours: Nos. 42, 57.

Total eclipses of the sun which were annular according to the present lunar theory: Nos. 13, 32, 43, 47, 76, 80, 119, 126.

THE END.

Mound Explorations in Southeastern Missouri.

By C. Croswell.

[Read June 18, 1877.]

The interest which attaches to any new facts connected with the prehistoric races which once peopled this continent, is manifesting itself in the numerous publications* and in the constantly increasing researches and explorations in different parts of the country; and it is a source of gratification to find that these investigations have not been entirely barren of results — that they are developing, little by little, the habits of life and the surroundings of this mysterious people. Ultimately, by comparison, we shall obtain knowledge sufficient to determine, approximately, the origin of the race. It affords me extreme pleasure to find that during my brief absence I have been enabled to add a few items to the facts heretofore disclosed in connection with this engrossing subject.

I found on the borders of a cypress swamp in New Madrid county evidences of a former densely populated settlement, the site of which is overgrown with heavy timber, and which, so far as my observation extends, is, like all other selections for residence by this people, pleasantly located convenient to water. The swamp appears to have been transformed from a large body of water to its present state during some of the convulsions to which this section of country was subjected centuries ago. It may formerly have been a lake of many miles in extent, as some of the inhabitants now living on its borders maintain; or an arm of the Mississippi, as others feel equally confident. There has been no radical change, however, in the swamp-bed within the last four hundred years; still the banks indicate, by what seem to be water-lines, that the large district of swamp was once covered by water of considerable depth. The inhabitants in the vicinity term it "West Lake" to distinguish it from another of similar character, lying parallel to this at a distance of three miles, called "East Lake." Along the margin of these swamps are belts of heavy timber, flanking on either side a beautiful and well cultivated

* We refer, among others, to the publication of Mr. A. J. Conant, on page 353 of this volume, which partly goes over the same ground.

prairie. This settlement had a breadth of about fifty rods, and was traced for a third of a mile to a cultivated field on the south, where it abruptly terminated. On learning that the field had been under cultivation nearly forty years, I concluded it accounted for the sudden limit to the settlement in that direction, as constant tillage for that length of time would completely obliterate all traces. To satisfy myself of this fact, I followed the bank of the swamp by a path deeply worn in the soil to a narrow belt of timber separating the first from a second cultivated field, and found, as I anticipated, depressions in the soil overgrown with timber. This discovery extended the settlement to considerably over half a mile, greatly augmenting the number of dwelling-places.

The evidences of this ancient settlement consist of circular cavities in the earth, generally three feet in depth, with diameters varying from eight to fourteen feet. They were originally some twenty inches deeper than at present, the growth and decay of vegetation from year to year having partially filled them. We may suppose that the dwellings, being well covered, were comfortable quarters in cold weather, completely sheltering the occupants from the low temperature of winter, while in summer they could quickly be made as open and airy as desirable. The covering was probably constructed of poles and bark, and were of no considerable height, not equal to the ordinary wigwams of the Indians. If it were possible, with the evidence I shall adduce, to doubt the object sought to be attained by the inhabitants in digging these cavities, the opinion of an eminent English antiquarian may be quoted. He says, "we have undoubted proofs from history and former existing remains, that the earliest habitations were pits or slight excavations in the ground, covered and protected from the inclemency of the weather by boughs of trees or sods of turf." *

I examined twelve of these dwellings, and found in each a hearth the substance of which was composed of a mixture of clay and coarse grass, having the color and appearance of brick, though in no instance the molded form. Many of the hearths were located on the west side of the cavities near the surface, others were discovered in the centre. These hearths average

* Sir R. C Hoare on the Antiquities of Wiltshire.

twenty-four by thirty inches, with a thickness of two and a half inches. They were made by smoothing the space desired to have covered; the clay was then prepared after the manner of the Egyptians by mixing it with straw, or its equivalent, and was spread over the surface; in due time a fire was kindled upon it, and thus the mixture was burnt and the hearth completed.

I have computed the area occupied by the settlement at something over fifty acres, and the number of excavations at thirty-five to the acre, making the number of dwellings one thousand seven hundred and fifty. It is customary to estimate the number of inhabitants in a community in the United States by allowing five members to a family. If we base our calculation on such an estimate, we shall have as the result eight thousand seven hundred and fifty, a population more than sufficient to entitle any of our modern settlements to the denomination of *city*. I consider, however, that the estimate falls far short of the reality, if we take into consideration the prevalence of polygamy among all barbarous and semi-civilized nations.

A few articles of burnt clay were obtained, but I am not able to determine the uses to which they were applied. The most notable of these odd pieces was a sphere of two and a quarter inches diameter, with compressed sides, and dotted over the whole surface with small rings, as if made by cutting the lower end of a goose-quill at right angles and stamping the soft clay. Dr. Schliemann, in giving an account of his explorations at the site of ancient Troy, speaks of finding many hundreds of them, all having the same circular form, but in other respects varied. He has in his collection perfect spheres, half spheres, cones, and elongated centres, as well as the compressed spherical form I have described. They were wrought from lead, marble, and blue-stone, but by far the greater number were of burnt clay. While referring to those obtained in one portion of his excavations, Dr. S. says, "they are *all* made of terra-cotta, and it is quite evident that the decorations were engraved when the clay was still in a soft state. All are of such excellent clay, and burnt so hard, that I at first believed them to be of stone, and only perceived my mistake after having carefully examined them." Some were quite plain, others contained a great variety of decorations, the sun and stars very generally forming a portion of the ornamentation. They were found at various depths beneath the soil, many having a covering of thirty-three feet. Owing to their resemblance to a spinning-top he calls them *whorls*, and expresses the opinion that they were emblems of ancient Aryan sun-worship.

Contiguous to this settlement, between it and the swamp, there are several mounds. One immediately on the bank was not less than twelve feet high, and between thirty and forty feet long by twenty wide, running parallel with the swamp. An excavation to a depth of eight feet was made in the top of this mound and careful examinations instituted along the margin of the same, but nothing whatever of interest was found. I conjectured that it was erected for the observance of religious ceremonies, as it was directly opposite the principal mound where the dead were deposited in great numbers. I desired to cross section this mound to the surface of the ground in search of an altar, but felt constrained to defer it until I had more time at my disposal.

There must have been deposited in the adjacent mound at least three hundred bodies—it was the largest of the several burial places of the inhabitants. The mode of raising this mound was apparently by first depositing a layer of the dead over the space appropriated for the purpose and covering them to a depth of about fourteen inches. After this had been accomplished a second layer was commenced, gradually contracting the circle to give the required slope. When the mound had received all the bodies that was desirable, soft clay was spread over the whole surface, after which followed a final covering of sand. The coating of clay was probably intended to prevent the penetration of water. In the manner described the mound was gradually raised to a height of about seven feet. All the skeletons were found on the north, south, and east sides of the circle, while the west next the swamp and the adjacent mound just mentioned was destitute of everything except pieces of broken pottery and a few scraps of bone. As a reason for this omission to fill the space on the west as on the other three sides with the remains of their friends, I can only conjecture, that, as the mound immediately on the bank of the swamp had been consecrated to their forms of worship, the latter was regarded by them as too sacred to be contaminated with the near presence of the dead. Notwithstanding the apparent want of necessity for the labor bestowed upon that portion, the west side was symmetrically rounded off and perfected in the same manner as the other three sides.

There appeared to have been no observance of order in depositing the dead in this mound, but this seeming carelessness may have been methodical and attributable to some peculiarity in their customs; of course, I make an exception of the systematic care practised in gradually drawing in the circle and increasing the height to the centre. The skeletons were as often with the feet as the head towards the centre, and were lying on the back, on the face, on the right side, and on the left, and in two instances appeared drawn up, as if placed in a sitting posture. As the first skeletons were uncovered on the outer margin, they were found lying side by side with a covering of about fourteen inches of earth. The next layer immediately above was advanced a little nearer the centre. Then followed others in the same order, until finally they were found lying six deep, the bones much decayed, separated and broken, and mingled together in a mass interspersed with the sand which had covered them. I could determine the number only by the skulls, many of which (and, as usual, they were the best preserved portions of the remains) would not bear removal. From the whole number exposed, I could obtain but eighteen.

In the second mound opened, a skeleton was found extended at full length on the back, with the skull resting upon a stone weighing sixteen pounds. The stone is a smooth drift boulder of quartzite, having on one side, which lay uppermost, nearly a flat surface with an artificial depression in the centre. It resembled the old-fashioned lap-stone used by shoemakers. Another singular form of burial discovered in this mound was that of a skeleton extended on the back with the skull resting in a shallow dish, the side next the shoulders having been removed to accommodate the head and neck, and keep the whole on a level.

The skulls obtained from these mounds form very interesting objects of study, as they present all the characteristics of the faces represented on the pottery, proving that these were no ideal figures, but an actual study from the living features of their own race. The shape of the nasal bone between the eyes and the spinal bone of the upper maxillary at the point dividing the nostrils, indicate a very prominent arched nose, which is accurately produced on all pieces of pottery that I have seen representing a human face. I also found on every skull that was sufficiently well preserved to permit of examination, the flattened shape of the occipital region so characteristic of the Mound-builder head. In stature these people were not giants, accurate measurements of all the skeletons that came under my notice proving them to have been of medium height, although the bones were large and joints massive; I did not find a skeleton that measured six feet.

During the examination of the second mound a hearth was exposed covering a space of about twelve feet square, in the immediate vicinity of which three vessels were discovered which had contained red and yellow paint. From this circumstance combined with the unusual size of the hearth, I was led to the conclusion that they had carried on the manufacture of pottery at that point. In removing a portion of the hearth, the spade struck and crushed one of the pots containing red paint which had been placed beneath it. Why it had been deposited in such a position I could not conjecture.

The Pottery, nearly all of it graceful in curved lines, and many pieces smooth and well polished, is decidedly beautiful. It doubtless formed a prominent feature in their domestic affairs as it evidently did in their burial ceremonies, and must have been regarded by the owners as of the greatest value and importance. These articles of combined utility and luxury, when placed in the ground, we feel assured, were filled with food such as tempted the appetite of the living, that it might cheer and support the spirit on the journey to its future abode. The several vessels were arranged systematically around the head, generally two pieces to each body, viz. a bottle and pot. In some instances this was varied, I suppose according to the wealth, prowess, or exalted position of the individual; there were instances where three pieces had been provided, a shallow dish being added to the other two, while at the head of others there was but one piece. To the articles of pottery enumerated, I must add a class of vessels occasionally met with, which, from their diminutive size, shape, and the holes in the rim for suspension, I conclude were incense cups. The pottery varied greatly in the amount of ornamentation bestowed upon it. Some vessels were elaborately wrought into the shape of fish, frogs, and images of grotesque shape; while others were decorated with human heads, and those of quadrupeds, birds, coiled serpents, &c. Among the birds, the Pelican and Owl were the most conspicuous. Bottles were found adorned with painted figures representing the sun, stars, and other designs remarkably graceful and tastefully executed. The favorite colors used in their works were red, white, and yellow; black was found upon only one piece. The largest pieces of pottery obtained were two vessels each capable of containing about two gallons. From their peculiar shape it is conjectured they may have been used as filters. They are circular in form, open at the top, the bottom gradually tapering to an orifice one and a quarter inches in diameter. Dr. Schliemann gives a description of one found at Troy, as follows: "Of the earthenware found in this excavation, there is one piece especially deserving of attention. This is a vessel in the form of a helmet, with a round hole at the bottom; it may have served as a kind of funnel." Fragments of urns were found, the rims of which when entire measured eighteen inches in diameter.

It is evident from the number of shells found in the mounds that they formed an important item among the treasures of the Mound-builders. From them they wrought articles for use and ornament. Many of them are sea-shells, inhabitants of the Gulf of Mexico, and from the long distance whence they were brought it is reasonable to suppose they were considered of great value. I found several large sea-shells of the Pyrula species in different stages of preservation, and one circular ornament three inches in diameter that had evidently been cut from a large specimen. The convex face was entirely plain, but the concave side bears the figure of a Tarantula, or large spider, very skilfully engraved, the body being formed by a circle enclosing a cross, showing beyond doubt its sacred and symbolic character. This ornament, when found, lay on the breast-bone of a skeleton, with the concave or ornamented side uppermost. Two holes in the upper part were evidently intended for the thong or string by which it had been suspended from the neck. A circumstance that renders this relic still more interesting is the fact that two other shell ornaments bearing precisely similar devices have recently been found in Illinois within seven miles of this city, thus proving that the figures were not a mere fanciful invention, but had some symbolic meaning. In the same mound, and in the immediate vicinity of the skeleton from which the engraved shell was taken, an altar or hearth of burned clay was found, on which stood a large shallow dish, the sides not exceeding four inches in height, containing charred animal bones and a few fragments of charcoal; the vessel had been subjected to such great and continuous heat that it was impossible to remove it, as it crumbled on being touched; but the bones were carefully collected and preserved. From these facts a conclusion may naturally be drawn, that the wearer of the symbolic shell bore the priestly office. What would be more natural than that the priest should be interred in immediate proximity to the altar he had served in life!

From time to time pieces of sandstone have been found in the mounds of this State, deeply grooved and furrowed as if they had been used for the purpose of sharpening some metallic implement, and I believe this was the general impression in regard to their use. I was so fortunate as to find one of these stones, and by its side a knife or implement, formed of bone, which exactly fitted the grooves and markings on the stone, thus leaving no doubt as to the manner in which this and similar tools had been made and sharpened.

The question as to the antiquity of the earth-works which I explored, is one involving so many elements of uncertainty that I will not now attempt to discuss it. All the evidences I found point to a remote antiquity, and although the trees growing on the mounds afford no clue to the age of the latter, still it must be admitted that they are older than the trees. All the mounds opened by me bore a heavy growth of timber; one tree, an elm, measured fifteen feet in circumference, a size which it must have required centuries to attain.

Whatever may have been the fate of the race whose remains are so abundantly scattered over our State — whether they emigrated to more congenial climes—were driven from their hearths and altars by the incursions of fiercer and more warlike tribes—or whether pestilence swept them away, and none were left to perpetuate their race and bear evidence of their history and customs, it is certain that our knowledge of them is very limited. To extend this knowledge, and to inscribe upon the pages of history the memorials of a lost race, are objects that may never be fully realized, but are at least worthy of all the skill and perseverance that can be brought to bear upon them. The explorations which have been commenced by the members of the Archæological Section are already yielding results which encourage them to hope that they may be able in time to make important contributions to the knowledge obtained by previous workers in this interesting field.

The Oaks of the United States.

(Continued from p. 400.)

Q. Catesbæi × *laurifolia*, a late discovery of Dr. Mellichamp, is found in the same neighborhood, "in the cove with *laurifolia* and *falcata*, a tree 50 feet high, bark very much like that of the former."— Leaves lanceolate to ovate in outline, the uppermost narrower and entire, the lower wider, and generally near the middle with 1 or 2, rarely with more, divaricate or even falcate, acuminate lobes, coriaceous, strongly reticulate above, persistent through the greater part of winter, 3-4½ inches long. ¾-2 or 2½ inches wide, petioles ¼ inch long; youngest leaves imbricate in bud, slightly downy below, densely fulvous-glandular above, soon glabrate; leaves of vigorous shoots much larger and more lobed; acorn subglobose, 7-7½ lines wide, about half immersed in a hemispherical, turbinate, downy cup.

The tree and its foliage resemble *laurifolia*, but the acorns and the shallow cup of this species are quite different; the long falcate lobes of many leaves point to *falcata* or *Catesbæi* as the other parent, while the larger size of the acorn and the deep cup indicate the latter as the most probable Notwithstanding these signs of hybridity, the probability is not excluded that we may have nothing but an abnormal form of *laurifolia* before us.

Q. imbricaria × *nigra*; *Q. tridentata*, Eng. in Hb.; *Q. nigra* var. *tridentata*, DC. l. c. 64. A single tree, rather small, which was soon afterwards destroyed, was found by me, in the autumn of 1849, on the hills 6 miles east of St. Louis, in company with both supposed parents and *coccinea* and *rubra*, together with some White-oaks. Foliage as well as fruit are of such decided character that the origin of this hybrid can scarcely be doubted; the leaves are rather those of *imbricaria*, with a touch of the peculiar lobation of *nigra*, and the fruit is more like that of *nigra*. Leaves elliptical to obovate, entire or often coarsely 3-dentate at the apex, occasionally with a few teeth on the sides; 4-7 inches long, 2 or 3 wide; base rounded or acutish; upper surface dark, shining green, lower one pale, and in September not yet quite glabrate; petiole 4-10 lines long. Acorns closely sessile; the hemispherical, turbinate, canescent cup about half-enclosing the globose nut.

Q. imbricaria × *palustris* was observed by me a few years ago, 8 miles west of St. Louis, in a little dell where *imbricaria* abounds; *palustris*, *coccinea*, and *nigra*, together with some White-oaks, were near by; the tree was only 8 inches in diameter but in full bearing. It had, unfortunately, to give way to a railroad track; but ripe fruit was obtained, which to Mr. Meehan of Germantown has furnished fine young plants, completely agreeing in character with the parent.—Leaves slightly revolute in vernation, though not as much as in *imbricaria*, pubescent, especially below, but completely denudated before the end of May. Full-grown leaves broad-lanceolate, mostly acute at base, entire or more frequently with a few (sometimes more) coarse, triangular-lanceolate, acute, bristle-pointed teeth, glabrous on both sides; about 4 inches long, $1\frac{1}{2}$ wide, rarely larger: peduncles 3–4 lines long; cup moderately deep, turbinate at base, 6–7 lines wide, 3-4 high; ovate, obtuse scales, canescent, with bright brown margins.

Q. imbricaria × *coccinea* was first described and figured by Nuttall, about thirty years ago, under the name of *Q. Leana*, Nutt. Sylv. Contin. 1, tab. 5 bis; DC. l. c. 62. The original tree was discovered by Mr. T. G. Lea, near Cincinnati, and is still in existence; soon afterwards, Dr. S. B. Mead found another tree in Hancock Co., Illinois. My specimen, obtained from the first discoverer, has entire or sinuate or dentate or dentate-lobed leaves, 4–6 inches long and half as wide, and even in September slightly pubescent below; lobes acute and bristle-pointed or quite obtuse: base attenuated into a petiole 5–8 lines long; acorns similar to those of *coccinea*, cup shallower with obtuse scales. The leaves in Nuttall's figure have a cordate base. Dr. Mead's tree is similar to Lea's; leaves apparently more commonly entire or undulate-sinuate, 5–7 inches long and half as wide, obtusish at base on a petiole 1 inch long; the pubescence has almost disappeared on the lower side of the autumnal leaf; acorns globose, covered $\frac{1}{3}$–$\frac{1}{2}$ by the canescent cup. Prof. G. C. Swallow found a similar tree in Missouri; Mr. E. L. Greene sends another specimen from Macon Co., Ills., rather more glabrous but otherwise similar; and Mr. L. F. Ward discovered one near Washington.—The relationship to *imbricaria* is unquestionable, and among the lobe-leaved Black-oaks we must look to one of the forms of *coccinea* for the other parent, as the acorns and especially the cup and its scales indicate. I have not seen very young leaves, but doubt not but that they are like those of the other *imbricaria*-hybrids, revolute on the edges.

Three years ago, I found in St. Clair Co., Ills., 20 miles from St. Louis, in low, fertile woods where both *rubra* and *imbricaria* form the bulk of the forest, a hybrid which I took to be an offspring of those species; growth of the tree and bark like *rubra;* leaves of the lower limbs ample, 4–8 or 9 inches long, 2–6 inches wide, obtuse or cordate, rarely acute, at base, the smaller more commonly oblong and entire, the larger ones oval or obovate, entire or sinuate, or with a few broad and shallow obtuse or triangular bristle-pointed lobes; in June still downy on the lower surface; petioles $\frac{1}{2}$–1 inch long, pubescent; the nascent leaves revolute on the margins, but much less so than *imbricaria*, and white-tomentose on both surfaces.—Now, since I have obtained upper branches and ripe fruit, I am convinced that *rubra*, though growing close by, is innocent of its existence, and that *coccinea*, forests of which grow on the hills a quarter of a mile off, must be one of the parents; in short, that it is a form of *Leana* itself. The cup of the acorn is, to me, decisive; it is turbinate, covered with rather large canescent scales, squarrose at tip, and very different from those of either *rubra* or *imbricaria*, but approaching those of *coccinea*. The globose acorn, 7 lines in diameter, one-third covered by the cup, shows 22–25 black stripes, so common in many Black-oaks. The leaves of the fertile branches are cordate or obtuse at base, and almost all deeply runcinate-serrate.— This instance ought to make us very careful not too hastily to judge of the parents of a hybrid from the species growing nearest to it.

Q. Phellos × *coccinea*, *Q. heterophylla*, Michx., is distinguished by the petioled leaves of lanceolate outline, entire, sinuate, spinulose-dentate, coarsely serrate, or with simple, sometimes spreading or falcate, lobes; leaves of different form on the same tree and often on the same branch, the uppermost leaves usually entire;* or some trees more with entire, others more with dentate or with lobed leaves. Youngest leaves strongly revolute, pubescent above, white-downy below, becoming glabrous in summer. Acorns subglobose to oval, 5–7 lines long, a little less wide, scarcely half immersed in the shallow-hemispherical, somewhat turbinate, canescent cups; scales lanceolate, obtuse. Fruit of same size and very similar to that of *falcata*, but cup usually deeper and with larger scales.

The typical specimen described by Michaux, found by him "in a field belonging to Mr. Bartram near Philadelphia," has long since been destroyed, but its offspring was introduced into Europe, and the trees now seen in Bartram's garden in West Philadelphia, at Marshall's place in Marshalltown, and in J. Hoopes' garden in Westchester, as well as those of the European gardens at Verrière, Herrnhausen and Prague, the latter fertile, are believed to be its seedlings. Only within the last ten or fifteen years the tree has been re-discovered, and now numbers of individuals are known in low woods on both sides of the Delaware below Philadelphia (6 miles east of Camden, *Smith*, *Leidy*, *Burk*, *Martindale*, and 2 miles west of Wilmington, *Commons*. *Canby*), often in groups together, probably the offspring of some few original hybrid trees.

A. DeCandolle and others viewed this hybrid as a form of *aquatica*, others as belonging to *Phellos*, while I was long inclined to follow Michaux in considering it as a distinct species. With *aquatica*, which does not grow within a hundred miles, it has no relationship; aside from other characters, the revolute vernation abundantly distinguishes it from that species; from *Phellos* it differs in the form and size of the leaves and their thick down in youth (in *Phellos* even the youngest leaves are almost glabrous), and in the larger acorn in a deeper cup bearing much larger and longer scales. That it is a hybrid is most probable on account of its great rarity and its so very variable foliage. One of its parents is undoubtedly *Phellos;* for the other we must look among the lobe-leaved Black-oaks of its neighborhood, *falcata*, *rubra* or *coccinea*. While the sometimes falcate lobes of the hybrid and the similarity of its acorns point to the first, and its frequency in those localities to the second, we find the texture of the leaf and its reticulation as well as size and form of the cup and its scales intermediate between *Phellos* and *tinctoria*, and quite different from the

* This is the case generally in heterophyllous hybrids, i.e. hybrids between entire-leaved and lobe-leaved species; the uppermost leaves of an axis are apt to be entire, while the middle ones are lobed, etc.; thus the lower branches also often bear entire leaves, while the upper ones have more lobed ones.

other two species, and thus come to the conclusion that the former must be the parents.

Q. ilicifolia × *coccinea*, Robbins in Gray Man., ed. 5, pag. 454, discovered by Dr. Robbins at Uxbridge, Massachusetts, in 1855, of which I have seen flowering and fruiting specimens in the Cambridge Herbarium, seems just intermediate between the two parents. "Tree 40 feet high, 19 inches in circumference, both parents within 4 rods"; leaves 4–5½ inches long, nearly 4 wide, sinuate-lobed, lobes acutate, mostly bristled-toothed towards their apex; youngest ones greenish pubescent above, canescent below, at maturity strongly reticulate (*ilicifolia* is very slightly so) and shining above, and with the branchlets lightly pubescent below; cup deeper than in *ilicifolia*, glabrate. The persistent though light pubescence resembles *ilicifolia*, while the shape of the leaf reminds one of *rubra* rather than *coccinea*.

Several forms of oaks have at one time or another been considered as hybrids which most probably are varieties or sports of of one or the other of the well-established species.

Q. olivæformis, Michx. is a variety of *macrocarpa* with elongated acorns in a deep and narrow cup, and not a hybrid of *macrocarpa* with *alba*, as has been suggested.

Q. runcinata was the name given to a form I found in the richest Mississippi bottom-lands opposite St. Louis, together with *rubra*, *imbricaria*, and *palustris*. From its smaller and narrower, coarsely dentate, not lobed leaves, and its smaller fruit, it seemed distinct enough from *rubra*, and was possibly a hybrid of it and some other small-fruited allied oak. But the leaves of *rubra* are so variable in size and outline that DeCandolle (l. c. 60) was right in considering it a variety of *rubra*.

Q. falcata var. *subintegra* is a variety of *falcata* which I had taken for a hybrid of that species and *cinerea*. Dr. Mellichamp sent it from South Carolina and Mr. Canby from Maryland. It seems to be nothing but a strange sport of *falcata* itself, an extreme state of var. *triloba*, with trilobed as well as entire leaves. The glandular pubescence of the young and the smoothish, not reticulated, upper surface of the mature leaf are those of the species. Fruit not seen.

Q. quinqueloba I named a form of *nigra* with 5-lobed leaves, which I found on the hills of St. Louis, and at one time considered as a cross between *nigra* and *tinctoria*; DeCandolle (l. c. 64) places it correctly with *nigra*. It is not even a variety, but rather a juvenile state which had become permanent in that tree;

young trees or shoots of *nigra* have sinuate-dentate or many-lobed leaves, but in fertile ones the leaves are almost always more or less 3-lobed or 3-dentate at the much-widened apex. I have since seen a tree which on one fruit-bearing branch had only the leaves of *quinqueloba*, while all the other branches had the regular cuneate 3-dentate *nigra* leaves. The same form occurs near Washington, *L. F. Ward*, in "Field and Forest," October, 1875, where several other real or supposed hybrids are enumerated, which call for further careful investigation *in loco*.

ADDITIONAL NOTES.

New material having come to hand since the above was in type, I have to add some further remarks.

The typical *Q. palustris* has globose or depressed acorns, but near St. Louis it is occasionally seen with oblong or even elongated acorns. A specimen of *Q. Texana*, Buckley, sent by the author to the Agricultural Department, Washington, is evidently this form of *palustris*, though it is said to grow near Austin "on hills."

Pag. 394. Another abnormal type, which I cannot but refer to *rubra*, has been sent from the bottom lands of the Comale and Blanco rivers, affluents of the Guadalupe, Texas, by Lindheimer and Wright. The leaves have the cut of *coccinea;* the large (1 inch long by less than $\frac{3}{4}$ wide) oblong acorns are borne in hemispherical slightly turbinate cups, covered by small, appressed, smoothish scales. The bark of the tree is "pale and smoothish, much like that of *aquatica*." In many respects the tree seems to be intermediate between *rubra* and *coccinea*, an "ambiguous" form.

Q. coccinea: numerous specimens, fresh ones from this neighborhood, and dried ones with mature fruit from different localities, have weakened my hope of distinguishing *tinctoria* from the typical *coccinea*. The yellowish-canescent, squarrose cup scales are found in all the forms of this region, but northward as well as eastward they do not seem to be so characteristic of the species; there they are often smaller, more appressed, and less canescent; and this may be the form which Michaux has figured as his *coccinea*, while his *tinctoria* has larger and paler scales. We may, then, distinguish the following varieties: 1. Large winter buds, leaves with broader undivided lobes, cup scales squarrose, acorns oblong or globose. 2. Small winter buds; leaves with slender, deeply cut, divaricate lobes, cup scales and acorns as in 1. 3. Buds and leaves as in 2; cup scales smaller, more glabrate, appressed; acorns more commonly ovoid.

The first may be Bartram's *Q. tinctoria*, the third the true *coccinea*, and the second an intermediate form. The third variety closely approaches what I have considered as the form *ambigua* of *Q. rubra.*

On the Larval Characters and Habits of the Blister-beetles belonging to the Genera Macrobasis *Lec. and* Epicauta *Fabr.*; with Remarks on other Species of the Family* MELOIDÆ.

By CHARLES V. RILEY.

[Read Nov. 5, 1877.]

The larval habits of the European Cantharis of commerce, as also those of its congeners in our own country and in other parts of the world, have hitherto remained a mystery, notwithstanding the frequency with which the beetles occur, their great abundance at times, and their commercial value and interest. The same remark holds true of the allied genera *Macrobasis*, *Epicauta*, and *Henous*, the species of which have the same valuable vesicatory properties as *Cantharis*. Some of these species are very common in the United States and quite injurious to vegetation, swarming at times on potato-vines, beans, clematis, and other plants. Their great numbers and destructive habits make it all the more remarkable that so little has hitherto been discovered of their early life. Harris, who evidently had hatched the first larva of the Ash-gray Blister-beetle (*Macrobasis unicolor* Kirby), says: "The larvæ are slender, somewhat flattened grubs, of a yellowish color, banded with black, with a small reddish head, and six legs. These grubs are very active in their motions, and appear to live upon fine roots in the ground; but I have not been able to keep them till they arrived at maturity, and therefore know nothing further of their history." (*Ins. inj. to Vegetation*, p. 138.) Latreille, according to Westwood, states that the larvæ live beneath the ground, feeding on the roots of vegetables (*Intr.*, vol. i., p. 301), but the statement is evidently founded on conjecture. Ratzeburg, who well describes the method of oviposition of the European *Cantharis vesicatoria*, and roughly figures the first larva (*Forst Insecten*, II., Col. Taf. ii., Fig. 27

* As stated by Dr. Horn (Rev. of the Sp. of several Genera of Meloidæ of the U. S.—*Am. Phil. Soc.*, Feb. 21, 1877), these two genera are very closely brought together by connecting species. There is certainly nothing in the adolescent habits or characters to separate them. Yet the same thing may be said of almost any two allied genera when comprehensively considered, and I follow LeConte's separation because it facilitates study, and because the species considered in this paper illustrate very well the differences on which the genera in question are founded.

B), believed that it was a plant feeder in the immature state. Olivier describes what is possibly the second larva as a soft, yellowish-white, 13-jointed grub, with short, filiform antennæ, and short, corneous, thoracic legs—"living in earth" (*Traité Elém.* etc., M. Girard, Col., p. 618); but his account is very loose, and may apply to any number of other coleopterous larvæ. Audouin, who studied the Cantharides intently, making them the subject of his thesis in his medical examination, was obliged to confess that absolutely nothing was known of their larval history; and Mr. William Saunders, of London, Ont., in a paper on the same subject read at the 1876 meeting of the American Pharmaceutical Society, could add nothing more definite.

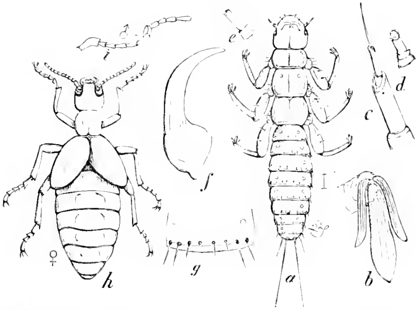
This is about all we learn from the older writers, and the opinion was general among them that, like their parents, the blister-beetle larvæ in question were vegetable feeders. In 1874 Laboulbène mentioned the fact (*Ann. Soc. Ent. de France*, 1874, lxxxiii.) that some one (name not given) had seen the European *Cantharis vesicatoria* issuing from ground in the neighborhood of which there were wasps (*guêpes*—no specific reference given), and rashly concludes that the former were parasitic on these. Still more recently, M. J. Lichtenstein, of Montpellier, France, has endeavored to discover the larval habits of this species, and in 1875 he succeeded, after many fruitless attempts, in causing the first larva to feed on honey kept in a glass tube, and to undergo one molting. While spending a few days with him, I had the pleasure of making a sketch of this second larva as it swam on the honey. It subsequently died. He afterwards reared two others in the same way until they had passed through three molts, and is of the opinion that *Cantharis* develops in the nests of *Halictus*. These facts, as well as analogy, pointed to a parasitic life and partly carnivorous, partly mellivorous diet for our own allied species, since the life-history of two genera in the Family, viz. *Meloë* Linn. and *Sitaris* Latr. has been fully traced. Indeed the young of all vesicants belonging to the *Meloidæ*, so far as anything has yet been known of them, develop in the cells of honey-making bees, first devouring the egg of the bee and then appropriating the honey and bee-bread stored up by the same. They all are remarkable, in individual development, for passing through seven distinct stages, viz. the egg, the first larva or *triungulin*, the second larva, the coarctate larva or pseudo-pupa, the third larva, the true pupa, and the imago.

HISTORY OF MELOË.

The history of *Meloë* may be briefly summed up as follows:—The newly hatched or first larva (now generally called *triungulin*) was first mentioned in 1700 by the Holland entomologist Gœdart, who hatched it from the egg Frisch and Réaumur both mistook it for a louse peculiar to bees and flies. DeGeer, who also obtained it from the egg, mentions it in 1775 as a parasite of Hymenoptera. Linnæus called what is evidently the same thing, *Pediculus apis;* Kirby in 1802 described it as *Pediculus melittæ*, and Dufour in 1828 named it *Triungulinus andrenetarum.* Newport in 1845 (*Trans. Linn. Soc.*, vol. xx. p. 297) first rightly concluded that it was carried into the nests of bees, and described. in addition, the full-grown larva from exuvial characters, and the coarctate larva and pupa which he found in the cells of *Anthophora retusa.* He failed, however, to fill the gap between the first and full-grown larva; and this Fabre first inferentially did in 1858 (*Ann. d. Sc. Nat.*, Zool. t. ix. p. 265) by tracing the analogous stages of *Sitaris.*

The female *Meloë* is very prolific. She lays at three or four different intervals, in loose irregular masses in the ground, and may produce from three to four thousand eggs. These are soft, whitish, cylindrical, and rounded at each end. They give birth to the triungulins, which, a few days after hatching—the number depending on the temperature—run actively about and climb on to Composite, Ranunculaceous and other flowers, from which they attach themselves to bees and flies that visit the flowers. Fastening alike to many hairy Diptera and to Hymenoptera which can be of little or no service to them, many are doomed to perish, and only the few fortunate ones are carried to the proper cells of some *Anthophora.* Once in the cell, the triungulin falls upon the bee egg, which it soon exhausts. A molt then takes place and the second larva is produced. Clumsy and with locomotive power reduced to a minimum, this second larva devours the thickened honey stored up for the bee larva. It then changes to the pseudo-pupa with the skin of the second larva only partially shed; then to a third larva within the partially rent pseudo-pupal skin, and finally to the true pupa and imago. These different changes of form are known by the name of hypermetamorphoses, the term first given them by Fabre to distinguish them from the normal changes from larva to pupa and imago, experienced by insects generally. The triungulin or first larva (Fig. 35, *a*) is characterized by a prominent labrum, very stout thighs, unarmed shanks, three broad and subspatulate tarsal claws, feeble and reduced trophi, untoothed jaws, 3-jointed antennæ* ending in a long seta, and four anal setæ, the two inner ones longest. When the abdomen is shrunken the general aspect is very much that of *Pediculus*, and it is hardly surprising that some of the early describers so determined it.

Fig. 35.



MELOE:—*a*, first larva; *b*, claws; *c*, antenna; *d* maxillary palpus; *e*, labial palpus; *f*, mandible; *g*, an abdominal joint; *h*, imago ♀; *i*, antenna of ♂.

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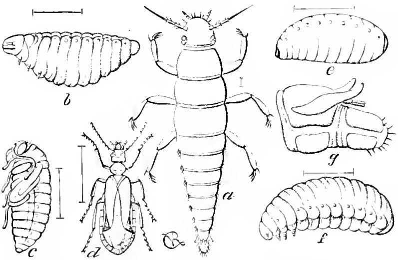
* My figure is from specimens affecting the mature honey-bee at San Diego, Cal. It corresponds very closely with Newport's original figure and description of that of the European *M. cicatricosus*, and belongs doubtless to one of our Pacific coast species, probably *M. barbarus*, Lec. It is 2 mm. long. The head is produced in front, with a strong labrum, beyond which the smooth jaws do not reach; the antennæ are 3-jointed, and similar to those of *cicatricosus*; the mouth parts are diminutive, the maxillary palpus 3-jointed, the 3d joint longer than the others together and tipped with a few short, weak points; the labial palpus is 2-jointed; the coxæ are armed with a few very strong spines; the femora are very stout and faintly imbricated; the tibiæ are unarmed, and the tarsal claws subspatulate, the middle one pale, $\frac{1}{3}$ longer and twice as broad as the two outer ones, which are dark, articulate close together and curve slightly outward. The first pair of stigmata are distinctly dorsal and on the mesothoracic joint. The dorsal hind border of the abdominal joints is armed with 8 spinous hairs, the 4 intermediate ones only half as long as the others. Newport is evidently wrong in considering the jaws articulate in themselves, while Candèze is wrong in describing the antennæ as 5-jointed (*Mem. de la Soc. Roy. des Sc.*, viii. p. 530, Liège, 1853). Packard's figure of what is in all probability *M. angusticollis* Say, fails to indicate the characteristic mesothoracic spiracles, and probably makes the two outer anal setæ too short —these anal appendices being in reality nothing more than prolonged spinous hairs, such as occur on the other joints. The form of the abdomen varies, contracting somewhat with age. Newport remarks on the similarity of the triungulins of *Meloë violaceus*, *M. proscarabæus* and *M. cicatricosus* being so great that he could discover no differences. Judging from figures sent me by M. Lichtenstein, very slight differences occur in the relative length of the antennal joints, and none other.

HISTORY OF SITARIS.

The history of *Sitaris* is also well known and agrees very closely with that of *Meloë*. Its first larva was figured many years ago by Westwood (*Introduction*, etc., Fig. 34, 5) from specimens obtained from Audouin, who found the female *Sitaris* in the cells of *Anthophora* enclosed in its thin pseudo-pupal and second larval skins, which Audouin erroneously took to be the pellicle of the devoured bee-larva. But the complete life-history of the genus was first given by Fabre in 1857 (*Ann. d. Sc. Nat.*, Zool., t. vii. p. 299; t. ix. p. 265), who studied the *S. humeralis* Fabr., while that of *S. colletis* V.-M. has been more recently given by M. Valery-Mayet, of Montpellier, France (*Ann. Soc. Ent. de Fr.* 1875, p. 65), from whom I have specimens in all stages. The former species infests the nests of *Anthophora*, the latter those of *Colletes*. In the former the newly hatched larvæ hybernate in huddled masses in the galleries of the bee; in the latter they hybernate in the bee-cell, slowly feeding while the temperature permits; but such differences doubtless depend on the relative earliness in the autumn that the eggs are laid. The first larva or triungulin (Fig. 36, *a*) agrees very much in the head, tarsal and general characters with that of *Meloë*, but differs in several important particulars and especially in having a pair of pre-anal spinnerets, from which is secreted a serous sticky fluid, which aids the animal in holding firmly to the bee that is to carry it into the nest. A pre-anal pair of claspers also assists in this work.* The hypermetamorphoses are very similar to those of

Fig. 36.



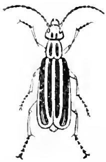
SITARIS:—*a*, first larva; *g*, anal spinnerets and clasps of same; *b*, second larva; *e*, pseudo-pupa; *f*, third larva; *c*, pupa; *d*, imago ♀ (after V.-Mayet).

* The small size (about 1 mm. long) and the hairless and spineless nature of this larva contrast strongly with the other triungulins considered in this paper. The tarsal claws are somewhat narrower than in *Meloë*, and unicolorous. A few soft lateral hairs are represented on the abdominal joints in the figure, but they are scarcely perceptible under the

Meloë. The triungulin after absorbing the contents of the bee egg, molts, and thereafter floats upon and devours the honey—the pseudo-pupa, third larva and true pupa all forming in due time within the second larval skin. The female does not feed, and on account of her heavy abdomen travels but a short distance from the bee-burrows where she developed.

It is generally stated by writers on the Hive-bee that the Oil-beetle (*Meloë*) is one of its parasites. The posssibility that our more common blister-beetles were similarly parasitic on bees, taken in connection with the frequent complaints from apiarians of the wholesale death of bees from causes little understood, led me, some years since, to pay attention to the biological characteristics of the blister-beetles, in the hope of ascertaining whether or not they really bear any connection with bee mortality. From these investigations I am satisfied that *Meloe* is only parasitic on the perfect Hive-bee as it is on so many other winged insects that frequent flowers; and that it cannot well, in the nature of the case, breed in the cells of any social bee whose young are fed by nurses in open cells.

I have had no difficulty in getting the eggs or the first larva of several of our vesicants, and described some of them at the Hartford (1874) meeting of the Am. Ass. Adv. Sc.; but these young larvæ refused to climb on to plants furnished to them, or to fasten to bees or other hairy insects. Nor would they nourish upon honey, bee-bread, or bee larvæ on which they were placed. They showed a proclivity for burrowing in the ground, and acted quite differently from those of *Meloë* or *Sitaris*, which not only readily attach to bees in confinement, but which, in the case of *Meloë*, I have known to so crowd upon mature hive bees as to worry them to death and cause extended loss in the apiary. Explorations into the nests of Solitary bees gave no clue, and, in fact, the immense numbers in which the more common blister-beetles occur rendered a parasitic life upon such bees highly improbable. In

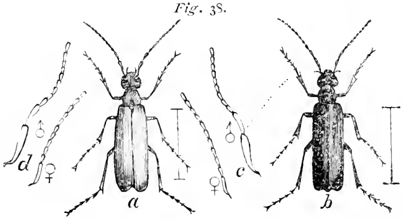


EPICAUTA VITTATA: normal form.

strongest microscope. Nor do any hairs or spines appear in any of the subsequent stages, even on the true pupa. The pseudo-pupa lacks the prominent lateral ridge so striking in the others. The stigmata are so faint in the triungulin that Mayet could not resolve them; but with proper light and specimens rendered transparent I have discerned them in the same positions as in *Meloë*. The mandibles are toothed.

sweeping plants and flowers with the net, I had never met with any of the first larvæ with which I had become familiar, as already indicated; while I had on several occasions, in digging ground where there was no trace of bee nests, met with the curious pseudo-pupa so characteristic of the Family. While analogy and the law of unity of habit in species of the same family pointed, therefore, to a parasitic life, I began to conclude, from the facts just stated, that the parasitism was of another kind, having satisfied myself by various experiments that the triungulins did not feed on roots. Few discoveries are stumbled upon. We find as a rule that only which we anticipate or look for. Late last Fall, in digging up the eggs of the Rocky Mountain Locust (*Caloptenus spretus*) at Manhattan, Kansas, the pseudo-pupæ were not unfrequently met with. The thought at once occurred to me that locust eggs might be the proper food for these blister-beetle larvæ, and it was encouraged by the fact that the Meloids abound most in those dry western regions where the Acrididæ most prevail, and by a pretty distinct recollection, which my notes support, that the years when the vesicants were most injurious to potatoes had been preceded by dry Falls, during which there had been much locust injury and, necessarily, unusual locust increase. The suspicion thus raised that these blister-beetles preyed in the preparatory states upon locust eggs was confirmed last spring by finding the larvæ of different ages within the egg-pods and devouring the eggs of *Caloptenus spretus*. Mr. A. N. Godfrey had, also, no difficulty, under my directions, in finding them last May at Manhattan; while they were sent to me among other locust-egg parasites by Mr. Seth H. Kenney of Morristown, Minn., and from St. Peters in the same State by Prof. Cyrus Thomas, who had no suspicion of their nature.

Fig. 38.



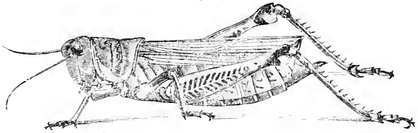
MACROBASIS UNICOLOR:—*a*, normal gray form; *b*, black (*murina*) form; *c*, *d*, male and female antennæ of either.

From such larvæ preying on the eggs of *spretus* I have reared the unicolorous form of *Epicauta cinerea* (Forster), or the Margine Blister-beetle* ; the *Epicauta pennsylvanica* (DeGeer),† or the Black Blister-beetle ; the *Macrobasis unicolor* (Kirby),‡ or the Ash-gray Blister-beetle ; and the form of it described as *murina* by LeConte, or the Black-rat Blister-beetle.

Since then I have found it very easy to trace the larval habits and development of the two more common potato-feeding species around St. Louis, viz. the Striped Blister-beetle (*Epicauta vittata*, Fabr.)§ and the Margined Blister-beetle (*marginata* Fabr.) just alluded to.

Careful examination of locust eggs in the vicinity of potato fields frequented by these beetles show a varying proportion of the egg-pods affected, and in some locations nearly every pod of the Differential Locust (*Caloptenus differentialis*) will contain the *Epicauta* larva. The eggs of this locust are laid in large masses of 70 to about 100. The pod is but slightly bent, rather compact outside, while the eggs are irregularly arranged, and capped with but a shallow covering of mucous matter. It is the egg-pod of this species which the larvæ of the two Blister-beetles in question prefer; for while they will feed upon those of other species in confinement, I have so far found

Fig. 39.



CALOPTENUS DIFFERENTIALIS.

* The black, gray-margined form, very appropriately described by Fabricius as *marginata*, is referred to *cinerea* Forster by modern systematists, and specifically united with it by Dr. Horn. Yet the fact remains that the two are not ordinarily, if ever, found commingled. The margined form is very common in potato fields in Missouri. It shows little variation and is found almost invariably in conjunction with *vittata*, but not with the unicolorous form in question, which is most common farther west and occurs abundantly without the margined form—all which is against the specific union of the two.

† =*atrata* Fabr.

‡ =*cinerea* Fabr., *Fabricii* Lec., *murina* Lec., *debilis* Lec. I accept Dr. Horn's conclusion that the last two are but poorly developed forms of this species. Yet the *murina* form is not due to rubbing or injury, but issues from the pupa without a trace of gray scales on the elytra.

§ =*lemniscata* Fabr. Dr. Horn retains *lemniscata* as a distinct species in his Revision already referred to. The outer stripe in the bi-vittate specimens divides up in others so as to give the tri-vittate character on which *lemniscata* is founded. Both extremes and every possible variation between them occur constantly together in the same potato field in Missouri, and there are no other differences of specific value.

none in the deeper-necked, narrower, more compact egg-pods either of *Caloptenus femur-rubrum*, *C. Atlantis*, or *Œdipoda sulphurea*, in which the eggs are regularly and quadrilinearly arranged as in those of *C. spretus*. Not only have I found a large proportion of the egg-pods of *C. differentialis* naturally infested with these *Epicauta* larvæ, but I have succeeded in hatching and rearing numbers in-doors, and have them even at this writing (Oct. 30th) by hundreds in all stages from the first larva to the pseudo-pupa. Referring the reader to the end of this paper for detailed descriptions, let me illustrate the larval habits of the genus by reciting those of one of the species in question, viz., *vittata*.

From July till the middle of October the eggs are being laid in the ground in loose, irregular masses of about 130 on an average —the female excavating a hole for the purpose, and afterwards covering up the mass by scratching with her feet. In confinement she sometimes omits both these instinctive acts and oviposits on the surface of the ground. She lays at several different intervals, producing in the aggregate probably from four to five hundred ova, judging from examinations made on the ovaries of some that were gravid. She prefers for purposes of oviposition the very same warm sunny locations chosen by the locusts, and doubtless instinctively places her eggs near those of these last, as I have on several occasions found them in close proximity. In the course of about 10 days—more or less, according to the temperature of the ground—the first larva or triungulin hatches. The hatching takes place without the aid of any *ruptor ovi*, for the egg-shell is so delicate that it easily splits, from mere expansion, along the back near the head, and breaks and shrivels up with the escape of the larva. These little triungulins (Pl. V., Fig. 2), at first feeble and perfectly white, soon assume their natural light brown color and commence to move about. At night or during cold or wet weather all those of a batch huddle together with little motion. but when warmed by the sun they become very active, running with their long legs over the ground, and prying with their large heads and strong jaws into every crease and crevice in the soil, into which, in due time, they burrow and hide. Under the microscope they are seen to fairly bristle with spinous hairs, which aid in burrowing. As becomes a carnivorous creature whose prey must be industriously sought, they display great power of endurance, and will survive for a fortnight without food in a moderate temperature. Yet in the search for locust eggs many are, without doubt, doomed to perish, and only the more fortunate succeed in finding appropriate diet. Upon the slightest disturbance they curl up in a ball with the head bent pretty closely on the breast.

Reaching a locust egg-pod, our triungulin, by chance, or instinct, or both combined, commences to burrow through the mucous neck, or covering, and makes its first repast thereon. If it has been long in the search, and its jaws are well hardened, it makes quick work through this porous and cellular matter, and at once gnaws away at an egg, first devouring a portion of the shell, and then, in the course of two or three days, sucking up the contents. Should two or more triungulins enter the same egg-pod, a deadly conflict sooner or later ensues until one alone remains the victorious possessor. By the time the contents of an egg are consumed, the body of the parasite has perceptibly increased so that the white sutures between the segmental plates show conspicuously, especially as there is a tendency on the part of the animal to curve its body, and bring the sutures more into relief. A second egg is attacked and more or less completely exhausted of its contents, when a period of rest ensues, the triungulin skin splits along the back and there issues the *Second Larva* (Pl. V., Fig. 4)—white, soft, with reduced legs and quite different in general appearance from the first. This molt is experienced about the eighth day from the first taking of nourishment. The animal now naturally lies in a curved position (Pl. V., Fig. 4, *d*), but, if extracted from the egg-pod, will stretch itself and move with great activity, reminding one very strongly of many Carabid larvæ, for which reason I would designate this as the *Carabidoid* stage of the second larva. After feeding for about another week, a second molt takes place, the skin, as before, splitting along the back and the new larva hunching out of it until the extremities are brought together and released almost simultaneously. This kind of molting, which is characteristic of our blister-beetles up to the pseudo-pupal state, is exceptional among insects, the skin being ordinarily worked backward from the head. The modification at this molt is slight. The mouth-parts and legs become rudimentary and the body takes on more fully the clumsy aspect of the typical Lamellicorn larva, for which reason I designate this as the *Scarabæidoid* stage of the second larva.

Another six or seven days elapse and the scarabæidoid skin is rent and shed with but slight modification in the form and characters of the animal.* In this, the *Ultimate* stage of the second larva (Pl. V., Fig. 5) the creature grows apace, its head being constantly bathed in the rich juices of the locust eggs, which it now rapidly sucks or more or less completely devours. The color is more yellowish than it was before, and the power to stretch and travel on the venter on an even surface is still retained. In another week it forsakes the remnants of the pabular mass, and, by burrowing a short distance in the clear soil, avoids the deleterious decaying influences of these egg remnants. In the soil it forms a smooth cavity, within which it lies stretched on one side, motionless and gradually contracting. The skin separates and becomes loose at the end of the third or fourth day, when it splits on the top of the head and thoracic joints and is worked toward the extremity, but never fully shed. The mouth-parts and legs are now quite rudimentary and tuberculous, the soft skin rapidly becomes rigid and of a deeper yellow color, and we have what has been called the semi-pupa (Pl. V., Fig. 8). The term pseudo-pupa given it by Fabre is more appropriate, and I should prefer myself to call it the *Coarctate Larva*, for it is nothing but a rigid and dormant larval stage, having its counterpart in the well-known "flaxseed" stage of the Hessian-fly larva and in the so-called coarctate pupa of the Diptera generally. A similar dormant but less rigid larval stage occurs with many Tenthredinidæ in Hymenoptera, and, in fact, the summer dormancy of certain Lepidopterous larvæ and the winter dormancy of others is analogous. We find something similar, therefore, in all the Orders undergoing complete transformations, but in no insects is the change so marked and exceptional or the freeing of the subsequent larva from the coarctate larva so striking as in these Meloidæ. The

* None of the observers of *Meloë* or *Sitaris* mention the two molts which the second larva undergoes, though these doubtless occur in those genera as they do in *Epicauta*. Only by the most careful watching from day to day of a number of specimens have I been able to observe these molts; for the exuviæ are generally devoured as soon as they are cast, and this fact doubtless accounts for their not having been observed in the two genera first mentioned.

insect has the power of remaining in this coarctate larval condition for a long period, and generally thus hybernates.

In spring the coarctate larval skin is, in its turn, rent on the top of the head and thorax, and there crawls out of it the *Third Larva*,* which differs in no respect from the ultimate stage of the second larva already mentioned, except in the somewhat reduced size and greater whiteness. The coarctate skin, when deserted, retains its original form almost intact. The third larva is rather active, and burrows about in the ground; but while there seems to be no reason why it should not feed, nourishment is not at all essential, and all my specimens have, in the course of a few days, transformed to the true pupa without feeding. In the transformation to pupa (Pl. V., Fig. 9) the third larval skin is worked into a wrinkled mass behind, as is also the skin of the true pupa when shed. The pupa state lasts but five or six days, and before the wings of the imago are fully expanded, or the abdomen contracted, the general aspect of *Epicauta* forcibly recalls the mature *Henous*.

Like all parasitic† insects that nourish on a limited amount of food and possess no power to secure more, the blister-beetles vary greatly in individual size in the same species, and the larvæ have the power of accommodating their life to circumstances, and of assuming the coarctate larval form earlier or later according to the size of the egg-mass which they infest. I have had some interesting illustrations of this in my experiments with them In an average sized egg-pod of the Differential Locust, however, there are more than enough eggs to nourish the largest specimen of *E. vittata*, and a few are usually left untouched.

The period of growth, from the first feeding to the coarctate larva, averages, as will be gathered from the foregoing, about a month; yet in the month of September, out-doors, under screens where I have had the Differential Locust oviposit for the experiment, I have known the full larval growth of *vittata* to occupy

* The coarctate larva is, properly speaking, the third and that following it the fourth; but just as I have preferred to designate as special stages of the second larva the stages between the first and fourth molts, so I prefer to call the last larva the third, to conform to the nomenclature now generally employed.

† An insect is not properly parasitic that simply feeds on eggs, but the term is permissible and even necessary to characterize and distinguish those species which develop within and are confined to a locust egg-pod from the predaceous species that are not confined but pass from one pod to another.

but 24 days. As this species occurs in the beetle state as early as June in the latitude of St. Louis and as late as October, there are possibly two annual generations here and farther south.

Larval Habits of Macrobasis and Henous.

The characteristics of the triungulins of the blistle-beetles, represented by *Epicauta* and *Henous*, are remarkably similar, and point to unity of habit. The slight differences of some are given in the appended descriptions. The same holds true of the characters of the second, coarctate and third larva and of the pupa of *Epicauta* and *Macrobasis*. They are precisely alike; so that, while appreciable differences may be found in the triungulins, it is doubtful whether the subsequent developmental stages will indicate specific or even generic differences in species of similar size in these three genera.

That the eggs of *Epicauta* may exceptionally hybernate is possible, but, from their delicate nature, improbable. That the triungulins frequently do so there can be no doubt, especially in species like the Black Blister-beetle, which is found on the flowers of Solidago, Eupatorium, etc., till the end of October, and continues laying till frost. I have at the present time many of these last that are quietly huddled together, and, with winter temperature, will doubtless remain so; while others have worked in between the locust eggs, there evidently to remain without feeding till spring opens. I have also found as many as five triungulins of this species curled up in the deep red mucous matter that surrounds the eggs of *Œdipoda phanœcoptera* — all numb and torpid, and evidently hybernating.

CONCLUSION.

From the foregoing history of our commoner blister-beetles, it is clear that while they pass through the curious hypermetamorphoses so characteristic of the family, and have many other features in common, yet *Epicauta* and *Macrobasis* differ in many important respects from *Meloë* and *Sitaris*, the only genera hitherto fully known biologically. To resume what is known of the larval habits of the family, we have:

1st—The small, smooth, unarmed, tapering triungulin of the prolific *Sitaris*, with the thoracic joints subequal, with strong articulating, tarsal claws on the stout-thighed but spineless* legs, and, in addition, a caudal spinning apparatus. The mandibles scarcely extend beyond the labrum; the creature seeks the light, and is admirably adapted to adhering to bees but not to burrowing in the ground. The second larva is mellivorous, and the transformations from the coarctate larval stage all take place within the unrent larval skin.—We have:

2nd—The more spinous and larger triungulin of the still more prolific *Meloë*, with long caudal setæ, but otherwise closely resembling that of *Sitaris* in the femoral, tarsal and trophial characters, in the subequal thoracic joints, in the unarmed tibiæ, and in the instinctive love of light and fondness for fastening to bees. The second larva is also mellivorous, but the later transformations take place in the rent and partly shed skins of the second and coarctate larvæ.—We have:

3rd—The larger and much more spinous triungulins of the less prolific *Epicauta*, *Macrobasis*, and *Henous*; with unequal thoracic joints, powerful mandibles and maxillæ, shortened labrum, slender femora, well-armed tibiæ, slender, spine-like, less perfect tarsal claws—combined with an instinctive love of darkness and tendency to burrow and hide in the ground. The second larva takes the same food as the first, its skin is almost entirely cast from the coarctate larva, while the subsequent changes are independent and entirely free of the shell of this last.

Larval Habits of Cantharis.

The question naturally arises here, whether *Cantharis*, in its larval habits, will most agree with *Meloë* and *Sitaris* or with *Epicauta*. The triungulin, except in becoming almost black, has much in common with *Meloë*, in the subequal thoracic joints, the toothless mandibles, and the long antennæ; also in its habit, observed by Lichtenstein, of fastening to bees. The fact that it can nourish on honey, though it does not appear to do so freely, would also indicate that it breeds in the nests of solitary bees. Nevertheless, in the slender thighs and the caudal and abdominal

* The larva of *S. humeralis* appears to differ from that of *S. colletis* in having hairs on the femora and tibiæ.

characters it agrees more nearly with *Epicauta*, and in the stage following the first molt the legs are still quite long and the general aspect much like the carabidoid stage of that genus. I should not be surprised, therefore, if *Cantharis* also nourished on locust eggs, and I hope that my friends in South France will not fail to make the test.

What is known of the Larval Habits of other Meloid Genera.

Mylabris, Fabr. (*nec* Geoff.), according to V.-Mayet, is much less prolific than any Meloids so far observed. The egg is 2.5 mm. long and ½ as wide, with a tolerably thick shell and the embryo more fully bent within it. The triungulin has many of the characters of *Epicauta*, judging from the published description (*Ann. Soc. Ent. de Fr.*, 1876, p. cxcvi.), which is, however, not sufficiently detailed as to the trophi. I doubt not that the genus will be found to infest locust eggs.

Horia, Fabr., from what little is known of it, would seem to have a similar partial parasitism to *Meloë*, but on Carpenter bees.

Tetraonyx, Latr. was found by Guérin-Meneville in places frequented by Bumble-bees.

The eggs of *Apalus* Fabr., as well as its triungulin, are said to resemble those of *Meloë*.

Zonitis, Fabr. is known to develop in the cells of *Osmia* and *Anthidium*, and to have a coarctate larva much like that of *Sitaris*.

DESCRIPTIVE.

Epicauta vittata.—*Egg.*—Average length 1.6 mm., diameter rather more than ¼ the length. Elongate, cylindrical, rounded at extremities, the anterior end being very slightly larger than the posterior. Rarely a little curved. Color very pale whitish-yellow. Smooth and shiny—the shell somewhat stiff, bearing considerable finger and thumb pressure and cracking with some noise. Laid loosely in the ground in irregular batches of 130 and upward. Embryo lying straight, with head bent on breast.

Larva: First Larva or Triungulin.—Elongate, subcylindrical, the venter being flattened. Average length when just from the egg, 3 mm. Width across prothoracic joint not quite ¼ the length; tapering thence gradually to anus. Head prominent, well separated from neck, flattened, slightly depressed, as broad as, or slightly broader than joint 1; with the ordinary Y-shaped suture superiorly and with an elongate medial triangular piece inferiorly, attenuating to thorax; also, a suture inferiorly starting from near the middle and curving toward base of antennæ; with a few spinous hairs from the sides and on the horny mouth-parts; mandibles long, prominent, sickle-shaped, the outer edge having a slight elbow about the middle, and the inner edge armed along terminal half with about 11 blunt, quadrate teeth, and slightly produced basally; labrum short, slightly excavated at middle, studded with very minute short hairs and with 4 stouter spinous hairs around border. Antennæ not extending as far as do the mandibles, 3-jointed, the basal joint bulbous and stout, the 2nd more slender and about as long, the 3rd as long as the other two together and surmounted with two fleshy tubercles, the outer unarmed and fusiform, the inner more elongate and tipped with 4 or 5 stiff hairs. Maxillæ short with a strong 3-jointed palpus, the basal joint less long than wide, the 2nd twice as long and the 3rd four times as long, fusiform and slighly flattened and armed with short spines on the inner terminal third—the chitinous covering on all joints showing regular imbrications (the maxilla proper is composed of two pieces not more than twice as wide as the palpus, so as to look rather like two stout basal joints). Labium composed of a short basal piece and a heart-shaped terminal piece, surmounted each side with a 2-jointed palpus, the terminal joint thrice as long as the basal and with short stiff apical hairs. Eyes round, dark, not prominent, and on the side just behind antennæ. Body with the normal 12 joints and subjoint; with a corneous covering superiorly, laterally, and across joints 11 and 12 ventrally, the fleshy sutures distinctly separating the plates; joint 1 (prothoracic) somewhat longer than joints 2 and 3 together, broadening posteriorly somewhat thicker than the others and with a few stiff hairs at sides; joints 2 and 3 subequal, with a transverse row (8 superior and several lateral and subventral) of spinous hairs; joints 4–12 gradually diminishing in width but increasing in length, each with a transverse row of superior short conical spines, and of longer spinous hairs at posterior border, a few more slender ones nearer the middle, and a ventral row of still more slender ones across the middle; anal joint with 2 longer setous hairs, about as long as the 3 terminal joints together. Legs long; coxæ stout, swollen in middle and $\frac{3}{4}$ as long as femora; trochanters small and short; femora slender; tibiæ still more slender and somewhat longer; tarsi rudimentary and with three long spinous claws of unequal length: all parts beset with spinous hairs, and the tibiæ with four regular rows of more slender ones. Stigmata subdorsal, with difficulty distinguished, from being concolorous, the first pair mesothoracic, the rest on joints 4–11 inclusive. Color yellowish-brown, with more or less black on the lower corners of joints 1, 4, 5, 10 and 11; borders of head, thorax and of joints also somewhat more dusky; tips of jaws and eyes dark brown; legs and venter paler. A pale medial longitudinal line observable especially on joint 1; the fleshy sutures and venter white: the lobes of anus, ventrally, may swell so as to appear like fleshy tubercles or pseudopods, but they are not used in running.

Second Larva; Carabidoid Stage.—With the first molt the whole aspect changes. The head is now narrower than the prothoracic joint and this again narrower than the three succeeding joints, so that the body tapers both ways; the legs are shortened and thickened, the corneous plates give way to fleshy wrinkles; the dorsal spinous hairs to a few weaker ones; the lateral ones are still stout and the anal setæ are lost. Prothoracic joint faintly corneous; antennæ with basal joint longest, 2nd joint short, and the unarmed apical tubercle longer than the other: the maxillæ are totally changed, having a rudimentary 2-jointed palpus and an inner lobe; the labium is not much altered, but the two inferior claws of tarsus have become tibial spines. The color is white and the skin is seen to be finely granulated under a strong power, while the stigmata are more easily discerned. *Scarabæidoid Stage*— With the second molt the trophi are still more shortened, the legs more rudimentary, the wrinkles of body more pronounced, and the general aspect is that of the typical Scarabæid larva. The head is faintly mottled. The jaws have anteriorly a large obtuse tooth, which still shows. more or less distinctly, the minute teeth of the first larva. The body is cream-white in color, and devoid of strong or spinous hairs, but sparsely covered instead with short setaceous points. A third molt takes place with little change, except that the dorsal wrinkles are evenly beset with tolerably dense, closely shorn, fulvous, setaceous hairs. *Ultimate Stage*— A fourth molt produces little change in general appearance, except that the color becomes more yellowish. The full-grown larva presents the following characteristics: Body soft, curved, largest in middle, tapering slightly toward head, more rapidly toward anus; heavily wrinkled transversely, and with a prominent lateral submonoliform fold; the soft parts evenly covered, except at sutures and on venter, with dense, ferruginous, setaceous points. Head slightly retractile, about half as wide as joint 1, with no distinct sutures, but with two U-shaped impressions on the face, and one running a short distance from base of mandibles, relieving the cheeks: color pale yellow, shaded with spots of a deeper yellowish-brown, which spots are most intense in the depressions, and in some specimens relieve a distinct, pale, Y-shaped line. Trophi much as in second larva, except that they are shortened, thickened, and less perfect. A slightly chitinised cervical shield, with a few faint ferruginous spots along middle, relieving a pale line. Legs with no distinct claws, and covered with the similar dense setaceous points that occur on other parts. A brown, horny, convex breastplate (already noticeable in the second larva) runs from the head on the front part of joint 1 ventrally. Stigmata light brown, the first pair on an anterior mesothoracic fold, the others, on joints 4–11 inclusive, just above the lateral fold.

Coarctate or Quiescent Larva.—Length 7 to 8.5 mm. Dorsum regularly arched, the transverse segmental sutures but faintly indicated. Venter convex, with transverse sutures still more faint; bulging at thoracic joints. Lateral outline elongate-ovate. Depth at joint 6 (from dorsum to venter) rather less than ⅓ the length, diminishing thence slightly to anal joint. Width at joint 6, ⅓ the length. A prominent longitudinal, lateral, rounded ridge, faintly constricted at segmental sutures and reaching from base of joint 4 to end of joint 11. Head small, well separated ventrally but not dorsally, the mouth-parts—consisting of a bow-shaped labrum, conical mandibles and maxillæ, and exarticulate antennæ—brown, rudimentary, and tuberculous; eyes small, imperfect, and scarcely raised. Six brown conical tubercles in place of the thoracic legs. Stigmata as in full-grown larva, but more conspicuous, being darker brown and raised. Anus rounded and unarmed. Color gamboge-yellow. Chitinous covering firm, and very faintly corrugate. The larval skin adheres, in shrivelled mass with its dark mandibles ventrally, to the end of the body, and sometimes extends to the middle.

Third Larva.—Somewhat paler, more contracted and clumsy than the ultimate stage of the second, but otherwise differing in no essential features.

Pupa.—Having the folded legs well-drawn back from sternum, the hind legs reaching well nigh to anus, with a transverse dorsal row of spines on all but the two or three terminal ventral joints, and about 6 much stouter ones each side of prothorax, near its hind border.

Epicauta cinerea (Forster .

The black, gray-margined form (*marginata* Fabr.) I have had in all stages from the egg to the coarctate larva, reared on the eggs of *Caloptenus differentialis*, and the unicolorous form, from the scarabæidoid stage of the second larva to the imago, on those of *C. spretus*. The egg is 1.3 mm. long, and somewhat stouter than in *vittata*. The triungulin is somewhat darker than that of *vittata*, and not quite so large (length 2.6 mm.) The head has a less formidable aspect, and, with the prothoracic joint, is more nearly of the same diameter as the abdomen. It may also be distinguished by the lateral dark brown of the prothorax being medial rather than at the lower corners, and by joints 3, 9, 10 and 11 being dark—almost black—across their entire dorsal posterior half. The metathoracic joint (3) is always conspicuously dark. The central apical antennal seta is longer, and the maxillary and labial palpi have frequently a minute apical, 2-jointed, fleshy process. The spinous hairs on the body are somewhat less strong. Otherwise it is undistinguishable, agreeing in every minute structural particular, as do all its subsequent phases.

Epicauta pennsylvanica (DeGeer).

The eggs of this species are but 0.9 mm. long. The triungulin averages but 2 mm. in length, and, while having the same form and characteristics as the other species, is easily distinguished by the following particulars, aside from the smaller size: The color is darker and more uniform, joints 1, 4, 5, 10 and 11 contrasting less with the others. The prothoracic joint is more slender, being about as long as wide. The maxillary palpi have the terminal joint less flattened inside and surmounted with a small fleshy 2-jointed apical process: the maxillary piece is scarcely broader than the palpi. The antennæ have the apical tubercles of equal length, the setous one, as also the labial palpi, likewise having a similar 2-jointed fleshy apical process to that on the maxillary palpi. These minute processes occur on all the specimens I have examined (40), but they are but modified setæ, and may exceptionally be noticed in *vittata* and more often in *marginata*. The subsequent states show no structural differences from the other species.

Macrobasis unicolor (Kirby).

The triungulin of this species is yet unknown to me, but from the coarctate larva to the imago I have noticed no characters of any importance or value which would distinguish it from the previous species.

Henous confertus (Say).

The eggs of this species, which also feeds on Potato, I have had laid in July. They are 1.8 mm. long, ¼ as wide, and differ from those of the other species described, in being of a deeper yellow and more compactly glued together in the lump by means of a reddish, glistening fluid, which separates in globules between the eggs and pulls in fine, web-like threads. The triungulin measures 3.2 mm. in length when first hatched, but otherwise differs but little from that of *vittata*. The dark brown color is more often confined to the lower corners of the prothoracic joint, and never occurs on joints 4 and 5; the head is rather more rounded; the mandibles are slightly more feeble, with only about 8 rather stronger teeth. The spinous hairs are somewhat more numerous and longer, but there are no short conical spines: the abdomen tapers less, being more nearly of a diameter with head and prothorax, and thus giving a heavier, more clumsy look; the dark eyes have a pale centre; the antennal maxillary and labial characters agree with those of *E pennsylvanica*, and the caudal hairs sometimes exceed the longest lateral ones but very little in length. I have not watched it through the subsequent changes, my notes being from specimens obtained in 1874; but the triungulins act just as in *Epicauta*, and doubtless feed on locust eggs.

ADDITIONAL NOTE ON CANTHARIS.

Since the first part of this paper was run off the press, a communication from M. J. Lichtenstein has reached me.* He has succeeded, by furnishing the larvæ of *C. vesicatoria* with artificial nourishment composed of the filled stomachs of honey-making bees, and especially of *Ceratina*, in tracing the development from the triungulin to the coarctate larva, which last differs from those of the other species considered by me, in freeing itself entirely from the second larva skin. He has thus established the fact that *Cantharis* agrees with the other species of the family in its hypermetamorphosis; but its natural habits remain as much as ever a mystery, which, let me hope, the present communication to the Academy may help to solve.

* *Comptes Rendus de l'Ac. des Sc.*, Paris, Oct. 11, 1877, p. 628.

EXPLANATION OF PLATE V.

All the figures enlarged unless otherwise stated, the hair-lines indicating the natural sizes.

Fig. 1.—Egg-pod of *Caloptenus differentialis* with the mouth torn open, exposing the newly hatched larva of *Epicauta vittata* (1 *a*) eating into an egg, and the passage which it made through the mucous covering—natural size.

Fig. 2.—Dorsal view of the first larva, or triungulin, of *E. vittata*; 2 *a*, one side of the head of same from beneath, greatly enlarged so as to show the mouth-parts; 2 *b*, terminal joint of maxillary palpus showing imbrications and flattened inner surface armed with stout points; 2 *c*, leg, showing more plainly the tarsal spines; 2 *e*, labrum; 2 *d*, one of the abdominal joints from above, showing stout points, stigmata, and arrangement of spinous hairs.

Fig. 3.—Eggs of *E. vittata*, the natural size indicated at side.

Fig. 4.—Dorsal view of the Carabidoid stage of the *Second Larva* of *E. vittata*; 4 *a*, its antenna; 4 *b*, its right maxilla; 4 *c*, its leg: 4 *d*, side view of same, showing its natural position within the locust-egg mass.

Fig. 5.—Lateral view of the Ultimate or full-grown stage of the *Second Larva* of *E. vittata*; 5 *a*, portion of the dorsal skin, showing short setaceous hairs.

Fig. 6.—Third head, or that from the Scarabæidoid stage of the *Second Larva* of *E. vittata*, from beneath, showing the reduction of mouth-parts as compared with the first head (2 *a*); 6 *a*, antenna of same: 6 *b*, maxilla of same; 6 *c*, mandible of same.

Fig. 7.—Fourth head, or that of the full-grown larva of *E. vittata*, from above; 7 *a*, leg of same; 7 *b*, the breast-plate or prosternal corneous piece.

Fig. 8.—Lateral view of the pseudo-pupa or *Coarctate Larva* of *E. vittata*, with the partially shed skin adhering behind; 8 *a*, dorsal view of same; 8 *b*, its head, from the front; 8 *c*, same from side; 8 *d*, tuberculous leg; 8 *e*, raised spiracle: 8 *f*, anal part of same.

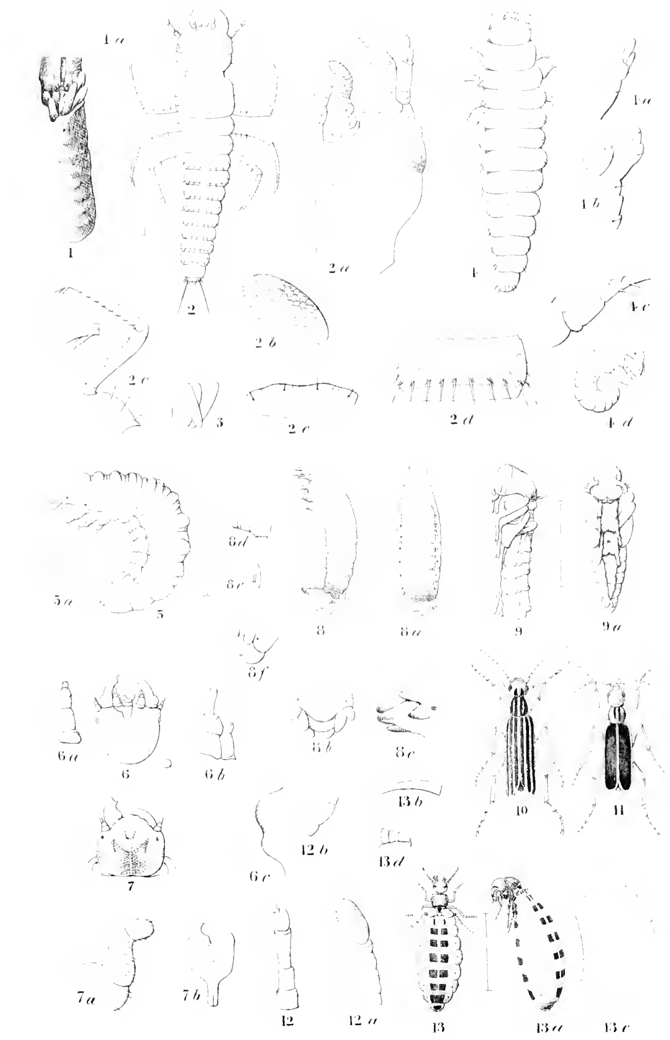
Fig. 9.—Lateral view of the true pupa of *Epicauta cinerea* Forst; 9 *a*, ventral view of same.

Fig. 10.—*Epicauta vittata* (*lemniscata* or trivittate var.)

Fig. 11.—*Epicauta cinerea* Forst. (= *marginata* Fabr.)

Fig. 12.—Antenna of the triungulin of *Epicauta pennsylvanica*; 12 *a*, maxilla of same; 12 *b*, labial palpus of same.

Fig. 13.—♂ *Hornia minutipennis*, dorsal view; 13 *a*, lateral view of same; 13 *b*, simple claw of same; 13 *c*, *Coarctate Larva*; 13 *d*, leg of ultimate stage of *Second Larva*.



C.V. Riley, del.

Hypermetamorphoses of Epicauta and Hornia.

On a remarkable new Genus in MELOIDÆ *infesting Mason-bee Cells in the United States.*

By CHARLES V. RILEY.

[Read Nov. 5, 1877.]

While the natural history of none of our N. A. species of *Meloë* has been traced or recorded, they will, beyond all doubt, be found to agree with their European congeners in their partial parasitism on Mason-bees. In examining the cells of *Anthophora sponsa*, Smith, I have so far failed to discover that *Meloë* is parasitic upon that species, but *Meloë* is, in reality, very rare around St. Louis. I have, however, found on four different occasions in the Fall, within the sealed cells of the bee mentioned, a very interesting and anomalous Meloid which may be taken to represent the typical partial parasitism of the family in the United States. There is a tendency in the family to wing reduction, but in no hitherto described species is the reduction carried to such extremes as in this, both sexes (Pl. V., Fig. 13) having the elytra as rudimentary as in the ♀ of the well-known European Glow-worm (*Lampyris noctiluca*). Another characteristic feature is its simple tarsal claws, which, together with the rudimentary wings and the heavy body, show it to be a degradational form. *Anthophora sponsa*, its host, builds mostly in steeply inclined or perpendicular clay banks, and, in addition, extends a tube of clay from the entrance. The burrow has usually two branches which decline about an inch from the surface of the bank, and 6 or 8 cells are arranged end to end. By means of saliva the inside of the cell is rendered impervious to the moisture of the honey and bee-bread stored in it for the young, It is evident, therefore, that this clumsy Meloid will have difficulty in crawling out of or about the cells, and it is probably subterranean and seldom, if ever, leaves the bee gallery. It can climb and drag its body, but with some difficulty, up a steep surface, and, as it does not leave the bee-cell till spring, when the *Anthophora* tubes are very generally broken and have fallen, it may possibly wander a short distance from the mouth of the bee-burrow. The triungulin is yet unknown, but the ultimate stage of the second larva as well as the coarctate larva, as shown by the distended and unruptured skins, exhibit the ordinary family characteristics, the legs and mouth-parts being atrophied in the former, and merely tuberculous in the latter. The lateral ridge, as found in *Epicauta* and *Meloë*, is not conspicuous, and in this respect, as well as in the final transformations taking place within the two unrent skins, the insect approaches *Sitaris*. In the hairless and unarmed surface of the second larva, and of the third larva and pupa, as shown by careful examination of their shrunken exuviæ, the insect also resembles that genus. I take great pleasure in dedicating the genus to Dr. Horn, who has so well studied the structural characters of our Meloids.

HORNIA, Nov. Gen. — Head oval deflexed, suddenly constricted posteriorly; clypeus emarginate in front; labrum transverse, truncate; mentum slightly longer than wide, rounded in front; labial palpi with the last joint elongate-oval; maxillary palpi with the 2nd joint rather longer than the others, the terminal joint somewhat longer than the preceding and elongate-oval; mandibles moderately prominent, acute at tip; antennæ filiform, slightly flattened, 11-jointed, slightly arcuate, as long as head and thorax in the ♂, scarcely longer than the head in the ♀; joint 1 robust, conical, 2 transverse, 3 somewhat longer than the others, 4–10 equal, 11 longer than the preceding and oval at tip. Scutellum cordiform. Elytra very small, semicorneous and translucent, oval, diverging from scutel, reaching to and resting against the first abdominal joint. Hind wings of same form but not $\frac{1}{5}$ as large as elytra, through which they may be discerned. Meso- and metathorax very short and constricted: side pieces small, partly covered at anterior end by the elytra. Tarsi spinulose, claws simple. Abdomen 8-jointed, elongate-oval, large, membranous; in the ♂ with two series of approximate, subquadrate, semicorneous, dorsal plates, and two more rounded, more widely separated ventral series: in the ♀ these plates are obsolete. First abdominal joint covered beneath by the metasternum. First pair of spiracles mesothoracic.

H. minutipennis, n. sp. — ♂ Head, palpi, prothorax, and legs, rufous antennæ and horny abdominal plates darker; labrum, wings, and elytra, whitish; abdomen yellow. All the corneous parts, as also the elytra, sparsely covered with short stiff dark hairs. Head, prothoracic and semicorneous abdominal plates, also sparsely punctulate. There is a dark, transverse, narrow line in the suture between metathorax and abdomen also similar sutural lines between the ventral plates. Length 16 mm.

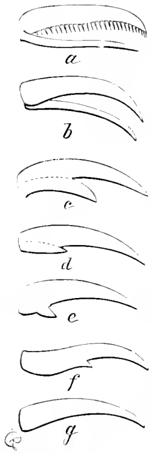
♀ Differs from ♂ in the antennæ being scarcely longer than the head: in the semicorneous pieces on metanotum more nearly covering the same: in the semicorneous plates entirely lacking on the venter, which is more evenly spinulose; in the dorsal plates, except on the anal joint, being subobsolete and colorless; and in the color of the abdomen being whiter.

Four ♂'s and one examined.

Ultimate stage of second larva with the jaws broad and simple, the other mouth-parts as in *Epicauta*, but with the three leg-parts well separated and tapering to a single tarsal point (Pl. V., Fig. 13, *d*).

Coarctate larva with the trophi tuberculous as in *Epicauta*, but with the lateral ridge but slightly developed, and the skin less firm and showing all the wrinkles of the larva (Pl. V., Fig. 13, *c*).

Fig. 40.



TARSAL CLAWS OF MELOIDÆ.

The variation from the more complex to the more simple—the degradational tendency in the tarsal claws of the Meloidæ is shown by outlines in Fig. 40.

In the Nemognathini the claw is double and the upper and thicker portion is strongly serrate beneath (Fig. 40, *a*). In the Lyttini, the upper portion becomes simple (*b*). In *Calospasta*, *Tegrodera*, *Eupompha*, *Rhodaga*, the lower division is shorter than the upper, and connate with it (*c*). In *Poreospasta* the lower part is still shorter, connate, and scarcely visible (*d*). In *Megetra*, and allied genera, the faint basal suture is obliterated, and the hook varies somewhat in size (*e*). In *Cordylospasta* the hook is more acute and nearer the tip (*f*); while in *Hornia* the claw is entirely simple (*g*).

The following table of our N. A. Meloini will serve as an amplification of that given by Dr. Horn in 1863 (*Trans. Am. Ent. Soc.*, vol. ii. p. 139), and show the position of the genus, which I have added.

A.—Antennæ 11-jointed. Hind wings obsolete, or nearly so.
- *b.* Elytra imbricated; claws equally cleft .... MELOË.
- *c.* Elytra divergent from scutellum; claws toothed .. MEGETRA.*
  - *cc.* Claws simple .... HORNIA.
- *d.* Elytral inner margins contiguous at anterior third; claws equally cleft .... NOMASPIS.
  - *dd.* claws with lower part very short and connate . POREOSPASTA.
- *e.* Elytral inner margins contiguous their whole length and entirely (or nearly) covering the abdomen; claws equally cleft; elytra subconnate .... HENOUS.
  - *ee.* Claws toothed; elytra connate and inflated .. CYSTEODEMUS.

B.—Antennæ 8-jointed, last joint equal to the three preceding. Hind wings feeble.
- Elytral inner margins contiguous throughout nearly the entire length: claws feebly toothed at middle .... CORDYLOSPASTA.

* *Pseudomeloe* (Fairm. &Germ.) is, as has been recorded by Dr. Horn (*Zoöl. Record*, London, 1875, p. 346), but a synonym of *Megetra*.

Additional Notes on MEGATHYMUS YUCCÆ.

By CHARLES V. RILEY.

[Read Nov. 5, 1877.]

Having reared this insect from the egg to the imago since the publication of the first article (p. 323, *ante*), I am able to give some additional facts, part of which appeared in my last State Report. There is but one generation annually, and the characteristic glistening powder that covers the full-grown larva is not secreted till toward the last molt. The habit of living at first within a cylinder made with one of the rolled leaves, webbed across with silk, is very marked, and even where the larva at first works at the base of a leaf, it will web the leaf and feed along up to its tip before entering into the more solid portions of the plant. In extruding the excrement the larva backs up to the end of the retreat, which is kept only partially closed.

Where several larvæ hatch out on the same plant (which not unfrequently happens), there is a struggle as to which shall usurp the privilege of entering the stem, and the first one to do so generally keeps the others out on the leaves, so that in the end they doubtless perish. The parent is by no means particular as to where she fastens her eggs, for Dr. Mellichamp has sent me dry leaves of *Quercus falcata* that had accumulated around his Yuccas and that have eggs fastened to them.

One larva I kept for a long time in a tin box, occasionally supplying it with fresh leaves. It formed a perfect cylinder of silk and excrement around the bottom of the box, fastening thereto the ends of the cut leaves, so that the cylinder was necessarily broken each time the leaves were changed. This specimen went through no less than seven molts at irregular intervals of 10, 11, 24, 14, 61, 15 and 21 days respectively. It changed but little in appearance, except in becoming somewhat paler, after the second molt, and died when about three-fourths grown—death resulting, I think, more from the mould that formed from the excrement, and which it was impossible to prevent, than from the nature of its food. It is doubtful if so many molts are suffered in more natural and healthy conditions.

Another specimen that entered a Yucca plant, in the garden of Dr. G. Engelmann, throve admirably, extending over a foot beneath the ground, and attaining full growth by the end of September; while a third, in a potted *Yucca aloifolia* in-doors, hollowed out the entire root, pupated on the 26th of January, 1877, and gave out the imago on the 25th of the following month.

I add the following to complete the description of the larva given on p. 331:

In the *second stage* (after first molt) the head is deep gamboge-yellow, with dark jaws—not polished but faintly shagreened: the cervical shield is narrow, entire. and polished black; and an anal plate is also obvious, also polished, dark brown, with the hind borders thickened and black. The body is olivaceous-brown; the stiff, black hairs of the first stage are very much shortened and pale, and the whole surface has a faintly pubescent appearance, caused by numerous minute points, each giving rise to a short soft hair. The wrinkles of the mature larva are already well defined. In the *third stage* the head is chestnut-brown, and the stiff, piliferous hairs are scarcely longer than the other minute ones on the general surface. The larva has now all the characteristics of the last stage, except in lacking the white powder, and in being of a pale olive-brown color. The cervical and anal shields are still highly polished and black, and the skin, instead of looking faintly pubescent, as in the previous stage, is translucent and glossy.

The imago is more variable than I had supposed. Thirteen other specimens, all from larvæ that fed at Bluffton, S. C., range in expanse from 1¾ to nearly 3 inches; 2 ♀'s have the wings broader and the posterior border of primaries more rounded than is usual, resembling *Ægiale* in this respect; 1 ♀ has the spot (usually lacking) on primaries just within the middle of the wing and below vein 2; while in 2 ♂'s, and among them that which I bred in-doors, the yellow is pale almost to whiteness. Some specimens, captured in Florida by Mr. A. Bolter of Chicago, expand only 1½ inches, and the secondaries have five such distinct yellow spots and such broad yellow borders that they look two-banded. Mr. H. K. Morrison captured many specimens in Colorado, the past summer, about *Yucca angustifolia*, and this Colorado form is remarkable for its small size and the paleness of its colors compared with those reared farther south on the larger-leaved, more luxuriant Yuccas. It is also distinguished by a second narrow white line on the underside of secondaries just outside the larger triangular white spot from costal vein; also by the dark spots on this underside of secondaries, generally having a white pupil—a tendency thereto being noticeable in the Carolina specimens. I cannot consider such differences more than varietal, and would designate this small pale variety as var. *Coloradensis*. The *Ægiale Cofaqui* of Mr. Strecker (*Proc. Ac. Sci. Phil.* 1876, p. 148), taken in Georgia, should, I think, also be considered but a well-marked variety.

Regarding the boring habit in butterflies, I learn from Prof. P. C. Zeller, of Stettin, Prussia, that there is also a Hesperian (*Erynnis alceæ*, Esp.; *malvarum*, Hoffm.) which Kirby gives as common to Europe, Asia and Africa, whose larva bores in autumn into the stems of its food-plant (*Malva sylvestris*), in which it hibernates, and in which it goes through its transformations the following spring.

Regarding other insects that bore the stems of Yucca, Mr. Bolter found a Cerambycidous larva at this work in Florida. It appears to belong to *Elaphidion*, enters from the side, but not very deeply, and enlarges the bottom of its burrow. The Curculionid *Scyphophorus yuccæ*, Horn, is said to bore the stem of *Yucca gloriosa** in California.

Further Remarks on PRONUBA YUCCASELLA, *and on the Pollination of Yucca.*

By CHARLES V. RILEY.

[Read Nov. 5, 1877.]

In a recent Bulletin of Hayden's *Geological and Geographical Survey of the Territories* (vol. iii., No. 1) is an extended article by Mr. V. T. Chambers on "The Tineina of Colorado," in which, on the very first page (121 of the Bulletin) the following paragraph occurs:

Pronuba yuccasella Riley.—Very abundant in the flowers of "soap-weed" (*Yucca*) as high up on the mountains as 7,000 feet, in the vicinity of Colorado Springs. Mr. Riley says (*Fifth Annual Report Noxious and Beneficial Insects of Missouri*. p. 151), "Front wings uniformly silvery-white." but at least half of the numerous specimens observed by me in Colorado had the wings more or less spotted with black (like *Hyponomeuta*, to which in the form and neuration of the wings it seems somewhat allied, though

* Probably *baccata* or *Whipplei*, since, according to Dr. Engelmann, *gloriosa* does not occur in California.

its affinities seem to be rather with the true *Tineidæ*: it is, however, *sui generis*). These spots vary in number from 0 to 13, and when all are present are arranged as follows: one (the largest) at the end of the disk, with three others before it, making a coffin-shaped figure; one on the dorsal margin before the cilia, and eight others around the apex. The one at the end of the cell is found oftener than any of the others, and those around the apex oftener than the other four. The expanse of wings is given by Mr. Riley at 1.00 inch for the ♀ and 0.90 inch for the ♂. The largest ♀ specimen observed by me scarcely exceeded 10 lines and the smallest ♂ was scarcely 6 lines, so that it seems to attain a greater development of wings in the east than in the west, contrary to the rule said by Prof. Baird, Dr. Packard, and others, to prevail among other insects and birds.

The statements in the above extract are altogether erroneous, being based upon mistaken identity. A careful examination of these supposed spotted Pronubas which I have been permitted to make through the courtesy of Dr. H. A. Hagen of Cambridge, Mass., whither Mr. Chambers had sent all his examples, enables me to state positively that the spotted moths which Mr. C. mistook for *Pronuba yuccasella* are, in reality, *Hyponomeuta*; and, what is the more remarkable, they are one of Mr. C.'s own described species—*H. 5-punctella*. Of the six specimens submitted to me, there was but one *Pronuba*, and that was immaculate, as the species always is. The spots on *Hyponomeuta* are very variable, while some individuals of *5-punctella* are immaculate, when at first sight they might be mistaken for *Pronuba*. Setting aside the less easily observed venation, this *Hyponomeuta* may at once be distinguished from *Pronuba* by its smaller size, narrower and at the same time less pointed wings, and more pearly-white color. The ♂ differs in the anal hooks, and the ♀ in having the ovipositor of different shape and faintly notched superiorly, as well as in lacking the characteristic maxillary tentacles.

I have reared upward of 500 specimens of *Pronuba*, and have it from South Carolina, Texas, California, Colorado and Missouri, and there is never the faintest tendency to maculation. The tendency to variation is, also, exceptionally small. If anything, the Colorado specimens are above the average size, which is natural, since the capsule of *Yucca angustifolia*, in which the Colorado specimens breed, are larger than in other species cultivated around St. Louis.

Mr. Chambers' premise being at fault, there is, of course, no force in what he says against the general rule laid down by Baird and Packard.

White moths are naturally attracted to white flowers, and it is rash to assume, without careful examination, that all white moths found in Yucca flowers are *Pronuba*.

An interesting fact connected with Yucca pollination came to my notice in the summer of 1876. I have elsewhere shown that the *Pronuba* larva, as it lies in the cocoon underground, is not susceptible to the forcing influences that hasten the development of most other insects. The moths usually issue in St. Louis too late to pollinize the flowers of *Yucca angustifolia*. This species blooms from two to three weeks earlier than *Y. filamentosa*, which, with its varieties, is most commonly cultivated. As a consequence, the former very rarely produces seed. One of the rare occasions on which it did so was in the year stated, in the garden of Dr. Engelmann. All the early flowers at the base of the raceme fell infertile, but a few of the very latest at the apex were fructified, and, as the subsequent discovery of the *Pronuba* larva in the capsules proved, they had been duly visited by the moth.

Since the publication (pp. 208–210, this vol.) of the article "On the Oviposition of the Yucca-moth," the experience of three summers has confirmed everything there said both as to the mode of oviposition and pollination, and as to the remarkable fact that *Pronuba* is the sole pollinizer of our Yuccas. This reiteration of the facts there recorded will scarcely seem necessary to those who have carefully perused what I have written. But one writer, Prof. P. C. Zeller, in Stettin, Prussia, has seen fit to doubt the accuracy of the observations; while a second, Mr. J. Boll, of Dallas, Texas, has attempted to refute my conclusions, in an article in the *Entomologische Zeitung* (1876, pp. 401–5), published at Stettin. To this article I wish, briefly, to reply; for I do not deem it altogether a waste of time, in a mattter so interesting, to notice even that which is palpably superficial and erroneous.

Prof. Zeller, as already shown in these Transactions (p. 325, note), considers the ♀ maxillary tentacles "not available" for purposes of pollination, notwithstanding I had shown so clearly that they were. "The strong tongue seems to me alone available therefor," he writes, and then vouchsafes the opinion that "other observers will be necessary to entirely clear up the curious circumstances connected with the propagation of the moth." Incited, as he avers, by this expressed belief of Prof. Zeller, Mr. Boll determimed to be one of the "other observers," by carrying some cut Yucca flowers (species not given) containing moths into the house, and placing them in glass cages, where he could observe the doings of the moths. Here is a literal translation of what he says he saw, with a few parenthetical figures of my own adding, to facilitate reference:

The females bored with the fine, pointed, horny ovipositor into the outer flesh of the pistil, which is certainly not quite soft, but on the contrary tolerably hard, and about a line thick (1), and laid each time an egg therein. Afterward they generally clambered on to the anthers and scratched the pollen grains out of the cleft of the same with the maxillary palpi so well fitted for the purpose (2). As soon as they had a sufficient quantity formed into a little lump between the rolled-up tongue, they pushed it into the hole previously made by the ovipositor (3). This opertion they often repeated several times on one and the same pistil, and then wandered to another flower. As Prof. Zeller has just narrated, Riley observed the same thing in exactly the same way. From this operation, Riley concludes, as I understand it, that the insect fructifies the plant, and even believes that a natural fructification cannot take place (4).

On which I would remark: (1) Before fructification the pistil is always soft: if unfructified, it remains soft till it wilts and falls; if fructified, it hardens from day to day. Mr. Boll's specimens were probably already fructified, and the poor moths, unable to obtain the sweets from the nectary, lacked the natural inducement to the act of pollination, which may account, perhaps, for their conduct, as he records it, in working at what little moisture there may have been at the punctures.

(2) Mr. Boll means, of course, that the pollen was scratched into a lump by the maxillary tentacle, and I hope this testimony as to the availability of those organs for that purpose will satisfy Prof. Zeller more than my own seems to have done. In reality the moth has little need of scratching, as described by Mr. Boll. Dr. Engelmann has well remarked that the anthers open, contract and curl back before the perigon opens, and often expel the large, adhesive pollen grains, which then lie on the inside of the petals, from which the moth may gather them. When not expelled, as is more often the case, they remain in an entire lump on the curled anthers, and the moth, as I have stated (6th Mo. Ent. Rep. 1873) has no difficulty in accumulating her little load.

(3) I have never noticed anything of the sort in my studies. This is owing, doubtless, to the fact that they have been made on the plants as they naturally grew, assisted by a confederate who carried a dark lantern. The conditions surrounding Mr. Boll's observations were unnatural, and to this circumstance or to pure imagination must be ascribed the stated conduct of his moths.

(4) Now, as I did not observe "the same thing in exactly the same way," but observed and described something totally different, viz., the thrusting of the pollen into the stigmatic tube (*ante*, p. 208), it is evident that Mr. Boll did not know what he was writing about. In truth, as is patent from the article itself, and as he has since confessed to me, Mr. Boll knew at the time absolutely nothing of my writings on the subject except what he learned through Prof. Zeller's notice. Further comment is needless. The fact that Yucca is not a self-fertilizer, I have demonstrated (*ante*, p. 209) by excluding the moth: it does not rest on my testimony, however, but is well known to all botanists who have studied the genus.

Following the portion of the article which I have translated is a long dissertation on the nature of the Yucca flower, in which we are vouchsafed the interesting information that the fruit can only be fertilized through the stigma, and not through the walls of the pistil! The argument is also made, that the capsules containing no *Pronuba* larvæ must have formed without the aid of the moth, notwithstanding I have conclusively shown that pollination may, from one cause and another, be performed without oviposition. The statement is reiterated about the self-fertilizing power of the flower, against experience, experiment, and authority. But the most amusing exhibition of Mr. Boll's logic is where he explains the object of stuffing with pollen the punctures made by the ovipositor, to be the closing of the wound, because the "pollen as soon as it comes in contact with the sap, rapidly swells"; and then, almost in the same breath, tells us that when pollen is not forthcoming, the papillose hairs of the stamens are gathered and used for the same purpose!! Do these swell, too? The truth is that the puncture of the ovipositor is so fine that no single pollen grain could be put into it, while the same will hold true of the papillose hairs referred to, which, by the way, the moth has no means of detaching, and for which Mr. Boll doubtless mistook, under his microscope, the hairs of the moth. The article closes with the following:

Fertilization of plants exclusively by insects is, to my knowledge, not yet positively proven; but intentional fertilization, if one should take this for such, would belong to the realm of fable. This moth, in my opinion, is no Pronuba, but a corruptrix.

Mr. Boll should increase his knowledge by perusing what has been written on the fertilization of flowers by insects. He should also learn something more than he has done in this instance of a subject he intends to treat, and especially of observations which he undertakes to criticize. Investigations, however instigated, should be carried on, not under the warping influence of individual motive, but solely for the love of truth and knowledge.

On the Differences between ANISOPTERYX POMETARIA, *Harr. and* ANISOPTERYX ÆSCULARIA, *W.-V., with Remarks on the Genus* PALEACRITA.

By CHARLES V. RILEY.

[Read Nov. 5, 1877.]

Through profound study alone can we arrive at the true relationships of animals, especially in the inferior classes. Among insects, dozens of species in some families are absolutely undistinguishable in the imago state, though differing widely in the adolescent stages and in habit; while others, again, vary to such a degree that the same species has been described under more than a dozen names, and not unfrequently been made the basis of different genera. The Canker-worms furnish good occasion for these remarks. In the previous communication to the Academy on these insects, I stated (p. 278) that *Anisopteryx pometaria* differed from the other species of the genus, so far as was then known, in having an additional pair of prolegs in the larva state, but added: "For the present I deem it best to refer it to *Anisopteryx*, as more careful study will probably show that in the characters of egg, larva, and chrysalis, the European species of the genus agree with it, and that some of the structural features of the adolescent states have been overlooked in Europe, as they so long were in this country." Through the kindness of Mr. Wm. Buckler of Emsworth, and of Mr. J. Hellens of Exeter, Eng., who have furnished me specimens, I am able to state that this surmise has been fully justified. A more careful study of the European *A. æscularia*, than had hitherto been made, shows it to agree with *pometaria* in structure and habit. The eggs have the same general form and are laid in the same regular manner; the larva has the third pair of prolegs (overlooked by former describers) on the 8th joint; the chrysalis is formed in a similar silken cocoon, and in both ♂ and ♀ is undistinguishable from *pometaria* except in the rather more distinct punctations on the abdomen.* While the two insects agree so well generically, *æscularia* is at once specifically distinguished by the eggs being somewhat broader, more rounded, less compactly pressed together, of a reddish-brown color, and particularly in being partly covered with hairs. The larva, while found on Elm, as is *pometaria*, feeds also on Oak, Lime and other trees, and has different colorational characters,† and the female is at once distinguished by a conspicuous anal tuft of hairs, which supplies those with which her eggs are covered. Yet the males of the two species bear such close resemblance that the best entomologists would be somewhat puzzled to separate a dozen of the least typical of each, if mixed together. The European species is, on an average, rather larger, lighter colored, and has the pale transverse band of secondaries more bent, especially on the underside.

In his "Monograph of the Geometrid Moths," published last year under the auspices of Dr. Hayden's Geological Survey of the Territories, Dr. A. S. Packard, Jr., gets badly confused on our two American Canker-worms. Although the misleading nature of Dr. Harris's language regarding the two species had been pointed out by Mr. Mann and myself (*ante*, p. 273), Dr. Packard nevertheless falls into the old error of concluding that Harris's *pometaria* is Peck's *vernata*. He does not stop here, however, but heightens the confusion that had once existed but had at last been dispelled, by re-christening *pometaria* with the new name of *autum-*

* I have described the chrysalis of *pometaria* as not pitted, but there is a very faint, more or less obsolete, punctation observable on more careful examination.

† Mr. Hellens has published a full description of it in *Ent. Monthly Mag.*, London, Oct. 1877, p. 114.

nata, and by calling the other species *vernata* Harris instead of *vernata* Peck. The inconvenience of this course, for which there is neither excuse nor justification, is seen in many parts of the work and particularly in the Introduction, where (p. 8) the names *pometaria* (not *autumnata*) and *vernata* are used in such manner that, after what is subsequently said on p. 402, the reader can only guess at the species intended.

But there is far graver error in what is published in the *Monograph* about these Canker-worms, and I call attention to it because it forms a marked exception to the high character and general excellence of the work. The structural characters which, as I have shown, separate *Anisopteryx* and *Paleacrita* are partly brought together in a generic diagnosis of *Anisopteryx*, which differs essentially from all other diagnoses of it, and which ends with the following remarks:

While Mr. Mann has shown, with much ability, from a consideration of the imaginal characters, that we have two well-marked and perfectly distinct species, Professor Riley has carried the matter further, and judges, from a comparison of the egg, larval and pupal states, as well as the imaginal, that not only are the two species distinct, but that there are really two genera, and for *vernata* he proposes the name *Paleacrita*. While his work shows great care and thoroughness, I am unable to agree with Mr. Riley's opinion that the differences he points out are of generic importance. The imaginal characters are certainly not so; for in other genera we have as great differences between the different species. The European *æscularia* would have to form the type of a third genus, if Mr. Riley's views are correct. We have seen that, as regards the larval characters, *vernata* in one case has an extra pair of legs, and the two species are sometimes easily confounded in the larval state. The eggs of the two species are very distinct; but the form and structure of the eggs in the *Phalænids* have not been examined enough yet for us to form a decided opinion as to what are generic and specific characters among them.

The facts that have just been stated of *æscularia* show clearly enough that that species will not have to form a new genus; and as to the single case of the larva of *vernata* Peck having an extra pair of legs, on which case Dr. Packard leans for several generalizations, a critical examination of the specimen enables me to pronounce it not *vernata* as unhesitatingly as he pronounced it to be that species. It differs from *vernata* in the indistinctly spotted head, and especially in the dark top; in having but six superior pale lines; in having the medio-dorsum dark and without black ornament; in the sub-obsoleteness of the piliferous spots, and the nonconspicuity of those on joint 11; in the subdorsal region being pale and the stigmatal region dark. All these characters, together with the third pair of prolegs, belong to *pometaria* as distinguished from *vernata*. From *pometaria* the specimen differs in the narrowness of the pale lines, and of the medio-dorsal dark line; and while it may be an aberrant specimen of this last, it cannot possibly be *vernata*. The probability is that it belongs to another species entirely, as there are several other Geometrid larvæ that feed on Elm and Apple.

I speak with confidence because I have reared both the Canker-worms from the egg and have a vivid knowledge of their larval characteristics, some of the most important of which are not stated in Dr. Packard's description of *vernata*.

Though the word *either* occurs with awkward frequency in the diagnosis referred to, it should nevertheless occur still more often, until all the opposite and heterogeneous characters in the left-hand and right-hand comparative columns, as published by me (pp. 274–7), are brought together.

The mixed genus thus obtained is cited by Dr. Packard, in the Introduction of the work, as an instance of the small classificatory value of the number of legs in larvæ; which is about as convincing as it would be to a botanist, if some one were to throw *Caltha* and *Anemopsis* together because of their superficial resemblance, and then cite the mixed genus as evidence of the classificatory worthlessness of the important characters which cause those genera to be placed in different families.

There is no recognized standard by which authors guage generic characters, and the greatest want of uniformity in custom unfortunately prevails among genus makers. Structure is of altogether more consequence than form, color, or dermal ornamentation; but the generic value of any character will depend on its invariability and rarity within the Family or Order. Wing-venation, on which systematists most rely in classifying moths, may be, and often is, of less value, on account of its variability, than special body covering. The abdominal spines and the general hairiness of *Paleacrita* are such very rare characteristics in the Family and even in the Order to which it belongs, that they acquire an importance which they otherwise would not possess.

As to the larval characters, the Geometrids have been separated into two great divisions on the pedal differences that distinguish *Paleacrita* and *Anisopteryx*, and while the divisions thus proposed, whether by Dennis and Schiffermüller, by Samouelle or by Duponchel, may be more or less artificial, Dr. Packard will, I think, have few followers in denying generic value to the characters on which they are based.

The fact that Dr. Packard differs from me in this matter is in itself of no scientific importance; but I cannot pass unnoticed the error which seems to have contributed to his decision, and on which he builds a generalization that is not warranted. The fact that in certain restricted localities in New England the two insects sometimes occur on the same tree, has had a tendency to lessen the importance of their differences in the minds of some entomologists. At first reluctant to admit that there were two species, they still imagine the differences may prove to be dimorphic. They forget that *pometaria* is confined to New England,* and that *vernata* is wide-spread through the west and south, where no specimens of the other have yet been reported.

A new Oak-gall on Acorn Cups.

By Charles V. Riley.

The gall which Dr. Engelmann refers to in the note to p. 392 is an undescribed species, the only hitherto known gall on the cups of acorns being the *Quercus-prunus* Walsh (*Proc. Ent. Soc. Phil.* iii. p. 639, and *Am. Ent.* i. p. 104), a quite large (½ to ¾ inch diameter) spherical, plum-like, fleshy growth, maturing in autumn on both *Quercus tinctoria* and *Q. rubra*. It grows out of the cupule, and, when fresh, is yellow with rosy spots. The new gall is more or less completely imbedded in the cup, and, on account of its resemblance to a diminutive acorn, I name it *glandulus*. I first received it from Dr. E. Michener of Toughkenamon, Pa., who wrote concerning it, Oct. 10, 1870:

"I found them this morning on the cups of *Q. bicolor* Wild. I think, although it was a shade tree in a field where cattle pastured, and the acorns

* In 7th *Mo. Ent. Rep.* I have quoted it (p. 80, note) from Dallas, Texas, on the authority of Dr. Packard; but I have since learned from Mr. Boll that it does not occur there, the specimens which he sent to Dr. Packard being *vernata*.

were badly trodden, that full two-thirds of the cups observed were affected. Those which I have opened still contain the larva."

I have seen it on *Q. prinoides* and *Q. bicolor.** The parent *Cynips* lays the egg very early in summer, as the gall is often formed on the aborted or blighted acorns, in which case, however, it seldom attains perfection. The ripe and well developed gall falls out of its cavity on to the ground, where the larva remains within it till the following spring. Those galls which remain within the cavity are generally imperfect. The fly producing this gall has not yet been reared nr described.

Cynips Gall *Quercus-glandulus*:—An elongate, pip-like body, averaging, when well developed, 5 mm. long, and not quite half as wide: sides sometimes parallel, but more often slightly bulging, more or less deeply corrugate longitudinally, and whitish-green; base truncate and covered with whitish down; crown flattened or slightly concave, with a central, conical nipple; color yellowish, often with a roseate tint. Larva lying in a cell near the crown. Formed in a cavity, and causing more or less bulging and swelling of the cupule. The mouth of the cavity either strongly fimbriated, or simple, according to the nature of the cup scales, and thus either hiding the gall or exposing a large part of it.

This gall is allied in structure to that described by Mr. Bassett as *Quercus frondosa* (*Proc. Ent. Soc. Phil.* iii. p. 688), which is a deformation of an oak bud. The axillary bud is made by the sting of the Cynips to prematurely develop a number of lanceolate or ovate leaves which surround one or more cells, which loosen from their leafy matrix when ripe and drop to the ground. An analogous deformation of an oak bud, caused by *Cynips fecundatrix* Hartig, is very common in Europe, and is known in England as the Artichoke-gall. The cell of this gall has been described as an aborted acorn by Mr. Albert Müller,† who has made a special study of galls. It is not surprising, therefore, that our *glandulus* gall should very generally be looked upon as a diminutive or secondary acorn. Yet such views are quite erroneous. The cells of very many other Cynipidous galls resemble acorns in form, and the resemblances to different fruits among these singular plant-and-insect productions is often so striking as to easily mislead.

* Dr. Engelmann has noticed it on *Q. Prinus*, *Q. Michauxii*, and *Q. Mühlenbergii*. It thus occurs on every form of the Prinus Group, to which it is apparently confined.

† *Jour. of Linn. Soc.* (London) *Zoöl.*, vol. xi. p. 3.

The Flowering of Agave Shawii.

By Dr. George Engelmann.

In May, 1876, Mr. Shaw received from San Diego, Cal., through the kind offices of Messrs. Hitchcock and Parker, a full-grown specimen of the fine species named for him. In June the new, innermost, leaves became more slender and their marginal teeth smaller. Early in July the flowering stalk began to rise. Regular measurements of its growth were made by Mr. Gurney, the superintending gardener, at 7 o'clock A.M. and at 7 P.M., from July 8th to September 5th. I have divided this period of 60 days into 6 decades, and have added the mean temperature and the fall of rain (at my station, 3 miles northeast of the garden) of each decade. The oliowing table exhibits these data:

AMOUNT OF GROWTH IN TEN DAYS.

1876.	7 P.M.-7 A.M.	7 A.M.-7 P.M.	Total.	Mean Temp.	Rainfall.
July 8–17	$2\frac{3}{4}$ in.	2 in.	$4\frac{3}{4}$ in.	82°.8	1.26 in.
" 18–27	3 "	$2\frac{1}{4}$ "	$5\frac{1}{4}$ "	77°.4	1.03 "
" 28–Aug. 6	$4\frac{3}{4}$ "	$3\frac{3}{4}$ "	$8\frac{1}{2}$ "	69°.1	0.72 "
Aug. 7–16	7 "	$4\frac{1}{2}$ "	11 "	78°.3	1.51 "
" 17–26	5 "	4 "	"	79°.1	2.21 "
" 27–Sept. 5	$4\frac{3}{4}$ "	3 "	$7\frac{3}{4}$ "	72°.6	1.71 "
July 8–Sept. 5	$27\frac{1}{4}$ in.	$19\frac{1}{2}$ in.	$46\frac{3}{4}$ in.		

The table shows that the night-growth (including the morning hours) was in every decade larger than the day-growth, and in the whole period surpassed it by 16 p. ct., the former amounting to 58, the latter to 42 p. ct.

It is further seen that the largest advance was made about the middle period, or from the 3rd o the 5th, and mostly in the 4th decade. After Sept. 5th the growth diminished rapidly, about the end of the month the head began to swell, and 3 months later the first blossoms opened.

The table also proves that the temperature of each decade did not have any material effect on the growth of the stalk; in the warm weather of the first two decades it grew much less than in the cooler 3rd period.

The largest growth in 24 hours, $1\frac{1}{2}$ inches, took place in the 4th decade, Aug. 10th–11th, mean temp. 78°; while on Aug. 18th, with mean temp. 84°, the growth is marked only $\frac{1}{2}$ inch, and Aug. 23rd and 25th, mean temp. 85°. it amounted to 1 inch and $\frac{3}{4}$ inch respectively.

The quantity of rain had apparently little or no immediate effect, as it was pretty evenly distributed through the whole period.

The full-grown scape measured 54 inches to the base of the panicle, which, when fully developed, was itself 21 inches long and a little wider, and consisted of 19 branches, the lowest ones the longest, somewhat S-shaped, and horizontal, with the end turned up.

About newyears the lower branches of the panicle, which thus far had formed a pointed club covered by the large bracts, began to straighten out, while the upper ones with their bracts yet formed a large cone. The first flowers opened on the lowest branch on Feb. 5th; the innermost ones of each cluster developed first, the others flowering n quick succession, so that all the flowers of a bunch were in bloom within about three days. Two or three weeks later the plant may be said to have been in fullest bloom, though the lower clusters were passed and the uppermost not yet open. These last flowered about March 18–20th, so that the flowering period (at this season and in a greenhouse) occupied from six to seven weeks.

Abundant opportunity was afforded to study the gradual development of the flowers (see also p. 298). I have, on Plate IV., represented these various phases by a series of figures carefully drawn from nature.

The bud bursts in the morning or in the middle of the day (Fig. 4); the bent filaments begin to straighten out, the still closed anthers commence to protrude, the top of the style has not yet reached the tip of the perigonial lobes. Only thus far the perigon and its lobes are fresh, exhibiting their fullest development.

In the evening of the same day the filaments are straightened out above the perigon, the anthers begin to open at the upper and lower ends, as Fig. 6 shows, and then all along their commissures; the style has not yet reached the length of the filaments, but the perigonial lobe are already withering at tip.

On the 2nd day the anthers are shrivelled, though quantities of pollen remain adhering to them; the perigon withers more; the style in the morning is still shorter than the filaments, but in the evening has exceeded their length somewhat; the stigmatic lobes remain entirely closed.

On the 3rd day these changes go on gradually and slowly. (Fig. 7.)

On the 4th the style is 2 inches onger than the perigon, the lobes of which are wilted and twisted, while the filaments also wither; in the evening the stigmatic lobes begin to separate and exude some moisture. The color of the flower, which at first was greenish and sulphur-yellow, now is of a deeper dirty yellow.

On the 5th day the style has reached its full development, 2¼–2¾ inches longer than the wilted perigon; the filaments are drooping, the anthers shrivelled, much pollen yet adhering to them; the stigmatic lobes have separated and are covered with a large drop of sweet, glutinous stigmatic liquid, which causes the pollen grains that drop into it to develope their long tubes (Fig. 8).

The drop of stigmatic fluid remains fresh and full for another and often even a third day, and then gradually dries up; the functions of the flower are ended wi h the fertilization of the ovules.*

I have not yet made mention of the abundant secretion from the nectariferous lower part (all the part below the insertion of the stamens) of the perigonial tube. During the several days in which the flowers were open the whole tube was filled to the brim with a sweetish watery liquid, of a slightly nauseous odor. I am not aware that such a secretion has before been observed in Agave flowers, and would now consider it as an abnormal phenomenon, originating under artificial circumstances, had not others, whose attention I had directed to such secretion, noticed the same in other species. Prof. C. S. Sargent, of Cambridge, Mass., saw it in an *A. yuccæfolia* which bloomed there last winter under glass, but could not find it in two specimens of the same species which in September flowered in the open air. Of greater importance, because made on a wild plant on its native mountains, is the observation of the Rev. E. L. Greene, who found last summer in

* Buds or flowers that are kept for a while separated from the plant such e.g. as are sent fresh by mail, become distorted, the ovary swells, the style lengthens, but the perigon and stamens wither even if not yet fully developed.

Southwestern New Mexico the large paniculate *Agave Parryi* so loaded with this liquid that it actually rained on him when he knocked on the stalk, or when the wind shook the panicle. South European botanists, who have numerous cultivated species and especially the naturalized *A. Americana* at their disposal, are in a position to investigate and experiment upon this curious physiological fact. Our *A. Virginica* exudes only a small quantity o honey in the base of the tube, but nothing like such a watery abundance.

Explanation of Plate IV.

Fig. 1. Diagram of the flower. Three exterior lobes of the perigon cover the thin margins of the 3 interior ones: 6 stamens opposed to the lobes; 3 carpels opposed to the 3 exterior lobes, each with two series of ovules; in the centre the stigma, its 3 lobes alternating with the carpels.

Fig. 2. Top of the flower-bud, showing one interior between two exterior lobes.

Fig. 3. The same. inside, exhibiting the broader hood of the inner lobe between the longer and narrower outer ones, all of them downy below the tip.

Fig. 4. An opening bud in the forenoon of the first day; the filaments begin to straighten, raising the anthers, appa rently in irregular order, above the perigon; style quite short.

Fig. 5. Section of the same, with style and filaments cut off; the perigon is seen in full development before it begins to wither; insertion of the filaments in the middle of the tube, the inner one slightly lower than the outer ones.

Fig. 6. Flower fully open on the first evening: filaments straight; anthers opening at the upper and lower end; style not yet of the length of the filaments.

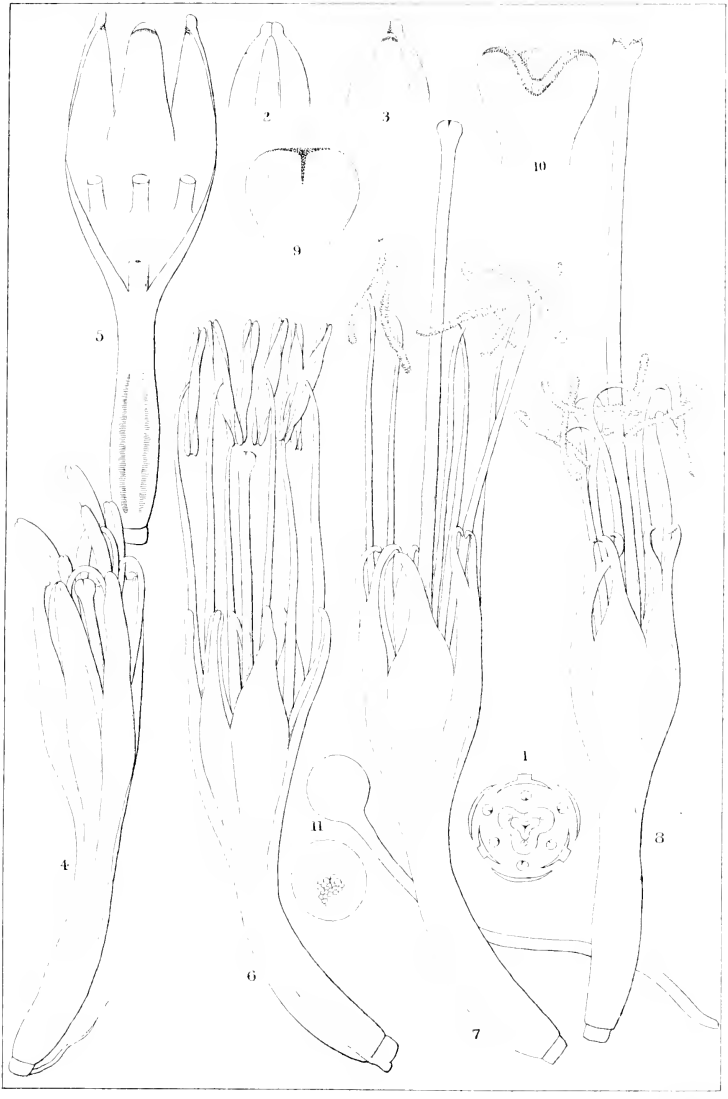
Fig. 7. Flower on the third day: anthers and perigon shrivelling, filaments yet erect; style of nearly full length; stigma yet closed.

Fig. 8. Flower on the fifth day: perigon and filaments wilted; style fully developed, stigmatic lobes separated and bearing a large drop of glutinous liquor.—All these figures in natural size.

Fig. 9. Stigma closed.

Fig. 10. Same with expanded lobes, both magnified 4 times.

Fig. 11. Pollen grains magnified 100 times: one intact, slightly elliptic; the other, developing its tube and somewhat contracted.



Agave Shawii.

The American Junipers of the section Sabina.

By Dr. George Engelmann.

The species of our Junipers, are, on the whole, well enough recognized, but their scientific definition is very insufficient—the characters, given in the books, vague and indefinite.

I have had a good opportunity to study the different species and forms from all parts of our country, fresh and living as well as preserved in numerous collections; among them those contained in the great Herbaria of New York and Cambridge (Torrey and Gray) and those of Kew (Hooker), and especially those of Berlin, whence the types of the different Mexican species were sent to me by my late excellent friend, Alexander Braun.

With the exception of *Juniperus Sabina*, which with us is always a prostrate plant, all our species occur both in the form of low shrubs or of trees, a few of them of magnificent dimensions. In the arid mountain regions, the trunks of the different species which occur there frequently assume peculiar conical forms, very thick at base and rapidly tapering to a slender point.

The BARK is in most species thin, fibrous, and at last detached in shreds; only in *J. pachyphlæa* it is 1–3 inches thick, cracked like that of some oak or chestnut, the surface at last pealing off in thin layers.

The WOOD is fine-grained and compact but not always hard; its growth is very slow, so that trees of 200 years have a diameter of 4–6, or, in the species growing in more generous soil and a more favorable climate, of 12–18 inches. Therefore, when we hear of mountain forms (necessarily of slow growth) having near their base a diameter of 3 feet, we cannot help estimating their age* at a thousand years and upwards. In *J. occidentalis* the annual rings are often quite eccentric. The resin is confined to the cambium layer and the inner bark; the wood is quite free from it but extremely durable, and, at least in *J. Virginiana*, almost indestructible. In this species the heartwood is red (hence the name *Red Cedar*) and very aromatic, soft, and splitting easily;

* This is also alluded to in a letter received, alter the above was in type, from Sir J. D. Hooker, who had just returned from an exploration of our western mountain regions, in which he speaks of the "stupendous age" of their Junipers, meaning probably *J. occidentalis*.

in *J. Bermudiana* it is said to be similar but harder; in all the others, the wood of which I could examine, it is paler red or yellowish, harder and less fragrant; they split less readily, but are, in the regions where they abound, not rarely the most available and highly esteemed firewood.

The LEAVES of young plants or of vigorous shoots are, it is well known, acicular and arranged in alternating whorls of threes (rarely in twos), quite similar to the permanent leaves of the *Junipers* of the section of *Oxycedrus*, but the older and especially the fertile plants have very short, mostly closely imbricate, almost scale-like leaves, the lower part more or less adnate to and forming part of the branchlet itself. These leaves occur in some species in pairs, in others usually in threes, so as to form 4-sided or 6-sided branchlets, but this arrangement is not constant and ought not to be much relied on for specific characters. The leaves bear their stomata on the concave, upper, appressed side; the lower, convex side or back has no stomata, but is marked by a more or less distinct, either prominent or sunken "gland," as it is called: the dorsal and only resin-vesicle or duct of the leaf. This is globose or oblong according to the shape of the leaf, or rarely (in *J. Bermudiana*) elongated, and lies in some close to the epidermis, or is in others separated from it by a layer of parenchymatous cells. The contents of this resin-vesicle are in some species or in some localities excreted through the epidermis, and are apt to appear on the back of the leaves as an aromatic balsam, and, later, as condensed resin.

The edges of the leaf are rarely entire, mostly delicately denticulate, or irregularly fringed with minute, corneous, often curved processes. This character permits us to distinguish species where others may fail.

In the figure on the next page the form and proportions of the leaf-margin of the different species is represented as it appears when magnified 280 times: but a much lower power, even a good glass, in a favorable light, will enable the student to recognize its character. The figures show that only *J. Virginiana* and *Bermudiana* have entire leaves, while *J. Californica* has the most marked fringe; the other species are intermediate between these extremes.

Of the old world *Sabinæ*, which I have examined, only *J.*

Chinensis (cultivated specimens) is in this respect similar to *J. Virginiana*; *J. fœtidissima* (coll. Hohenacker) has the strongest dentation, somewhat like Fig. 2, but with more erect teeth; *J. phœnicea* (from Italy) and *J. thurifera* (from Spain) are less marked, more like Fig. 3, and *J. excelsa* (coll. Kotschy) still less so, somewhat like Fig. 4, and only a little more than *J. Sabina* (from Switzerland), Fig. 7.

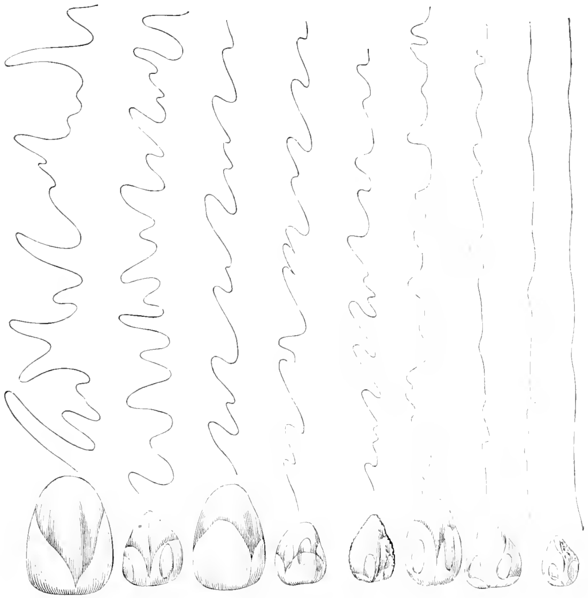


Fig. 1. *Fig.* 5. *Fig.* 2. *Fig.* 6. *Fig.* 5* ig. 3. *Fig.* 4. *Fig.* 7 & 8.

Margins of the leaves magnified 280 times, and seeds twice the natural size: Fig. 1, *J. Californica*: 2. *J. Mexicana*; 3. *J. pachyphlœa*; 4. *J. flaccida*: 5. *J. occidentalis*: 5*. var.? *conjungens*: 6. *J. tetragona*; 7. *J. Sabina*; 8. *J. Virginiana* and *Bermudiana*. On the seeds the impressions made by the resin vesicles and the pale bilobed hilum are distinctly visible. The seed under Fig. 7 & 8 is the same in both.

The species of *Sabina* are subdiœcious, or more commonly diœcious; no specific characters can be founded on these peculiarities.

The male FLOWERS (*vulgo* aments) and female aments have, like the peduncles, and in continuation of them, binate or ternate scales; the edge of the anther-scales corresponds in its character to the margin of the leaves of the same species; the number of anther-cells varies from 4 to 8 on each scale. more in the robuster, less in the slenderer forms.

The juicy strobil, GALBULUS, which we may for shortness' sake designate by the popular name of *berry*, matures like the fruit of many oaks and of the true pines in the second year, but, unlike them, it attains almost its full size in the first autumn, when even the stony coating of the seed is pretty well formed, but it matures fully a year later. We often observe berries of both years, young and maturing ones, on the same stock; but where it bears only every other year, as conifers often do, fruit of one season and of one state of maturation only is found at one time. The berry is generally closed, but in some species (I have seen it in *J. Mexicana*, *J. occidentalis*, and *J. tetragona*) it occasionally—on certain trees almost always—remains open at top, with protruding seeds.

The berry is always full of resin receptacles, mostly close to the seeds, often leaving longitudinal impressions on their surface, giving them a grooved appearance. In some species the berries are larger, drier, of a reddish-brown (when fresh reddish-glaucous) color, fibrous texture and sweetish taste, the resinous matter—present in the immature berry—having apparently mostly been changed into sugar;* in other species they are black with a blue bloom, smaller, more pulpy, and retain to a great extent their resinous contents unchanged. These differences in the berries may be used to divide the species into two groups, while form and arrangement of leaves are unavailable for this purpose.

The SEEDS vary in number; in some species they are single or sometimes in twos, rarely in threes, while in others the number rises from 5 to 10 or even 12, of which some usually remain imperfect The seeds have a hard, stony coating, often of great thickness, ovate in general outline, smooth, or grooved or angled and variously compressed, and sometimes rough or tubercled;

* I have been able to examine the fresh fruit of only *J. Californica* and *pachyphlæa*, but have little doubt that that of the other two species, referred here, is of the same character. A similar process seems to take place in the sap of the sugar-pine, *Pinus Lambertiana*.

they are brown and shining upwards, and are marked below with a larger or smaller, mostly bilobed, pale hilum. I cannot discover that the shape of the seeds, the presence or absence of the grooves or impressions, or the roughness of the surface, have much specific value.

The embryo of most species has two cotyledons; only in *J. Californica* I find regularly more (4–6, mostly 5) cotyledons—a curious repetition of a constant character of *Abietineæ*, and perhaps the only instance of it in *Cupressineæ.* Marked as this peculiarity is, it is not accompanied by any other character which would justify us in separating this species generically from its allies.

The GEOGRAPHICAL DISTRIBUTION of our Junipers is an interesting and, at least in regard to one of the species, an abnormal one. Most of the Junipers are rather local. Three species (*J. Mexicana*, *flaccida*, *tetragona*) are confined to the highlands of Mexico and one (*J. Bermudiana*) to several West Indian Islands. Among those within our boundaries, one (*J. Californica*) is peculiar to the coast ranges and islands of California, and another one (*J. pachyphlœa*) to the interior of Arizona and New Mexico, into which and into Utah a variety of the former also extends. Another species, properly named *J. occidentalis*, is characteristic of the whole western mountain region from West Texas, New Mexico, and Colorado, as far as California and Oregon.

Then there is the northern *J. Sabina*, which as well as *J. communis*, of which we do not treat here, follows the laws of high northern, or, as it is called, circumpolar distribution, extending from Maine and Nova Scotia along the great lakes and to British Columbia as well as through Northern Asia and Europe, *J. communis* reaching down to lower latitudes than the other, especially in the mountain ranges.

Thus far all our species have not deviated in their distribution from the well known laws of geographical botany. But one species, our common Red Cedar (*J. Virginiana*), makes a remarkable exception. It is the only conifer and one of the very few trees* which is found east as well as west, and certainly the only

* The others belong to the universal poplars, and may perhaps as well be classed among the circumpolar vegetation extending south along the mountains

one which at the same time extends through so many degrees of latitude. It is well known from the St. Lawrence to the Cedar Keys of Florida, from the Atlantic to the Rocky Mountains; and farther, even to the Pacific coast of British Columbia.

I arrange the eight American species in the following order:

I. SABINÆ, with larger, reddish-glaucous, fibrous, dry, sweetish berries.

A. Seeds single or few; leaves fringed or denticulate.

a. Cotyledons 4–6.

1. *J. Californica.*

b. Cotyledons 2.

2. *J. Mexicana.*

B. Seeds numerous, 4–12; leaves slightly denticulate.

3. *J. pachyphlæa.*
4. *J. flaccida.*

II. SABINÆ, with smaller, bluish-black (rarely brown) pulpy berries, of resinous taste.

A. Leaves ciliate or denticulate.

5. *J. occidentalis.*
5*. *J. conjungens.*
6. *J. tetragona.*

B. Leaves entire or nearly so.

7. *J. Sabina.*
8. *J. Virginiana.*
9. *J. Bermudiana.*

1. J. CALIFORNICA, Carrière: A stout shrub, or small tree (rarely 20 to even 35 feet high) with stout branches, the branchlets perhaps the thickest of any *Sabina*: leaves almost always in 3's, in young shoots acerose, white above, in adult plants, even on the thicker branches, closely appressed, short and thick, rounded at tip, distinctly cartilaginous-fringed on the margins; anther-scales (18–24) mostly in 3's, rhomboid, scarcely acute; scales of female ament usually 6, spreading; berry globose or mostly oval, 5–6 lines long, with scale-tips scarcely prominent; seeds 1 or sometimes 2, 4–6 lines long, with a very thick and hard shell, smooth, shining brown above, with large bilobed whitish hilum. — Rev. Hort. 3, 352 (1854); Conif. 58. *J. tetragona*, var. *osteosperma*, Torr. Bot. Whipp. in Pac. R. Rep. 4, 141; Bot. Mex. Bound. 210. *J. Cerrosianus*, Kellogg, Proc. Calif. Acad. 2. 37, fide spec. auctoris in Herb. Torrey. (See Fig. 1.)

Var. UTAHENSIS: In all the parts smaller, leaves and tips of fruit-scales often in pairs, fringe of leaf-margin shorter; berries more commonly globose; seeds mostly single, smaller.

California, from San Francisco (Monte Diablo) southward, principally on the Coast range and on the Islands; the variety all over the southern parts of Utah and into Arizona and Nevada. — Bark shreddy, wood pale;

about St. George, Utah, where the variety furnishes the common firewood. it is a small tree 20 feet high; berries smaller, 3-5 lines long; cotyledons same as in the species, never less than 4. Dr. Palmer has sent from the Colorado River a form with whitish, scaly bark, which I cannot otherwise distinguish, but have seen no mature fruit of it.—The plant is often confounded with the stouter forms of *J. occidentalis*. but in fruit can always be readily distinguished.

2. *J. Mexicana*, Schlechtend.: A bush or (fide Parlatore) a pyramidal tree; spray much more slender than the last, older branchlets with semi-acerose, squarrose leaves; leaves o ultimate branchlets mostly in pairs, slender, acute, irregularly denticulate; anther-scales in pairs (about 12) strongly cuspidate or almost acuminate; scales of female ament about 2 pairs, spreading, rarely in 3's; berry globose or oval, as large as and similar to that of the foregoing species; seeds single or often 2 or 3, similar to the last. — Linnæa 5, 77 (1830); ib. 12, 494. Parlat. in DeProd. 16, 2, 491. (See Fig. 2.)

Mexico.—The 1-seeded form is Shlechtendal's original, sent by *Schiede* from Llanos de Perote; Real del Monte, *Hartweg*, 433. A 2-3-seeded form has been collected at the last locality by *Ehrenberg* (often with protruding seeds) and *Gregg*, 636; in the Sierra Madre, *Seemann*, 2001; Cosiquiriachi, *Wislizenus*, 230.—Most collectors describe this species as a bush or small tree, but Parlatore assigns to it, without giving his authority, a height, sometimes, of 70-90 feet; he gives the bark as *secedens*, shreddy. The slender branchlets, the acute, denticulate, not deeply fringed leaves spreading on the older branchlets, and the regularly 2-cotyledonous embryo, distinguish it readily from the last.

3. J. PACHYPHLŒA, Torr.: A middle-sized tree with a spreading, rounded top, thick and much cracked bark and pale reddish wood, closely allied to the last, with the same squarrose leaves on the stouter branchlets, but distinguished by the slenderer, acuter, less prominently denticulate or ciliate leaves, usually in pairs, and by the obtusish anther-scales; berry globose or irregularly tubercled, 5-6 lines thick; seeds mostly 4, angular. —Bot. Whipp. in Pacif. R. Rep. 4, 142 (1857); Bot. Mex. Bound. 210: Parl. l. c. 490. *J. plochyderma*, Sitgr. Rep. (1853), tab. 16, spalm.; Parl. l. c. 492. (See Fig. 3.)

New Mexico and Arizona, *Woodhouse*, *Parry*, *Wright*. *Coues*, *Palmer*. *Greene*.—Further examination must show whether it stands not too close to the last; but the character of the bark seems to distinguish it completely from that and any other species. In the report of Sitgreave's Expedition, p. 12, this singular species is mentioned, and on page 173 Torrey gives a short account of this and two other forms, without naming them. The plate with the name of *J. plochyderma*, probably a mistake of the lithographer for *pachyderma*, gives a rough figure of our tree.

4. J. FLACCIDA. Schlectend.: A bush, or small or middle-sized tree with shreddy bark, with spreading branches and slender, nodding branchlets: leaves always in pairs, acute with spreading tips and slightly denticulate

margins; male flowers quadrangular, narrow, consisting of 16–20 keeled cuspidate anther-scales: large (6–7 lines thick) globose or often irregularly tubercled berry, mostly with recurved acute scales, containing 8–12 seeds in several tiers; seeds small, much distorted, many of them abortive.—Linnæa 12, 495 (1838); Parlat. l. c. 492. (See Fig. 4.)

Mexico, *Ehrenberg* and others; *Coulter*, 1419; Saltillo, *Gregg*, 432, a shrub, 10 feet high.—Well distinguished by its slender branchlets and acute, mostly somewhat spreading leaves.

5. J. OCCIDENTALIS, Hook.: A shrub, or mostly a small tree (in Oregon of the largest dimensions) with shreddy bark and pale reddish-yellow wood: closely appressed leaves in 3's or often in pairs, obtuse or acutish, delicately fringed on the edges; anther-scales obtusish or short-cuspidate; berries 4–5 lines in diameter, with 1 or more seeds.—Hook. Fl. Bor. Am. 2, 166 (1840); Parl. l. c. 489. (See Fig. 5.)

Var. α. PLEIOSPERMA with straighter, stouter branchlets, leaves almost always in 3's; berries larger (4–5 lines diam.), very resinous, deep black-blue, with 2–3 much grooved seeds.—*J. excelsa*, Pursh. Fl. 2, 647, not M. Bieb. *J. Andina*, Nutt. Sylv. 3, 95, t. 110.

Oregon to the higher mountains of California, in the north sometimes a large tree (*Lewis, Douglass, Newberry*), generally smaller or bushy; if without fruit, it is not always easily distinguished from *J. Californica* which Parlatore unites with it; the margin of the leaf is much like that of var. *Utahensis* of that species, but the fruit is very different.

Var. β. MONOSPERMA, a shrub or small tree, often with eccentric layers of wood (Cañon City, Colorado), of scraggy growth, with short branchlets at right angles; leaves as often in 2's as in 3's; berries smaller, with 2 or more, commonly only 1, less grooved seed.

From the Pike's Peak region of Colorado through West Texas and New Mexico to Arizona and California, where var. α takes its place.—In Colorado the berries are often copper colored, as Parlatore describes those of the species, and in some trees the seeds protrude.

Var.? γ. CONJUNGENS, a bush or tree 20–40 feet high, often with eccentric layers of wood; branchlets slender, with 4-ranked, obtuse, closely appressed, slightly denticulate leaves; anther-scales obtuse or slightly cuspidate; berries globose, 3–4 lines thick, with 1–2 smooth or more or less tuberculate seeds. (See Fig. 5*.)

West Texas, where it forms forests and is an important timber tree, "although not as large nor as easily worked and useful as the red cedar of the plains of Eastern Texas" (F. Lindheimer). *Berlandier*, 671, 2081; *Lindheimer, Wright, Bigelow, Hall.*—Mr. Chas. Wright found in the damp rocky woods of the mountains of Eastern Cuba a few individuals of a middle-sized tree, apparently very rare, of which only male specimens were obtained (Pl. Cub. 3187, *J. Virginiana*, Griseb. Pl. Cub. 217), which without fruit I cannot distinguish from this Texan form; what I take to be the same thing, has been sent from Mexico by Sartorius in Hb. Torrey, and by Aschenborn from Zimapan, 381, in the Berlin Herb.; the latter with small 1-seeded berries.—This form connects the northwestern *J. occidentalis* with the southern *J. tetragona*, so that it is sometimes difficult to clearly separate them.

6. J. TETRAGONA, Schlechtend.: A low bush with spreading branches and thick sharply quadrangular branchlets; leaves closely appressed, obtuse, strongly keeled, distinctly denticulate; anther-scales obtusish, short-cuspidate; berries globose, dark blue-black (4–5 lines thick), 3–5 seeded, seeds angular and more or less grooved or pitted.—Linnæa 12, 495 (1838); Parlat. l. c. 491. (See Fig. 6.)

Var. OLIGOSPERMA, a bush or low tree; berries smaller, with 1 or 2 more regularly formed seeds.

Mexico, Real del Monte, *Ehrenberg*, *Hartweg*, 436, *Uhde;* Orizaba, *Linden*.—A low shrub 3–6 feet high. The variety from Saltillo, *Gregg*, 106 & 398, 10–30 feet high, with seeds somewhat similar to var. ? *conjungens* of the last species, and occasionally protruding, but with stouter branchlets.

7. J. SABINA. Lin.; var. PROCUMBENS, Pursh.: A prostrate shrub with appressed or slightly squarrose acute leaves in pairs, margin slightly or indistinctly denticulate; anther-scales obtusish, nearly entire: berry on short recurved peduncles, 3–4 lines in diameter, with 1 or 2, rarely 3, often rough seeds.—Fl. 2, 647 (1816); *J. Sabina*, Michx. Fl. 2, 246; Parlat. l. c. 484; *J. prostrata*, Pers. syn. 2, 632; *J. repens*, Nutt. gen. 2, 245; *J. Sabina*, β *humilis*. Hook. Fl. Bor. Am. 2, 166. (See Fig. 7.)

From Maine and New Brunswick to the shores of the great Lakes and northward to the Hudson Bay regions; westward to the Yellowstone River and to British Columbia and the Pacific coast.—Michaux as well as Hooker seem to indicate that northward the ordinary form of *J. Sabina* is also found, but I have seen no specimens; the plants from the localities given above are all prostrate, spreading over and closely carpeting sandy shores and rocks, with stems up to 1 inch or more in thickness, with red heartwood and brown scaly, scarcely shreddy bark; the branches extend 6–10 feet or more; branchlets often covered with subacerose leaves, and sometimes even bearing fruit in that state; but generally the fertile plants have the short, appressed leaves common to the whole section. Mr. H. Gillman—late of Detroit, now in Waldo, Florida—who has very attentively studied the Flora of the Upper Lake country, found the branches usually flattened, and with eccentric annual rings. He observed that where they recline on rocky soil, the lower part, touching the rock, is rubbed off, or the formation of wood there prevented: but where they spread over fine sand, the lower side is protected and the upper surface undergoes a similar process through the friction of wind-driven sand. He occasionally found berries even 5 lines thick, containing as many as 4 seeds.

8. J. VIRGINIANA, Lin.: The largest, the widest spread and the most useful of our American Junipers, commonly of pyramidal form, with shreddy bark and red and aromatic heartwood; slender 4-angled branchlets, with opposite obtuse or mostly acutish leaves with entire margins;

anther-scales 10–12, rounded, entire, each bearing usually 4 or sometimes 6 anther-cells; berries on straight peduncles, 1–2-seeded; seeds angled, mostly grooved, and often rough toward the upper end. — Spec. Pl. 1471 (1753); Parlat. l. c. 488. (See Fig. 8.)

From the St. Lawrence to Florida and from the Atlantic to the Northern Pacific; it is not found in Southern Texas, in the greater part of Utah and Arizona, and in the whole of California and perhaps Oregon; in Washington Territory and British Columbia it associates with *Sabina* and perhaps with *occidentalis*, and in the Rocky Mountains south of Pike's Peak with the latter species; on the upper Missouri (Cedar Island) it attains large dimensions. — Usually the berries are small, about 3 lines thick, but in the Rocky Mountains forms occur with berries of 4 or 5 lines in diameter, and with larger seeds; among the foot-hills of Pike's Peak the trees of this species have the size and shape of an apple tree, with a rounded, spreading top.

9. J. BERMUDIANA, Lin.; A tree said to have been common on the Bermudas, and also in other West Indian Islands, of which I have seen only a few specimens. Branchlets stout; leaves in pairs, oblong or linear-oblong, obtuse, closely appressed, with entire margins and a well marked linear gland or resin-duct on the back; anther-scales about 16, large, rounded, smooth-edged, with about 6 cells; berry with 2–4 seeds, much like those of the last species.—Spec. Pl. l. c.—Parlat. l. c. 490. (See Fig. 8.)

J. Barbadensis, Lin. is said to be the same species, and *Biota Meldensis*, Gord. its acerose young state. Michaux, as well as Parlatore, quotes Florida as its home, but all the specimens from that country which I have seen, even those from Cedar Keys, and those of Michaux's Herbarium in Paris under the name of *J. Barbadensis*, are nothing but forms of *J. Virginiana*, with very small, rounded and strongly convex leaves. The forms from the different West Indian Islands, all referred to *J. Bermudiana*, require further examination, as we know that one at least, from Cuba (see p. 590), is certainly quite different from it.

A Synopsis of the American Firs (Abies *Link.*)*

By Dr. George Engelmann.

Great confusion prevails in regard to the distinction of species of our Firs and in their synonymy. This is owing partly to the innate difficulty of the subject and to the very imperfect descriptions in the books, and partly to the inordinate zeal of seed collectors and horticulturists. But in the last decade the western mountain regions, the homes of most of our firs, have been more fully explored and the geographical limits of the species ascertained; and in about the same period the anatomical structure of their leaves has been investigated, and has furnished welcome aid in the distinction and the classification of the species.

It is a most interesting as well as significant fact that while the anatomical structure of the leaves of higher organized plants shows considerable uniformity, so that it rarely can be made available for diagnostic purposes, the conifers exhibit such a wonderful variety of leaf-structure (approaching thereby the lowest orders of vascular plants), that often a single leaf is sufficient to recognize the genus, and often the species, even when the ordinary characters may leave us in doubt.

The anatomy of coniferous leaves has been often examined into, but the first to appreciate their characters as a means of classification was F. Thomas, who in 1865 published an extensive treatise on the subject in Pringsheim's *Jahrb.* 4, pp. 23–63. He was followed in 1871 by C. E. Bertrand, *Bull. Soc. Bot. France*, 18, pp. 376–81. The same author gave a more elaborate paper on this subject in 1874 in *Ann. Sci. Nat. Bot.* 20, pp. 5–153, with 12 plates. He was followed in the succeeding year by W. R. Mc Nab in *Proc. Irish Acad.* 2, pp. 209–13, with 1 plate; and in

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* I follow Link (*Linnæa*, 15, 525, 1841) in his name, definition, and circumscription of the Genus, which seems to be a very natural one, comprising the silver or balsam firs. The synonym *Picea* Don, in *London Arb.* 4, 2329, 1838, is the older name and enjoys the Linnean prestige, but is contrary to classical (Plinius, etc.) and philological authority. The name *Abies* is generally adopted on the continent of Europe, while *Picea* was heretofore principally used in England, but is now being abandoned. *Picea* Link (the same as *Abies* Don) is the proper name for the spruces. Tournefort, the elder DeCandolle, Gray, and others, comprise under the name of *Abies* both firs and spruces. The generic distinctions between them are based both on the floral and fruit characters as well as on the leaf anatomy.

1877 the same published an exhaustive paper in the same journal, pp. 673–704, with 4 plates. E. Purkinje, of the Foresters' Academy of Weisswasser in Austria, made, four or five years ago, extensive investigations on the same subject, but has, I believe, not yet given his results to the public. My own studies in this line, commenced some fifteen years ago, when the conifers of the Rocky Mountains first got into the hands of botanists, have been carried on more assiduously within the last three years.

Highly important as the microscopic investigations of the leaf anatomy are, they have sometimes been relied on too exclusively, disregarding the characters furnished by the reproductive organs.*

It may not be useless to repeat that the leaves of all firs are sessile with a circular base (leaving a circular scar in falling off), and without the prominent persistent ligneous cushion which is peculiar to the spruces. They are usually more or less flattened, grooved above and keeled below, and those of the branches are mostly twisted above the base so as to give them a more or less distichous direction; the leaves of the erect shoots are thicker and convex above, and not twisted. The tip of the leaves of young trees and of the lower branches of older ones is notched in almost all species; the leaves of robust shoots and of fertile branches are mostly entire, obtuse in some, acute in others.† All the leaves have stomata on the under side, arranged in a smaller or larger number of series, forming bands on each side of the keel. On the upper side of the leaf stomata are present in some, especially in those with thicker leaves, and absent in other species, mostly in those with flatter leaves; in several species the leaves of the lower or sterile branches are without stomata above, and the thicker ones of the upper or fertile branches have a few (in the upper part of the groove) or many. The thick epidermis of the upper surface is mostly underlaid and strengthened by very robust longitudinal cells, with thick walls and a very slender cavity,

* The separation by Bertrand, followed by McNab, of *Abies nobilis* from the other firs, and the connecting it with *Pseudotsuga Douglasii*, notwithstanding their striking differences in pollen, fruit, and seed, must be considered as the result of such one-sided investigation.

† Hence the necessity of collecting, if possible, branches of a young tree, erect shoots, lower branches of older, fertile trees (the only specimens which we usually find in herbaria because easily attainable) and branches with male and such with female flowers, or with their vestiges; besides these, the cones and seeds and young seedling plants are important A slice of the bark of old and of young trees ought to complete the material.

which have been named pseudo-bast cells, but are now generally known as hypoderm cells. They are almost always present on the edges and the keel of the leaf, there sometimes crowded in 3–5 layers, and they often form a more or less interrupted stratum on the upper side. Where stomata pierce the epidermis, the hypodermic stratum is incomplete, or entirely absent. Only in a few species (*A. bracteata* and *religiosa* and the Asiatic *firma*) we find such cells also in the interior of the leaf, a case which is common in true pines. In some species the diameter of these cells is equal to that of the epidermis cells; in some it is smaller, and in a very few larger. Their presence, distribution, and relative size, is tolerably constant, and furnishes good specific characters.

I do not describe the parenchymatous cells containing chlorophyll, nor their variety the so-called pallisade cells (elongated cells perpendicular to the upper side of the leaf), as no essential characters are derived from them. But of great diagnostic importance are the resin ducts, of which there are always two in the Abies leaf, readily seen in a horizontal section. In some species they are placed on the lower side of the leaf, close to the epidermis and mostly near the edges; in others we find them in the parenchyma, about equidistant from the upper and lower surface.

The fibro-vascular bundle occupies the centre of the leaf either single (in the more square leaves of the 4th section), or mostly divided in two distinct bundles (in the flat leaves). Both cases occur sometimes in the same species. The bundles show the larger (ligneous) cells above and the smaller (bast-) cells below; they are surrounded by small pith-like cells, and the whole separated from the parenchyma by a sheath of larger cells.

On the differences of the leaf-structure we can base the subdivisions of the genus with much greater certainty than on the length of the bracts, as was formerly done.

Sec. I. BALSAMEÆ: Resin ducts within the parenchyma, in the interior of the leaf; leaves on lower branches notched, and mostly without stomata on the upper side, on fertile branches entire, obtuse, or often acute, mostly with a few or more stomata above, towards the tip.—Two eastern and one northwestern species.

* *Exserta:* bracts protruding, recurved.

1. *A. Fraseri.*

** *Inclusæ*: bracts shorter than the scales.

2. *A. balsamea.*
3. *A. subalpina.*

Sec. II. Grandes: Resin ducts close to the epidermis of the lower side, towards the edges: leaves on lower branches notched or obtuse: on upper obtuse, rarely ever acute; bracts enclosed.—Two western species.

4. *A. grandis.*
5. *A. concolor.*

Sec. III. Bracteatæ: Resin ducts as in last; upper side of the rigid, mostly acute, leaves without stomata, with a continuous layer of hypoderm cells, usually similar cells within the sheath of the fibro-vascular bundle; pallisade-parenchyma very strongly developed; bracts exsert.—A Mexican and a southwestern species.

6. *A. religiosa.*
7. *A. bracteata.*

Sec. IV. Nobiles: Leaves of the adult tree and especially of the fertile branches quadrangular, short, curved, but scarcely twisted: resin ducts close to the epidermis of the lower side, and equidistant from the edge and keel; fibro-vascular bundles single; stomata on both sides; leaves of young trees much like those of Sec. II.—Two species of the higher mountains of the Pacific slope.

* *Exserta*: bracts protruding.

8. *A. nobilis.*

** *Inclusa*: bracts shorter than scales.

9. *A. magnifica.*

1. A. Fraseri (*Pinus*, Pursh. Fl. 2, 639, 1816; Parlatore in DC. Prod. 16, 2, 419), Lindl. Pen. Cyc. 1, No. 5 (1833), Forbes, Link, etc. This is probably the most local species in the United States, being confined to the tops of the highest mountains of North Carolina, which have an altitude of 6,000 feet or more, and the tops of which it covers together with some *Picea nigra*, but it never occurs mixed with the following species.—A small tree rarely as much as 30 or 40 feet high, and 12 or 18 inches in diameter, probably never more than 60 to 75 years old, with cinnamon-brown smoothish bark; readily distinguished from *balsamea* by the shorter, more oval cones with largely exsert and reflexed bracts, and always, even when sterile, by the almost uninterrupted stratum of hypodermic cells on the upper side of the leaf, more crowded on the edges. The white bands on the under side of the leaf consist usually of 8 or 10, or even 12 series of stomata; heighth of scales (without the stipe) equal to one-half or two-thirds their width; length of seeds equal to length and width of wing.—Forms of the next species with exsert tips of bracts, in the mountains of Pennsylvania, Vermont, and other northern regions, seem to have been mistaken for this species. In eastern as well as in European gardens forms of *balsamea* are often cultivated under the name of *Fraseri*.

2. A. BALSAMEA (*Pinus*, Lin. sp. pl. 1421, 1753; Parl. l. c. 423), Marshall Arb. Am. 102, Link, etc. *A. balsamifera*, Michx. Fl. 2, 207, in part. —The northeastern "Balsam" extends from Canada and the northeastern States along the mountains to Virginia, and along the Great Lakes to and beyond the Mississippi. It is a larger tree than the last, often 70 feet high, 1½ feet in diameter, and up to 150 years old; bark smooth and reddish-gray when young, brown and much cracked in old trees. Its slenderer cones with enclosed bracts (only their points sometimes protruding), and especially the leaves with scarcely any hypoderm cells above and very few on edges and keel (fewer than in any other of our species and sometimes none) and with narrower bands of stomata below (of 4–8, usually about 6 series), readily distinguishes it. *A. Hudsonia* of the gardens, often considered as a form of *Fraseri*, is a sterile dwarf form of *balsamea*, found also on the White Mountains of New Hampshire above the timber line.

3. A. SUBALPINA, Engelm. in Am. Naturalist, 1876, p. 554. *A. lasiocarpa*, Hook Fl. B. A. 2, 163.? *A. bifolia*, Murr. Proc. R. Hort. Soc. 3, 318. *A. amabilis*, Parl. l. c. 426, in part. — Closely allied to the last species, the western representative of which it must be considered to be; it extends from the higher mountains of Colorado and the adjoining parts of Utah northward to Wyoming and Montana, where it is the only species, and westward to the mountains of Oregon and into British Columbia (Fraser's River) and southward probably to Mount Shasta, always scattered in the subalpine forests, and, at least in Colorado, coming up almost to the timber line, but never alone constituting forests. It is a larger tree than *balsamea*, often over 2 feet in diameter and 60–100 feet high, with thin, pale whitish, smooth bark, which only in very old trees becomes cracked and ashy-gray; timber so poor and soft that in some parts of the Rocky Mountains it is called pumpkin pine. Leaves like to those of *balsamea*, notched on sterile and pointed on fertile branches; hypoderm considerable, though interrupted on upper surface, crowded on edges and keel. Cones retuse, brown-purple, 2–3½ inches long, 1–1¼ inches in diameter, the smaller ones near the timber line. Scales rounded or almost square, often almost as high as broad, similar in their proportions to those of *balsamea*, but larger; bracts short, emarginate, mucronate; seeds, including the wing, over 1 inch long, the latter nearly twice as long as it is wide.

Var. FALLAX has the resin ducts of this species, but the foliage almost of *concolor;* leaves sometimes 1½ or even 1¾ inches long, mostly obtuse, and covered with stomata above, glaucous when young.—Dr. Newberry's specimen in the Herb. Agricult. Dep. Washington, collected on the higher tops of the Cascades, south of the Columbia River, and described* by him as *A. amabilis* in Pac. R. Rep. 6, bot. 51, belongs here; the loose scales (12

* His description of the foliage, however, seems to refer to what I call below *A. grandis* var. *densifolia*. Dr. N. may have mixed both forms, an unfortunate mishap which is by no means rare in such collections, mostly made in haste and often under unfavorable circumstances.

lines wide, 11 high, with pointed bracts, seed with narrow wings, as in the species, but larger) brought home, indicate a large cone, such as he describes as 6 inches long and 2½ thick. S. Watson and lately A. L. Siler collected a similar form on the Wasatch Mountains; but the loose broad scales sent by the former may possibly belong to *concolor*, which grows in the same region. The mere fragments of this interesting form, seen by me, do not permit me to give more than the above indications.

This species has troubled botanists considerably. It is probable that Hooker's *lasiocarpa* belongs here, as a branchlet together with a few scales, preserved under that name in the Kew Herbarium, seems to point out; but the description in the Flor. B. A., which mentions the leaves as the longest of any N. A. *Abies*, refers perhaps to something else, and has certainly given cause for the application of the name to the long-leaved forms of *concolor* in the English nurseries. Then, in 1863, A. Murray distinguished a form of this species, collected by Lyall in British Columbia and on the Upper Columbia River, as *A. bifolia*, recognizing the different forms of foliage, but misapplying the scientific name. About the same time specimens and seeds from Colorado were distributed by Dr. Parry and by E. Hall as *A. grandis*, and may now be cultivated as such in Europe. That Parlatore and others have taken it for *amabilis* has already been stated.

4. A. GRANDIS (*Pinus*, Douglass Mss., 1830, and in Bot. Mag. Comp. 2, 147, 1836; Parl. l. c. 427), Lindl. Pen. Cyc. n. 3 (1833), Link, etc.—This is one of the tallest firs known and therefore properly named *grandis* by Douglas, a tree up to 200 and frequently 240 (Nuttall) or even 300 feet high (E. Hall), but in diameter less than some others, perhaps not more than 4 feet; bark smooth and brownish (Nuttall); wood white, soft, and coarse: a native of the litoral regions of the northwest coast, from Cape Mendocino in California, *Bolander*, *Vasey*, which seems to be the southern limit of several northern trees, to the British Possessions (in Vancouver's Island as *A. Gordoniana* Carr.) at least as far north as Fraser's River, *Jeffrey*, *Lyall*. But, common and valuable as this timber tree is in Oregon, very little information about it has reached us, and its cones seem to be almost unknown in collections.—The foliage is glossy green, without stomata above, and with 2 well marked white bands, each of 7–10 rows, below; leaves mostly 1–2 inches long, more markedly distichous, at least in the sterile branchlets, than in most other of our species, strongly grooved and notched; leaves on the fertile branchlets similar but rather shorter, and occasionally rounded at tip. The hypoderm cells are scattered all over the upper surface of the leaf, forming an interrupted stratum under the epidermis; on the sides and keel they are, mostly, only moderately developed. Cones cylindric, 2–4 inches long, with broad scales (nearly twice as broad as they are high), and short, bilobed or 2-auriculate bracts, with or without a short mucro. Seeds with a broad, very oblique wing, almost as broad as it is long.

This species is cultivated in European gardens from Douglas' seeds, sent home 45 years ago; in the Edinburgh bot. garden under its proper name, in Dropmore Park as *A. amabilis;* but, though now over 40 years old, seems not to have coned yet. In the same establishments another fir is cultivated, in Edinburgh as *amabilis*, in Dropmore as *grandis*, thus continuing the confusion which has existed from the first in regard to these names. I suspect this to be the real *amabilis* of Douglas, but take it for a variety of *grandis*, which—Douglas' name being doubtful—may be designated as :

Var. DENSIFOLIA : Foliage denser than in the species, clustered on the upper side of the branches like that of *Nordmanniana ;* leaves dark glossy green above, with 2 very conspicuous white bands below; hypoderm cells more crowded under the upper surface of the leaf; cones and seeds the same.—Apparently a mountain form of *grandis*. from the base of Mount Hood, *E. Hall*, mixed with *subalpina*, to British Columbia, *Lyall*. Douglas found his *amabilis* in September, 1825, "on the mountains immediately south of the Grand Rapids of the Columbia," together with *A. nobilis ;* but the cone sent home by him (at that time or later?) was a much larger one, 5-6 inches long, 2½-3 thick, with lanceolate bracts; from its seeds the above-mentioned trees are said to have sprung. Unfortunately the large cone, figured by Lambert as *grandis*, and by Loudon and in Pinet. Woburn, as *amabilis*, and formerly preserved in the collection of the London Horticultural Society, seems to have been lost since the sale of that collection; it may have been similar to Newberry's cone of *fallax*, described above.

The following species have been claimed for *amabilis: A. subalpina* is called so by Parlatore l. c., who seemed to rely on its native locality and on its leaves (or many of them) being entire, but overlooks other characters. — Var. *fallax* of that species, taken for *amabilis* by Newberry, has a large cone and similar bracts, but is not in cultivation, as Douglas' tree is supposed to be.—*A. magnifica*, the *amabilis* of the Californian botanists, has the large cones, the lanceolate bracts, and the entire leaves, claimed for *amabilis ;* but the foliage is quite different, and so is its locality.—*A. nobilis :* Prof. McNab finds the leaves of the type specimen of *amabilis* in Herb. Kew identical with *nobilis* leaves; I have examined the same leaves and take them with scarcely a doubt for those of a form of *grandis*.—*A. concolor* has been named *amabilis* in some gardens.—Locally the "yellow fir" of Oregon, as *Pseodotsuga Douglasii* is often called, seems to have been also taken for *amabilis*, perhaps on account of its entire leaves.—There remains only the tree which I have designated as *A. grandis* var. *densiflora*, which, together with *grandis* itself, is the only western *Abies* (*nobilis* excepted) which has sprung from Douglas' Oregon seeds. No *subalpina*, *magnifica* or *concolor* has been in cultivation longer than the modern knowledge of California extends back and the influx of English seed collectors, beginning with Jeffrey in 1851. None of these species, then, can be Douglas' *amabilis*, but every consideration points to the tree cultivated under that name in Edinburgh. Prof. McNab has come to the same conclusion, but differs from me in considering it a distinct species. Further exploration of the Cascade Mountains between the Columbia River and Shasta, probably the least known mountain region of the Pacific coast, will, it is hoped, clear up these doubts.

5. A. CONCOLOR (*Pinus*, Engelm. in Herb. 1848; Parlat. l. c. 426) Lindl. Mss. in Gordon Pin. 155, 1858. Long known only from Fendler's New Mexican specimens No. 828, coll. 1847, this elegant species now proves to be wide-spread over the southern Rocky Mountains, from Pike's Peak in Colorado, where it occurs only in the valleys of the foothills, to the higher mountains of New Mexico, the southern parts of Utah, and the northern of Arizona, and throughout the Californian sierras, at an elevation of 3-7,000 feet, to Mount Shasta; whether in the southern Cascades, is not known. It is *A. Lowiana* Gord. suppl. 53; *A. grandis* of the Californian botanists; *A. lasiocarpa* of the nurseries (so called from its long leaves, which constitute a character of the original *lasiocarpa*); *A. amabilis* of some establishments (because of the large cones and obtuse leaves); *A. Parsoniana* of the gardens. It is a stately tree, in California up to 150 feet high, 3-5 feet in diameter, and 200-300 years old (Lemmon); in the Rocky Mountains not quite so large.—The bark is pale in young trees, but darker than in *subalpina*, and soon becomes rough and of an ash-gray color, in old trees often several inches thick and deeply fissured. The wood is more valuable than that of *subalpina*, perhaps equal to that of *grandis*, but much less so than the wood of *magnifica*. The tree is always readily distinguished by its pale glaucous foliage, which at last gets dull green, and by the length of the leaves of the young trees, 2-2½ and sometimes even 3 inches long—longer than in any other of our firs. Only such leaves or those of the lower branches of old trees are notched at the end; on the older trees they are shorter, very broad, convex above, usually falcate, and always obtuse; on the flowering branches they become often quite thick, keeled above, and almost quadrangular. On older trees stomata cover the upper surface; in young ones they are usually confined to the middle line of the leaf, but are never absent. Hypoderm cells are interruptedly distributed over the upper surface. Cones oblong, 2-4 or even 5 inches long, retuse, or in some trees short-pointed; usually apple-green before full maturity, but, at least in Colorado, varying to different shades of brown or purple.* The scales are very broad in proportion; the bracts short, rounded, or truncate, or sometimes emarginate, with, or rarely without a short mucro; wing of seed broad, as wide as it is long; cotyledons 5-7, usually 6.

6. A. RELIGIOSA (*Pinus* H. B. K. n. gen. sp. 2, 5, 1817; Parl. l. c. 420) Schlecht. Linnæa 5, 77, 1830.—On the higher lands in Mexico, extending to Guatemala. A tall tree with linear, acute, or rarely obtuse, dark, glossy leaves; cones oval-oblong, 3-5 inches long, 1½-2 thick; bracts more or less

* The color of the cones is often considered as of specific value, but in the Black Forest of Germany all the shades between light green and deep purple may be seen on the cones of *A. pectinata*, just as in our *concolor* in Colorado.

protruding, acute or cuspidate; scales one-third wider than they are high; seed-wings longer than wide; cotyledons 5.—*A. hirtella* (*Pinus*, H.B.K. ib. is scarcely a variety.

7. A. BRACTEATA (*Pinus* Don in Trans. Lin. Soc. 17, 443, 1837; Parl. l. c. 419) Nutt. Sylv. 3, 137, 1849. *P. venusta* Dougl. Bot. Mag. Comp, 2, 152, 1836.—A well marked, but little known tree, of very limited geographical distribution, being confined, as far as known, to the Santa Lucia Mountains in Southern California, though other localities in different parts of California are attributed to it by seed dealers, and having been gathered only by very few collectors.—Leaves linear-lanceolate, always acute, of very firm texture. The bract is scarcely longer than the somewhat rounded, glabrous (all the other firs have pubescent ones) scale, but its awn or midrib protrudes 1–1½ inches; wing of seed rounded.

8. A. NOBILIS (*Pinus* Dougl. Comp. Bot. Mag. 2, 147, 1836; Parl. l. c. 419) Lindl. Penn. Cyc. 1, No. 5. *Pseudotsuga nobilis* Bertrand, McNab, under *Pinus*: the red fir of the Cascades in Oregon, extending southward to the Shasta region of California; stately trees, 200 feet high, with rigid, glaucous foliage; thick, rough, cinnamon-brown bark, and useful timber. A section in the Oregon collection of the Centennial Exhibition was taken from a tree 2½ feet in diameter, bark 1 inch thick, 119 annual rings of nearly even thickness throughout. The leaves of young trees and of the lower sterile branches of old trees are longer, flat and grooved, the resin ducts lateral, and the fibro-vascular bundles more or less divided in two; those of the fully developed and especially the fertile branches are shorter, flat-quadrangular, their thickness not more than ½ or rarely ⅔ of the width;* bundles single, cylindrical. Bracts more or less protruding and reflexed; scale high in proportion to its width (7 : 10); the oblique, angular wing of the seed about as wide as long and as long as the slender seed; the only good seed I could examine had 7 cotyledons.

9. A. MAGNIFICA Murray Prov. Hort. Soc. 3, 318, 1863; *A. nobilis* var. *robusta* in Hort. Dickson & Turnbull; *A. campylocarpa* Murr. Trans. Bot. Soc. 6, 370; *A. amabilis* of the Californian botanists; *Pseudotsuga magnifica* McNab: the red fir of the higher California sierras, at an altitude of 7–10,000 feet; large trees often 10 feet in diameter, over 200 feet high, with thick cinnamon-brown bark, and valuable wood.† Leaves of young specimens flat but scarcely grooved, never, I believe, notched, the fibrous bundles often in twos. On full-grown trees, and especially on fertile branches, the leaves are mostly ¼ wider than thick, or even perfectly square; the resin ducts in these leaves are placed equidistant from the edges and the keel, separated from the epidermis by a layer of hypoderm

* The leaf sections, figured by McNab, all seem to refer to young trees; none are as thick as I find them in native specimens.

† A section in the Agricultural Dep. of Cent. Exh., sent by J. G. Lemmon, indicates a tree 6½ feet in diameter, with brown, almost fibrous, bark, 3 inches thick, about 400 years old, with a pretty uniform growth, 10 rings measuring 1–2 inches in thickness, about the same as in a specimen of *nobilis* in the Oregon collection.

cells, which is externally indicated by a green stripe dividing the bands of stomata, so that these leaves show 4 lower white bands. Cones 6–8 inches long, 2½–3¼ thick, purple; bracts lanceolate, shorter than the broad scale (height to width as 6 : 10); wing of slender seed very oblique, wider than long; the only seed examined had 10 cotyledons.

Many years ago it was suggested by Mr. McNab of the Edinburgh garden, that *nobilis* and *magnifica* might be forms of the same species; some seedsmen of California seem, also, to have come to this conclusion; and now Messrs. Hooker and Gray, who a few months ago enjoyed the opportunity of examining both on their native mountains, incline to the same opinion; *magnifica* would thus be the southern, short-bracted, and *nobilis* the northern, long-bracted form. It is quite probable that the length of the bracts may vary; we know it of *nobilis*, but it is doubtful whether this could be the case to such an extent as to permit us to unite both species. In *magnifica* no lengthening of the bracts has been observed thus far, and in *nobilis* they never, I believe, become shorter than the scale. But besides this, I confess, rather doubtful difference in the length of an organ of minor importance, the flatter and grooved leaves of the young *nobilis*, and the higher and proportionately narrower scales of this species, together with the smaller number of cotyledons (if constant), seem to indicate specific distinction. Further explorations must show whether *magnifica*, or anything like it, grows in the regions which we know as the home of *nobilis*.

JOURNAL OF PROCEEDINGS.

March 16, 1868.

DR. GEORGE ENGELMANN in the chair.

Five members present.

Exchanges received were laid upon the table.

The Committee on Publication reported that arrangements had been made for the publication of No. 3 of vol. ii. of the Transactions.

Mr. Spencer Smith presented a map from the report of the U. S. Land Commissioner, mounted on rollers.

Hon. T. J. C. Fagg presented several geological specimens from the limestones of Louisiana, Pike county, Mo., some of them exhibiting an oölitic structure.

April 20, 1868.

DR. WISLIZENUS, Vice-President, in the chair.

Ten members present.

Exchanges received were laid upon the table.

Dr. Engelmann presented a cone from a species of Pine (*Pinus Coulteri*) from California.

Charles V. Riley, State Entomologist, was elected an associate member.

May 4, 1868.

DR. WISLIZENUS, Vice-President, in the chair.

Ten members present.

Letters were read, and various foreign exchanges were laid upon the table, by the Corresponding Secretary.

Dr. Briggs exhibited a specimen of the Mayflower (*Epigæa repens*) from New Hampshire, in bloom, a primrose (*Dodecatheon*) and a small fern (*Camptosorus*) from St. Clair county, Illinois.

Dr. Wislizenus reported as the result of his meteorological observations for March and April, that the mean temperature for March (51.1°) was much above the average, and that for April (50.4°) was far below it. Vegetation started, accordingly, much earlier in March than usual, but was checked again by the cold weather in the first half of April. The rain in these months very much exceeded the average, being for March 7.67 inches, and for April 7.85 inches.

Mr. Holmes presented a specimen of the iron made at the new Carondelet Furnace, in South St. Louis, with the bituminous coal from the Big Muddy River in Illinois. It had been pronounced to be of excellent quality.

May 18, 1868.

DR. WISLIZENUS, Vice-President, in the chair.

Five members present.

The Corresponding Secretary laid upon the table No. 1 of vol. i. of the Transactions of the Chicago Academy of Science, and reported that No. 3 of vol. ii. of the Transactions of our Academy had been issued, and copies duly forwarded to the various societies upon our exchange list.

Dr. L. D. Morse, Commissioner of Statistics, presented a copy of the "Missouri Statistics for 1867."

Dr. O. H. Potter, having resigned the office of Recording Secretary, Mr. Spencer Smith was elected to fill the vacancy.

June 1, 1868.

Dr. Wislizenus, Vice-President, in the chair.

Seven members present.

Dr. C. W. Stevens reported that the artesian well at the Insane Asylum, near St. Louis, had reached the depth of 3,076 feet, and that the boring was still going on at the rate of about two feet a day. On comparing the actual measurement of the thickness of the strata, it was found that they agreed very nearly with the geological estimates of Prof. Swallow.

June 15, 1868.

Dr. Wislizenus, Vice-President, in the chair.

Three members present.

Letters were read, and exchanges from foreign societies were laid upon the table.

Judge Holmes called the attention of the members to an interesting paper, entitled "The Ancient and Modern Ligurian Race in Italy," by G. Nicollucci, Member of the Royal Academy of Sciences of Naples (Atti dell' Acad. delle Scienze, vol. ii. No. 1, Napoli, 1865).

The learned writer gives very satisfactory reasons for believing that the ancient Ligurians of Piedmont, and other parts of Italy, were identical in race and language (with some difference of dialects) with the ancient Iberians of Spain, Southern France, and other parts of Europe. They are traced historically, and are identified, not merely upon philological data, but upon craniological and physiological peculiarities, as belonging (together with the Finno-Ugrians of Northern Europe) to the aboriginal Turanian stock which was indigenous over Europe before the advent of the Aryans (Pelasgian, Celtic, or Teutonic). Weighty reasons are given for believing that this Turanian people inhabited Europe as far back as the stone age. They were the same in race, (though comprising various nations,) and were called *Liguri* and *Siculi* in Italy, *Iberi* in Spain, *Finni* and *Tatari* in Northern Europe, and *Scythi* in the East. They were brachycephalic in type of skull, in complexion brunette, medium in stature, with eyes black and horizontal, and square visage, and black flowing or curly hair; while the Aryan or Indo-Germanic stock is characterized in general as dolichocephalic, with blue eyes, light complexion and hair, and larger stature, with the exception of the Sclavonians, in whom the Turanian element appears to prevail over the Aryan.

By a comparison of ancient crania, and by the study of linguistic affinities, the author refutes the opinion that the Iberians came from Libya, or Northern Africa, as the Guanches of the Canary Islands most probably did, since the ancient crania of this people exhibit something of the prognathous type of skull.

The author sums up his researches in five distinct propositions (which may be translated) thus:

1. The Ligurians of the present day are the direct descendants of those Ligurians of antiquity who inhabited, not only Italy, but a part of France and of Spain, in the ante-historical epoch.

2. They were kindred in stock with those other peoples that inhabited Europe before the arrival of the Aryan families, and were a race distinct from them by the brachycephalic character of the skull, and by those other natural characteristics which are peculiar to the Turanian race.

3. The Aryan colonies which penetrated into Italy have in part replaced the more ancient inhabitants, and have been superimposed upon the indigenous race whose type disappeared and was absorbed by the Aryan, which became the general type of the Peninsula.

4. And in Piedmont and Liguria the old race remained predominant, because the ancient type was either not pushed aside or was only slightly modified, for there is still observable, at this day, in the majority of the inhabitants of those provinces, the brachycephalic form of the skull which is preserved unchanged from what it was in the more remote age.

5. Nevertheless, the natives of Piedmont and Liguria, commingled with the rest of the inhabitants of the Peninsula, and bound together with them by community of language, religion and customs, have for a long time formed but one single nation, as the whole territory between the Alps and the sea has for a long time formed, and still forms, but one sole and indivisible country.

July 6, 1868.

Dr. Wislizenus, Vice-President, in the chair.

Five members present.

Dr. Wislizenus reported an abstract from his meteorological journal for the last month, showing an average temperature about the same as for the last 30 years in the same month. There was a wide range of the thermometer, the lowest being 50°, and the highest 99°. The amount of rain was 1.58 inches. The usual average is 5.56 inches. During the month of May, rain was nearly twice the usual average. At points 20 miles distant the electrical state of the atmosphere had been much disturbed. The rain-storms prevailed over small areas only, while sections in close proximity had no rain for nearly four months. Positive electricity in the atmosphere had been extremely low (only one quarter of a degree, the usual mean being 3°). Positive electricity had been very low this year. Thunder-storms are usually accompanied by negative electricity.

Judge Holmes tendered his resignation as Corresponding Secretary.

August 3, 1868.

Dr. Wislizenus, Vice-President, in the chair.

Six members present.

Dr. Wislizenus presented from the Hon. C. D. Drake the Report of Commissioner Brown on the Mineral Resources of the Country west of the Rocky Mountains.

He stated, also, from his journal, that the mean temperature for the last month had been 84° ; the mean for the last 30 years being 79°. The highest range in this month was 101½°, for several days ; the lowest was 66°. Quantity of rain 2.03 inches ; the usual average for the month being 4.17 inches. There had been nine slight thunder-storms. Positive electricity low (about 1½°). During the period of extreme heat, the mortality had rapidly increased.

Dr. Charles E. Briggs was elected Corresponding Secretary, in place of the Hon. N. Holmes resigned.

August 17, 1868.

Dr. Wislizenus, Vice-President, in the chair.

Five members present.

Foreign exchanges received were laid upon the table.

Dr. Wislizenus, in addition to his report of the temperature of last month, communicated the observations of Mr. Fendler, of Allenton, St. Louis county, showing that on the 18th of July last, the thermometer had stood at 109° in the shade, and at 156° in the sun. During the same "heated term" in St. Louis, the thermometer had stood for six days at above 100°, and for three weeks at over 90°, the daily maximum falling below 90° only three times.

September 7, 1868.

DR. WISLIZENUS, Vice-President, in the chair.

Eight members present.

Publications received were laid upon the table.

Dr. Sander presented, in the name of Col. Jacobs, several pamphlet reports on the Route of the Pacific Railroad.

Dr. Wislizenus read an abstract from his meteorological record for the last month, as follows: Mean temperature of the month, 77.71°; usual average, 76.5°; warmest day, (August 6th), 95°; rain, 8.53 inches; usual average for August, 4.15 inches; whole amount of rain from May 1st to May 28th, 8.86 inches.

Mr. Hayes remarked that he had observed the star-shower, commencing on the 12th of August; that about the same number (20) fell every night, and that the number observed was somewhat less than during the same time last year, but that the shooting stars were much brighter.

On motion of Mr. Richard Hayes, a committee, consisting of Dr. G. Baumgarten, Messrs. S. Smith and R. Hayes and the Vice-President, were appointed to arrange an agreement with the Board of St. Louis Public Schools, whereby the property of the Academy might be transferred to the Polytechnic Institute building, and suitable rooms be provided therein for the use of the Society.

September 21, 1868.

DR. WISLIZENUS, Vice-President, in the chair.

Eight members present.

Letters were read, and publications received were laid upon the table.

Mr. Charles Keates, of Keatesville, Mo., was elected a corresponding member, and Dr. P. V. Schenck, of St. Louis, was elected an associate member of the Academy.

October 5, 1868.

Dr. Wislizenus, Vice-President, in the chair.

Six members present.

Publications received were laid upon the table.

On motion, the Hon. Samuel Treat, Dr. C. E. Briggs, Dr. John Green, and Mr. Enno Sander, were added to the committee on removal of the Academy to the Polytechnic Building.

Dr. Wislizenus presented to the Academy, from Dr. B. F. Shumard, a collection of specimens of meteoric iron, which had been received from Prof. Silliman, in exchange for other specimens of minerals.

His monthly record for September, showed for mean temperature 63.2°. Usual average, 69.9°; maximum, 84.5°; minimum, 40.5°. Rainfall, 5.2 inches. Positive electricity, 1.4°.

October 19, 1868.

Dr. Wislizenus, Vice-President, in the chair.

Six members present.

Publications received were laid upon the table.

Mr. G. Sharswood, of Philadelphia, a corresponding member, being present, made some remarks upon the depredations of an insect on the potato in Pennsylvania. He stated that the crop in some places had nearly been destroyed by it.

November 2, 1868.

Dr. Wislizenus, Vice-President, in the chair.

Nine members present.

Publications received in exchange from foreign societies were laid upon the table.

Dr. C. E. Briggs, from the Committee on Removal reported a memorandum of proposals made to the St. Louis Board of Public Schools, for accommodations for the Academy of Science in the Polytechnic Building:

That the stated meetings of the Academy are held on the first and third Mondays in each month, at 7½ P.M., and that for this purpose room is desirable for seating fifty persons.

For the Library, arranging it upon shelves, there are needed, at present, seven rows in height, and eight feet in length, and twenty feet more are required for the probable growth in five years.

For the Cabinet, if arranged, on upright cases placed against the wall, one hundred feet in length are requisite; but the Academy possesses cases constructed for standing in the middle of the room.

It is the opinion of the Academy that it would elevate the system of public education to accomplish this union, by which the Public Schools would be formally connected with the advance of the Natural Sciences in this country and Europe, and the Academy proposes to grant the use of its Library and Cabinet for the instruction of the teachers in the Public Schools, and of the pupils of the High and Normal Schools.

The proposals were approved, and the committee continued, with authority to act in the matter.

Dr. Wislizenus communicated his monthly observations in meteorology: Mean temperature for October, 55.3°. Usual average, 55.8°; highest, 76.5°; lowest, 31°. Range, 45.5°. Rainfall, 2.11 inches; average, 3.39 inches. Positive electricity, 2.6°; average, 6.3°. Prevailing wind, mostly N.E.

On motion of Dr. Pollak, the regular dues collected from Dr. John P. Hodgen were ordered to be refunded to him in consideration of his liberal donation of the use of the Hall for the meetings and museum of the Academy.

November 16, 1868.

DR. WISLIZENUS, Vice-President, in the chair.

Five members present.

Publications received were laid upon the table.

The Corresponding Secretary reported a donation from Gen. W. T. Sherman, of a copy of the map of his "March to the Sea," for which the thanks of the Academy were voted to Gen. Sherman, and the map was ordered to be mounted on rollers, and hung up in the Hall.

Dr. C. E. Briggs presented a small collection of human bones and Indian beads, made of bone, taken by himself from the Big Mound of St. Louis.

Mr. Spencer Smith read a paper on the origin of the Big Mound at St. Louis. Referred to the Committee on Publication

December 7, 1868.

Dr. Wislizenus, Vice-President, in the chair.

Six members present.

Publications received were laid upon the table.

The Committee on Removal reported the proposals agreed upon with the Board of St. Louis Public Schools for the use of rooms in the Polytechnic building, as follows: That the parties were to enter into contract for two years, subject to six months' notice of removal by either party, room No. 6 of said building to be used for meetings and for the Cabinet, but not to interfere with the use of the room by other societies. The Library of the Academy to be placed in the Library of the Public Schools, to be used only as a library of reference, and $3 a year to be paid by members consulting it.

The report was approved in general terms by the Academy, and the committee was instructed to treat with the Board on the above basis.

December 21, 1868.

Dr. Wislizenus, Vice-President, in the chair.

Six members present.

Dr. Sander read a letter from Dr. Baldermus, President of the German Ornithological Society of Berlin, proposing an exchange of publications. The proposition was accepted.

S. A. Holman, M.D., of St. Louis, was elected an associate member.

January 4, 1869.

Dr. Wislizenus, Vice-President, in the chair.

Fifteen members present.

Letters were read by the Corresponding Secretary, and various publications received were laid upon the table.

Dr. Wislizenus reported the mean temperature for December at 27.9°; lowest, 11° below zero; average for 33 years, 33.8°. For 24 days in December, the thermometer had stood below the freezing point. Rainfall, 3.09 inches.

Dr. Wislizenus also presented his annual report of Atmospheric Electricity observed at St. Louis, accompanied with diagrams. Referred to the Committee on Publication.

The annual address of the President, Dr. B. F. Shumard, was then read, as follows:

ANNUAL ADDRESS OF THE PRESIDENT.

GENTLEMEN: We have just entered upon the thirteenth year of the existence of our Academy, and as your President it devolves upon me to lay before you some account of its progress during the year that has just passed, and its prospect in the future.

There is much cause for congratulation that our institution, notwithstanding the serious pecuniary embarrassments under which it has labored almost from its commencement, has gone steadily onward, contributing its share to the great fund of scientific knowledge, until it now occupies an exalted position among learned societies throughout the world, and its memoirs and transactions are eagerly sought for and prized wherever science is cultivated. "What has the Academy of Science done?" has not unfrequently been asked by some paying members who do not attend our meetings, but cheerfully contribute their annual dues. I propose to answer that question, this evening, by giving some account of the present condition of its Museum and Library, and of its system of exchanges with scientific bodies in all parts of the world.

I hope to be able to demonstrate that our Academy, though working very quietly, has accomplished a great deal, and that its object and aims are eminently worthy of support and encouragment, not only from its members, but from the intelligent citizens of St. Louis. It will be seen that our Collections and Library, if properly classified and displayed, would prove not only an ornament to the city, but a most useful Museum of reference to the manufacturer, the miner, and the man of science. And who can doubt that such a Museum would be in the highest degree attractive to strangers, and an object of honest pride to every citizen?

MUSEUM.

Mammalogy. The collection of mammals, though not large, contains some rare and valuable specimens, in a remarkably fine state of preservation. Among them we may mention the stuffed skins of a full grown Grizzly Bear, a cub of the same, several Rocky Mountain Sheep and Goats, the head of a Buffalo, several specimens of Deer and various smaller animals from the Rocky Mountain region. For these rare objects the Academy is indebted to our members, Charles P. Chouteau, Col. Vaughn, and Dr. Stevens. In this department we have lost some valuable skins from the ravages of insects, the funds of the Academy not permitting the employment of a taxidermist to care for their preservation. For this reason our Rocky Mountain friends have not taken the same pains to secure for us rare specimens as in former years. This is much to be regretted, since many of our wild animals are becoming rapidly extinct with the advance of civilization, and in very few years the opportunity for obtaining them for our Museum will be lost forever.

Ornithology. The collection of Birds is handsomely displayed in two large cases; they are neatly mounted and labelled, and present quite an attractive appearance. The number of specimens amounts to several hundred, some of them of great rarity and beauty. A large number of them have been donated to us by the Academy of Natural Science of Philadelphia, and the Smithsonian Institution in exchange for other specimens. Others have been obtained through members and by purchase. It is earnestly recommended that this collection, as well as that of the mammals, be placed in the hands of a competent taxidermist at an early day, to prevent further ravages from insects.

Herpetology. This department contains a collection of Serpents and other Reptiles preserved in alcohol, and dried preparations of tortoises and turtles, chiefly from the Mississippi Valley, presented by Drs. Stevens, Sander, Pollak, Engelmann, and Shumard.

Icthyology. We possess but a meagre representation of Fishes in our Museum. It is therefore highly desirable that more attention be directed to this great department in the future, for there is certainly no branch of zoölogy which is more attractive, or which promises to the earnest naturalist a richer harvest. Our western rivers, creeks, lakes, and ponds, abound in fishes in great variety of species and some of them of great beauty. Many of them are yet unknown to science and to the museums of this country and Europe.

Conchology. Our collection of marine shells consists of about six hundred specimens, and about three hundred species donated by the Smithsonian Institution. They are arranged in a long vertical case, numbered and labelled according to the Smithsonian catalogue. These add not a little to the attraction of our Museum. We possess, through the liberality of the same institution, a considerable collection of shells from the Pacific coast labelled by Dr. Warrington Carpenter, of England, and a box of fresh-water and land shells from various parts of the United States. These have not yet been unpacked for want of room and cases for their display. Drs. Engelmann, Pope, Stevens, and Shumard, and Mr. Broadhead, have also contributed fresh-water species from Western waters. When the entire cabinet is arranged, it will form a valuable reference collection to the student of Conchology.

Entomology. We possess several cases of insects donated by members of the Society. In view of the importance of this department, it is highly desirable that more attention be paid to it in future. Our Museum should, at least, have a full suit of insects injurious to vegetation.

Zoöphytes. The collection in this department consists of several tin cases containing medusæ, star-fishes and sea urchins, presented by Edwin Harrison, Esq., of St. Louis. These, when properly arranged in glass jars, will form an interesting feature of our Museum. To the Smithsonian Institution we are also indebted for dried star-fishes, and several species of corallines.

Botany. Our botanical collection embraces an extensive series of lichens and mosses, amounting to several hundred species, chiefly from Western States and Territories. These were collected by Dr. T. C. Hilgard of this city, and by him presented and arranged in our Museum. We are indebted to Dr. Engelmann for a suit of canes and woods from various portions of the United States, and to Dr. McPheeters, and Mr. G. C. Broadhead, for collections of plants from Missouri. Besides the material in our own Museum, we may mention the magnificent Herbaria of our resident members, Dr. Engelmann and Mr. Henry Shaw, comprising many thousand specimens collected with great labor and at great expense from all parts of the world, and which these gentlemen, with great liberality, have rendered accessible to the student of Botany.

Ethnology This department contains distorted crania from the mound near Little Rock, Ark., also stone axes, spear and arrow heads, quoits, shells, and coralline beads, and other aboriginal implements and ornaments from Western States. The principal donors were Drs. Wislizenus, Briggs, George G. Shumard, and C. A. Pope. We may also mention some Indian costumes, war implements, cooking utensils, and ornaments of the Upper Missouri Indians, donated by Charles P. Chouteau, Dr. C. A. Pope, and Col. Vaughn, and an interesting series of some twenty figures representing costumes of the natives of the East Indies, from the Rev. C. C. Marsh. In this department we find a beautiful series of porcelain ornaments in bas-relief, representing figures of men and animals, and used as decorations in the great Porcelain Tower of China; also highly polished bricks employed in its construction. This very interesting collection was obtained by Mr. William Clark of this city, shortly after the destruction of the Tower, and by him deposited in our Museum.

Comparative Anatomy. Our Museum is unusually rich in fine specimens of skeletons and crania of mammals, birds and reptiles, donated by C. P. Chouteau, Col. Vaughn, Dr. Stevens, Lieut. Bryan, U.S.A., Dr. Shumard, and the officers and employees of the American Fur Company. The total number of specimens cannot now be ascertained, but they may be estimated at several hundred, included in upwards of one hundred species. They constitute by far the largest cabinet of the kind in the Mississippi Valley. Among the more prominent objects may be enumerated the crania of the moose, deer, elk and antelope, with antlers attached; of the bison, Rocky Mountain goat and sheep, grizzly and black bear, prairie wolf (several species), wild-cat, American panther, lynx, otter, martin, prairie dog, &c., &c. We also possess a fine specimen of the skull of the *Bos urus* of Europe, a species becoming rapidly extinct, and now only found living in the parks of the Emperor of Russia. Besides our own collection, Dr. Chas. A. Pope has deposited in our Museum his extensive and choice series of mounted skeletons of mammals purchased in Europe, and transported by him to St. Louis at great expense.

Mineralogy. The cabinet of minerals consists of about 1,200 specimens from all parts of the world. It embraces a pretty full suite of Missouri minerals and ores, and therefore forms a valuable reference collection to those engaged in mining pursuits in our State. For these specimens we are indebted to the old Western Academy at St. Louis. Prominent among the treasures in this department, is the well known Nebraska meteorite, found about twelve miles west of Fort Pierce, on the Upper Missouri River, and presented to the Academy by Mr. C. P. Chouteau. It originally weighed 40 pounds, but it has been reduced several pounds by cuttings to supply the principal cabinets of Europe and this country with specimens. For these, the Academy has received in exchange valuable slices of meteoric irons from both foreign and home localities. Our collection at this time contains specimens of meteoric iron, representing thirteen different localities.

Geology. The collection of rocks may be estimated at from 400 to 500 specimens. Among these we find a valuable series from our fellow-member Dr. Wislizenus, collected by him during his memorable tour to Western Mexico, in connection with Col. Doniphan's Expedition. The collection also contains volcanic rocks from Italy, some of them neatly polished, and donated by the old Western Academy of Natural Sciences.

Palæontology. The cabinet of fossils forms, perhaps, the most valuable part of our Museum. But while the faunas of some of the great geologic periods are well represented, others have scarcely a place in our Museum. From the Post-Tertiary period, our Museum contains a number of teeth and bones of *Mastodon giganteus* and *Elephas primigenius*, in good preservation, from Missouri and other Western States; a very fine example of the head and several vertebræ of *Bos bombifrons*, an extinct fossil ox which was exhumed by Drs. Pope and Stevens, several years since, from Chouteau's Pond, and by them deposited in the Museum of the Academy. The fossil is so rare that only two specimens have hitherto been discovered. We have also a full skeleton of the great cave bear (*Ursus spelæus*) from Europe, belonging to the same geological period. From strata of Miocene age, we possess an extensive series of bones and teeth of extinct animals, collected from the celebrated Mauvaises Terres of Nebraska, chiefly by Dr. F. V. Hayden, and presented to our Museum by C. P. Chouteau, Col. Vaughn, and some liberal citizens of St. Louis. This collection contains three species and 14 specimens of extinct fossil turtles, the remains of the gigantic Titanotherium, two species of extinct rhinoceros, a hyena, and two species of Oreodon. Of the latter, we possessm any specimens of the head and teeth in fine preservation. Of Cretaceous fossils, a fine suite has been donated by Drs. Stevens and Pope, and by Messrs. C. P. Chouteau and Charles Gilpin of the American Fur Company. From the Palæozoic strata, we have a suite of Silurian fossils from Cincinnati, donated by the President (Dr. B. F. Shumard), and a small display of species from the St. Louis Limestone.

In concluding this account of our Museum, it must not be supposed that all its objects have been enumerated, for there are many others amounting to hundreds of specimens which cannot now be noticed.

LIBRARY.

Our Library is the best and most extensive west of the Alleghany Mountains. It consists of about 3,200 volumes and pamphlets, kept in admirable order and preservation by our Librarian, Dr. G. H. E. Baumgarten, who without compensation has generously devoted much time and labor to its classification and arrangement.

Many of the volumes are neatly and substantially bound, the funds for this purpose having been furnished by a few of the members. The Library is particularly rich in memoirs and transactions of foreign and home societies, many of them being of the most costly character. At the present time we are receiving regularly the transactions of upwards of 170 foreign academies and societies, and of about 75 home societies. These are sent to us in exchange for our own publications, of which two large octavo volumes have been published, embracing about 1,400 pages, and profusely illustrated with maps, and diagrams, and engravings of objects of natural history.

Papers. During the past year, papers have been read before the Academy by Dr. Edmunson, and Messrs. Wislizenus, Holmes, Swallow and Spencer Smith; and many scientific subjects have been brought before the Society, and discussed by its members.

Removal. From the organization of the Academy to the present time, our meetings have been held in the Dispensary Building, rooms having been generously provided by Dr. C. A. Pope, and, since his removal to Europe, by Dr. John P. Hodgen, free of expense to the Academy. We are now expecting to remove our Library and Museum to the Polytechnic Building, where it is hoped sufficient accomodations will be allotted to us to arrange our collections and Library in rooms which will be more accessible to the public. It is confidently believed that in a few days arrangements will be perfected that will be satisfactory to both the Institute and the Academy.

The election of officers of the Academy for the ensuing year resulted in the choice of the following gentlemen:

President—Benjamin F. Shumard, M.D.
1*st Vice-President*—Adolphus Wislizenus, M.D.
2*d Vice-President*—John Green, M.D.
Corresponding Secretary—Charles E. Briggs, M.D.
Recording Secretary—Spencer Smith.
Treasurer—Dr. Enno Sander.
Librarian—G. H. E. Baumgarten, M.D.

January 18, 1869.

Dr. John Green, Vice-President, in the chair

Seven members present.

Dr. Green reported from the Committee on Removal, that all the conditions of the contract between the Academy and the Board of Public Schools had been agreed upon, and only awaited the proper legal forms to be drawn up and executed.

Dr. C. W. Stevens made some remarks upon the skull of the fossil ox (*Bos bombifrons*), found, several years ago, at the bottom of Chouteau's Pond, in the city of St. Louis, and now belonging to the Museum of the Academy.

Dr. Stevens also stated that the boring of the Artesian Well, at the Insane Asylum, near St. Louis, had reached the depth of 3,562 feet, and that the boring was, at present, in the white sandstone, supposed to be below the 4th Magnesian Limestone.

February 1, 1869.

Vice-President Wislizenus in the chair.

Eight members present.

Dr. C. E. Briggs reported from the Committee on Removal, that the contract with the Board of Public Schools could not be signed at present, for the reason that some business touching the possession of the Polytechnic building had yet to be transacted. And at the suggestion of Mr. Hayes, it was directed that a removal should not take place until the contract could be signed in due form of law.

Dr. Wislizenus gave a summary of his metereological record, as follows: Mean temperature for January, 37.2°; average for 33 years, 32.4°; range from 23° to 62°. No snow during the month. Further south there had been 7 inches of snow, and several severe storms. Rainfall during the month, 2.2 inches; average, 3.16 inches.

Mr. Spencer Smith stated that he had recently made a trigonometrical measurement of the height of the Big Mound of St. Louis, and found it to be 34.59 feet above the sidewalk on Broadway. It was remarked that this sidewalk was some five feet below the natural level of the ground, which would reduce the actual elevation of the Mound on the west to less than thirty feet, while toward the east it rose much higher above the slope.

Charles E. Hornstein, M.D., H. Z. Gill, M.D., and W. T. Harris, Superintendent of the Public Schools, were elected associate members.

February 15, 1869.

Dr. Charles W. Stevens in the chair.

Six members present.

Dr. Stevens stated that the boring at the Artesian Well had now reached the depth of 3,624 feet.

He had compared the borings brought up by the pump with some pulverized granite from the well-known granite quarries, near the Iron Mountain, and to all appearance and under the microscope the material appeared to be identical. He concluded, therefore, that the boring had reached the primary rocks, and that it would be useless to continue the work.

On motion of Mr. Spencer Smith, a petition was directed to be prepared to be sent to the Legislature of the State, now in session, asking for the completion of the State Geological Survey.

March 1, 1869.

Dr. Wislizenus, Vice-President, in the chair.

Six members present.

The Corresponding Secretary laid upon the table numerous foreign publications received in exchange.

March 15, 1869.

Dr. Charles E. Briggs in the chair.

Five members present.

Various foreign publications, received in exchange, were laid upon the table.

Dr. Robert von Schlagentweit was elected a corresponding member of the Academy.

April 5, 1869.

Vice-President WISLIZENUS in the chair.

Eight members present.

Publications received were laid upon the table.

Dr. Wislizenus presented to the Academy, from and in the name of Mr. Fendler, of Allenton, Mo., an ancient urn, dug up in a field in the State of Venezuela, South America.

Dr. Wislizenus reported the following summary of his meterological record for the last month: Mean temperature 37.3°; average for March, 44.4°. Rain and snow, 4.24 inches; average, 3.81 inches.

George D. Rand, Esq., was elected an associate member.

At a special meeting, held on the 16th day of April, 1869, (Vice-President WISLIZENUS in the chair,) upon the occasion of the death of the President, Dr. Benjamin F. Shumard, the following resolutions were unanimously adopted, and ordered to be published in the daily papers and printed copies to be transmitted to all the learned societies in communication with the Academy:

The Academy of Science of St. Louis having sustained a great loss on the 14th of April, 1869, in the death of its President, Dr. Benjamin Franklin Shumard; therefore be it

Resolved, That the Academy has been deprived of an ornament of which it had no equal, and of a leader and fellow-laborer that it can scarcel hope to replace.

That his name has been an honor to us, for which no distinction that we have been able to confer upon him could be deemed an equivalent.

That by publishing these resolutions in the Transactions of the Academy, we desire to announce to members of learned societies, who occupy themselves in palæontology, geology, and the other branches of Natural Science, in which Dr. Shumard was distinguished, the sad news of his premature death, and to ask their sympathy in our peculiar loss.

That we respectfully tender to his family circle this expression of our regret for the departed, and our high esteem of his worth.

April 19, 1869.

Vice-President WISLIZENUS in the chair.

Six members present.

The Corresponding Secretary laid upon the table numerous exchanges from American and European Societies.

Dr. Wislizenus presented for the Museum a string of shell discs (Indian beads), found in the excavation of the Big Mound at St. Louis, which, with other human remains found in the same mound, furnish indubitable evidence of its artificial and sepulchral character.

Dr. Briggs and Mr. Smith made some further verbal communications on the same subject.

Dr. Wislizenus offered some remarks upon the Aurora Borealis lately observed in the Eastern States, and noticed in general its connection with terrestrial magnetism and atmospheric electricity.

Special Meeting, May 10, 1869.

Vice-President WISLIZENUS in the chair.

Eleven members present.

The Vice-President explained that the object of the meeting was to consult upon the condition of affairs resulting from the late fire at the Medical College building, in which the Museum and Library of the Academy were kept and its meetings held.

Upon discussion it was agreed that little could be done until some permanent settlement of the negotiation with the Board of St. Louis Public Schools should be effected; and, on motion, it was ordered that the removal of what remained uninjured by the late fire should be under the control of the Curators; and that the Corresponding Secretary be requested to address the Board of Public Schools for permission to use their meeting-room for the future meetings of the Academy.

May 17, 1869.

Vice-President WISLIZENUS in the chair.

Seven members present.

Exchanges received were laid upon the table.

Dr. Green, from the Curators, reported, besides the Library saved, nearly all the volumes of the Transactions of the Academy had been recovered, though a large number of them were badly wet, and were being dried as rapidly as possible; and that a few anatomical specimens had been recovered, but that until the debris was removed, there was little hope of obtaining any more.

Dr. Briggs stated that he had addressed the Board of Public Schools, as requested at the last meeting, and had received the following reply:

Office of Superintendent of Public Schools,
St. Louis, May 15th, 1869.

Charles E. Briggs, M.D., Corresponding Secretary of the Academy of Science.

Sir: The President of the Board of Public Schools requested me to acknowledge your communication of the date of May 10th, and to say to you that the use of room at the times you speak of is fully and freely granted for the present. He desires me to add that the proper committee is about to be appointed to take the completion of the contract into consideration and make over permanent accommodations to your honored society.

I am, very respectfully, in behalf of the President of B. P. S., yours, &c.,

WM. T. HARRIS, *Supt. P. S.*

Dr. Briggs also reported that, in compliance with the resolution passed at a late meeting, he had transmitted to Mrs. B. F. Shumard a copy of the resolutions of the Academy, together with a letter of condolence upon the decease of her late husband, our lamented President.

On motion of Dr. Briggs, who stated that he had had some conversation with Mrs. Shumard in relation to the cabinet and library of her late husband, it was

Ordered, That a communication be addressed to the Board of Public Schools, asking for room to deposit the said cabinet and library in the Polytechnic building.

Also, Ordered, That a committee be appointed to draw up a circular to kindred societies asking such aid as they may be willing to contribute for the purpose of restoring our cabinet.

September 6, 1869.

Adjourned meeting in the Directors' Room of the Board of Public Schools, Polytechnic building.

Vice-President Wislizenus in the chair.

Four members present.

Correspondence read and publications received, were laid upon the table.

Mr. Spencer Smith read a paper on the "Origin of the Big Mound at St. Louis," which was referred to the Committee on Publication.

September 20, 1869.

Vice-President WISLIZENUS in the chair.

Four members present.

The Corresponding Secretary stated that he had received from the Smithsonian Institution, Washington, a number of pamphlet publications, together with a collection of plants; and he presented, also, in the name of Mr. D. C. Jaccard, a beautiful Geological Map of Switzerland, with an accompanying text, entitled "Materiaux pour la Carte Géologique de la Suisse," by Mr. Auguste Jaccard, published at Berne, Switzerland.

October 4, 1869.

Vice-President WISLIZENUS in the chair.

Four members present.

The Recording Secretary produced a copy of the contract between the Academy of Science and the Board of St. Louis Public Schools, providing for accommodations for the Academy in the Polytechnic building.

On motion of Dr. Green, it was ordered that the President and Recording Secretary be authorized to execute the same whenever the verbal error now existing in our copy should be corrected.

A communication as follows, was received from Mr. G. C. Broadhead on a

FOSSIL HORSE IN MISSOURI.

In vol. ii. No. 2, p. 418, of Trans. St. Louis Acad. of Science, Prof. Swallow announced the discovery of horse remains in the altered drift of Kansas.

I have now the honor to announce that similar remains have recently been discovered in a well at Papinville, Bates county, Missouri. Mr. O. P. Ohlinger procured a tooth at the depth of 31 feet from the surface, resting in a bed of sand beneath a four inch stratum of blueish clay and gravel. Above the last was 30 feet 10 inches of yellowish clay to the surface.

Beneath the sand containing the tooth, was found a gravel bed of 5 feet in depth, consisting mostly of rounded pebbles resembling river gravel, generally hornstone, many partially and some firmly adhering together. Other pebbles shown me from the same bed were of iron ore, coal, and micaceous sandstone. I was further informed that some remains of fluviatile shells were found. I sent the tooth to Prof. Joseph Leidy of Philadelphia, who pronounced it to be the last upper molar of a horse, probably an extinct species. From a similar gravel bed on the banks of Marais des Cygnes a fragment of a tusk was given me, very much resembling that of a mammoth. Its whole length was said to be 7 feet 4 inches. About 10 miles above Papinville, the banks of Marais des Cygnes River appear to be of similar formation to the well of Ohlinger, consisting of about 12 feet of brown sandy clay, resting on 10 feet of blue clay, with many pebbles of worn gravel at the lower part.

These gravel beds I consider of more recent age than the Drift, but older perhaps than the Bluff or Loess, and we may regard them as altered drift. They seem rather to abound on the Osage and its tributaries, and are often reached in digging wells. The tooth from Maysville, Kansas, was found in altered drift at a depth of 45 feet from the surface. Dr. Albert Koch exhumed the famous *Missourium* (*Mastodon giganteus*) from a bed of gravel and clay, on Pomme de Terre River, 20 feet below the surface. In these beds of altered drift, we may therefore expect to find many interesting remains of mammals.

October 18, 1869.

Vice-President Wislizenus in the chair.

Four members present.

The Vice-President stated that the contract with the Board of Public Schools had been duly signed. He expressed the hope that the society would now prosper, and soon be able to replace the losses which the Cabinet had sustained by the fire last spring.

Mr. Spencer Smith remarked that he had recently visited a newly discovered iron mine near Vineland Station, on the Iron Mountain Railroad, on land belonging to Dr. W. S. Dyer. A body of ore, thirty feet long and twenty feet deep, had been uncovered. The deposit appeared to run under the Magnesian Limestone, and was probably not a mere surface deposit. The ore was the red hematite. Occasionally small pieces of yellow ochre were found in it.

November 1, 1869.

Dr. Wislizenus, Vice-President, in the chair.

Nine members present.

A letter was read announcing the death of Hon. Gottfried Theobald.

The Corresponding Secretary stated that he had received numerous publications and exchanges, which he would keep until the Library Room was ready to receive them.

The President remarked that the room for the Library was now ready, and only awaited the attendance of the Librarian to put the books in order.

Dr. Wislizenus read an abstract from his monthly metereological record for October: Thermometer—highest, 77½°; lowest, 20°; range, 57½°. Mr. Fendler's themometer showed 10° lower. He had found, on consulting Dr. Engelmann's tables, that a lower temperature for the month had occurred only once in 33 years. Rain fall, 3.42 inches; average for the month, 3.39 inches. Positive electricity had been unusually high, reaching 7½°.

November 15, 1869.

Vice-President Wislizenus in the chair.

Six members present.

The President announced the death of Dr. F. E. Baumgarten, an associate member, and Dr. John Green was appointed to report at the next meeting suitable resolutions commemorative of the deceased.

Various foreign exchanges were laid upon the table by the Corresponding Secretary.

Dr. Wislizenus announced that the contract with the Board of Public Schools for the use of the Polytechnic building for the purposes of the Academy, had been finally signed, sealed and delivered.

Mr. G. C. Broadhead made the following communication on the discovery of

BONES OF LARGE MAMMALS IN DRIFT.

From the foundation pit of a bridge abutment on the Pacific Railroad, 4 miles north of Pleasant Hill, Missouri, I obtained the tooth of an extinct species of ox. The excavations passed through soils and clays, and at 12 feet below the surface of the bottom lands a bed of gravel containing decomposing remains of fresh-water shells was reached. From this gravel bed the tooth was obtained.

In 1868, when in Moultrie county, Illinois, I found in alluvial banks of the Kaskaskia River the skull and a part of the vertebral column of an ox (probably the "*Bos latifrons*"). The skull measured across between the horns at their roots 12 inches, the same distance between the eyes. The horns were short and thick, and slightly curved upward and forward. The bones were surrounded by dark clays and debris. Trees 2 feet in diameter were growing upon the bank above.

In 1871 I obtained a portion of a bone of a mammal, probably a horse, from a well dug in the bluff clays at Pleasant Hill, 28 feet below the surface.

VEGETABLE REMAINS IN DRIFT.

Sticks of wood have often been found in modified drift, at 20 or more feet beneath the surface. In North Missouri, sticks of wood have been found at 75 feet from the surface, part of a grape vine at 40 feet. In Illinois, a piece of cedar at over 100 feet beneath the surface. In Nevada, Missouri, a walnut log 2 feet thick was dug up from 16 feet depth; and four miles north, charred wood and bivalve shells at 19 feet below the surface.

BOULDERS.

Boulders and pebbles of igneous rock are rarely met with south of the Missouri River. Very large boulders and many rounded pebbles of granite, syenite, greenstone, quartzite, and limestone with accumulations of drift sands abound in North Missouri, more especially in the northern part, becoming less frequent as we go south. I have only observed evidences of boulder drift at a few localities south of the Missouri, viz: Kansas City, near Lexington, Berlin, and at one locality in Osage county. In Sullivan county, I observed a granite boulder 25 feet in diameter. In Monroe, a greenstone boulder 3 feet in diameter. Near the Missouri River it is rare to find one over a foot in diameter.

The Missouri River sands abound in small pebbles of granite, quartzite, greenstone, &c. These are borne down from the head waters in the Rocky Mountains. The range of granitoid boulders extends much farther south in Illinois than in Missouri.

The absence of granitoid pebbles in the accumulations along the Osage and its tributaries may be sufficient evidence to place the era of these deposits in a different and probably a more recent period of time than that of the modified drift of North Missouri. They may be of the same age as the older bluff deposits near the Missouri River. And we may conclude that the horse, ox, mammoth, and mastodon of Missouri were co-existent. It is even very probable that they may have roamed America during the life of the mound builders.

Dr. Green presented for the Museum a fine specimen of rattlesnake, preserved in alcohol, which he had received from Dr. Spinzig.

Dr. George Engelmann gave an interesting account of his recent journey through Europe, and especially of observations made during an eruption of Mt. Vesuvius.

December 1, 1869.

Vice-President Wislizenus in the chair.

Five members present.

The Corresponding Secretary read a letter from J. M. Currier, M.D., Secretary of the Orleans County Society of Natural History of Vermont.

Dr. Wislizenus reported the result of his meterological observations for November: Mean temperature, 39.3°; average for 30 years, 43.4°; range during the month, 55°; rain fall, 7.48 inches, nearly twice the average quantity.

Lieut. J. C. Clifford, U. S. A., was elected an associate member.

December 20, 1869.

Vice-President Wislizenus in the chair.

Eight members present.

Exchanges received were laid upon the table.

Dr. Wislizenus exhibited a fossil tooth, said to have been found in St. Louis by Mr. Shands. The fossil having been referred to the authority of Dr. Joseph Leidy, of Philadelphia, was determined by him to be "a lower molar of *Entelodon Mortoni*, belonging to the fossils of the Mauvaises Terres" of Nebraska. Dr. Leidy had promised to send to the Academy a copy of his new work on the "Extinct Mammalian Fauna of Dakota and Nebraska," which would soon be published.

January 3, 1870.

Vice-President WISLIZENUS in the chair.

Sixteen members present.

Dr. Green reported resolutions commemorative of our deceased associate, Dr. F. E. Baumgarten, which were adopted as follows:

"WHEREAS, In the death of F. E. Baumgarten, M.D., the Academy of Science of St. Louis has lost one of its oldest and most respected associates;

"*Resolved*, That the Academy record its testimony to the sterling integrity of character, the kindly nature, and the eminent professional, scientific and literary attainments of our late colleague and officer, and that we tender to the surviving members of his family our heartfelt sympathy in their great bereavement."

Dr. Wislizenus read his annual report of Meteorology and Atmospheric Electricity observed at St. Louis for the last year. Referred to the Committee on Publication.

Dr. A. Wislizenus, acting President of the Academy, then delivered his annual address, as follows:

ANNUAL ADDRESS.

FELLOW-MEMBERS OF THE ACADEMY:—The last year has been one of uncommon fatality. Our late President, Dr. B. F. Shumard, prostrated by hopeless disease, paid his debt to nature and left a vacuum in our midst that cannot be easily filled. His eminent services in geology and palæontology were appreciated both here and in Europe, and no member of the Academy is at present capable of filling his place. Another active member of our society, Dr. F. E. Baumgarten, was unexpectedly taken from us by a sad accident that cut off his useful career within a few days. Aside from these personal losses, we suffered a great material loss in the conflagration which in the month of May destroyed the building, where, by the generosity of Dr. Pope and his successor, Dr. Hodgen, we were accustomed to hold our regular meetings, and where we kept our Museum and Library. The Museum, collected by the labor of long years, and containing most valuable specimens in all branches of natural science, but especially in Western palæontology, has been destroyed almost entirely. The few remnants that are left are comparatively of inferior value, or a great deal injured. The only specimens of higher value left uninjured are the skull of the "*Bos cavifrons*," some vertebræ of the mastodon, and several meteorites. As all our cases, too, have been destroyed, and our finances are not very flourishing, we shall have to begin again on a small scale, and preserve only specimens of greater value, and not requiring much care or labor. Although the loss of our Museum was a hard blow to the Academy, we had, after all the satisfaction of saving our entire Library. This Library, acquired mostly by exchanges and donations from scientific societies all over the globe, and containing between three and four thousand volumes and pamphlets, is exclusively of a scientific character, and especially devoted to natural science. Hundreds of learned societies, who favor us with their publications, increase yearly the number of our books, and thus provide us with a Scientific Library which for its generality, intrinsic value and variety could not be procured in book stores even at great expense. This valuable collection is now in the reading room of the Polytechnic. The Board of Public Schools, who own at present this magnificent building, offered us, after our expulsion by fire, with great liberality, a room in the Polytechnic for meetings, and a separate place for our books in their own Library. A contract to that effect was signed by both parties towards the end of the year. Being provided again with a proper room, and with cases for our Library, we ought to make strenuous efforts to have the books at once put up, rearranged and catalogued to make them useful to ourselves and the public. After all the afflictions that befell us the past year, it was not to be expected that we should have felt encouraged to unusual activity: still we kept up our regular meetings (except during the hottest months): we continued scientific discussions, regular meteorological reports were made, occasionally papers were read, for instance, one by Prof. Spencer Smith, on the origin of the Indian Mounds, which stirred up many antiquarians; but most of our time was, after all, taken up by unavoidable business, and the publication of our Transactions was this year out of the question. Being reinstated, we now begin a new year with renewed efforts towards progress.

The number of our present associate members is about 70, six of which have been received in the past year. The report of the Treasurer will show you that if the regular contributions of our associate members were paid more promptly, they might cancel our present debts, amounting to about $400. At any rate the next annual contribution coming in March, will have that result, and, it is the hope, leave us a surplus to publish again some Transactions, provide for the Library, start a new Museum, etc.

Having disposed of the business part of my report, allow me yet to add a few words in regard to the scientific purport of our Society. Academies of Science generally flourish more in older countries, where, patronized by government, they find ample pecuniary means, and more men of leisure pursuing specialties in natural science. The patronage of government is not so much needed in a country where the liberality of individuals is wont to furnish means for the most various public undertakings. But immediate usefulness is the criterion by which all such institutions are judged in this practical land of utilitarianism. The quiet and tedious pursuit of scientific researches is not always appreciated, except when accompanied by visible, eminent results. Such golden fruits, however, do not every day ripen and fall from the tree of science; the harvest is but occasional, while the labor is constant. Lovers of science have, therefore, to content themselves often with the conviction of having searched after truth, which is the highest and last aim of science; truth, in investigating the complicated phenomena of Nature; truth, in reducing them to certain laws. This is the great privilege of mankind. Stones, plants, animals, obey unconsciously the laws of nature, but they neither understand them nor make them. Man alone, of all created things on this earth, though also subject to the same physical laws, has been endowed with the privilege of investigating and appreciating the laws of nature, and of applying them to his own life. But as all nature is a unit in design and effect, and as the smallest and the largest things in the universe are connected by an endless chain of cause and effect, there is nothing too small or too large for our investigation, and the scientific man who, with the highest microscopic power, examines the invisible spores of a despised fungus, accomplishes as much for truth as the explorer of celestial bodies. Every new discovery will eventually evoke others. Such splendid discoveries as the application of steam power or electricity did not spring from the intellect of one man, like Minerva from the head of Jupiter, but resulted really from the labor of thousands of scientific men who had worked up physical science to such a degree of certainty that the new link could be added. Natural sciences cover, now-a-days, such a large field that nobody can longer overlook its whole extent, and nobody can work these exclusively for himself. Division of labor has therefore been introduced by common consent, and one works for the other, and all for one purpose, for the unity of nature. The younger members of our Academy may learn from that how desirable it is to devote themselves to some special study in the wide domain of natural science. Every one is thus enabled to add a few grains to the mass of knowledge, accumulated for thousands of years by the highest intellects of all nations. No object in nature is too trifling for observation, and nobody can determine in advance its importance in the chain of nature. Let every one, therefore, pursue some special favorite object of study. If some special advantage to mankind is attained by it, so much the better; if not, every increase in knowledge and enlargement of our views is sufficient reward.

The following gentlemen were elected officers of the Academy for the ensuing year:

President—George Engelmann, M.D.
1st Vice President—A. Wislizenus, M.D.
2d Vice-President—Isaiah Forbes, D.D.S.
Corresponding Secretary—Charles E. Briggs, M.D.
Recording Secretary—Spencer Smith.
Treasurer—Dr. Enno Sander.

January 17, 1870.

The President in the chair.

Eight members present.

Exchanges received were laid upon the table.

Dr. Forbes presented to the Academy a copy of the "Dictionnaire Française, Illustré par B. D. de Vosepierre," in 2 vols. quarto.

Dr. Engelmann exhibited some photographs and drawings from the vicinity of Naples, comparing the present state of the Temple at Pozzuoli and of Mt. Vesuvius with their condition when visited by him some ten years ago.

Mr. John J. Bailey was elected an associate member, and also Librarian of the Academy.

February 7, 1870.

The President in the chair.

Eight members present.

Prof. Leidy's work "On the Extinct Mammalian Fauna of Dakota and Nebraska," lately received, was laid upon the table.

Dr. I. Forbes, from the Auditing Committee, reported that the committee had examined the accounts of the Treasurer for 1869, and found them correct, and the report was approved.

On motion of Dr. E. Sander, a special committee, consisting of Drs. Forbes and Sander, and Mr. Bailey, was appointed to confer with the Board of Public Schools with a view to securing a room for the Cabinet of the Academy.

Messrs. H. Morgan, J. E. Kimball, and W. D. Butler, were elected associate members.

February 21, 1870.

The President in the chair.

Seven members present.

Exchanges received were laid upon the table.

Dr. Wislizenus presented a Biographical Sketch (in pamphlet) of the late Dr. Benjamin F. Shumard, by L. P. Yandell, M.D.

Dr. Wislizenus presented for the Museum a molar tooth of *Elephas primigenius*, which had been sent to him from Montana Territory by Mr. Auguste Steitz, of Helena, Montana.

Mr. Spencer Smith sent in his resignation of the office of Recording Secretary, on account of continued ill-health.

Dr. Charles Lips and Messrs. Lipmann and C. F. Cuno were elected associate members.

F. L. Yoakum, M.D., of Larissa, Cherokee County, Texas, was elected a corresponding member.

March 7, 1870.

The President in the chair.

Four members present.

Dr. Engelmann presented the report of the United States Naval Observatory on the recent total eclipse of the sun. He announced also the receipt of a package of plants for the Herbarium, from Prof. Paul Reinch, of Zweibrüken, in Rhenish Bavaria.

Dr. John Green was elected Recording Secretary in place of Mr. Spencer Smith, resigned.

March 21, 1870.

Dr. Wislizenus, Vice-President, in the chair.

Eleven members present.

The Corresponding Secretary made his report of correspondence and exchanges received.

Dr. Bollman, Dr. Whittaker of the British Army, and Prof. W. J. Davis, of St. Petersburg, Russia, were present as visitors.

Prof. Davis, upon invitation, favored the Academy with an interesting address.

April 4, 1870.

The President in the chair.

Eight members present.

Dr. Forbes, from the Special Committee, reported progress in the negotiations for a room for the Cabinet in the Polytechnic building, and received instructions to complete an arrangement.

Mr. James Duross was elected an associate member.

April 18, 1870.

Vice-President FORBES in the chair.

Five members present.

Exchanges received were laid upon the table.

May 2, 1870.

The President in the chair.

Eight members present.

On motion of Dr. Forbes, a committee consisting of Hon. S. Reber and Drs. Forbes, Sander and Engelmann, was appointed to memoralize the Governor of the State with a view to securing the completion by Prof. G. C. Swallow of his Geological Survey of Missouri.

Mr. John Gillespie was elected an associate member.

May 16, 1870.

The President in the chair.

Eight members present.

Exchanges received and laid upon the table.

On motion, a committee consisting of Dr. Wislizenus, Mr. Malinckrodt, and Dr. Curtmann, was appointed to procure data and report upon the Artesian Well at the County Asylum for the Insane.

June 6, 1870.

The President in the chair.

Six members present.

Dr. Wislizenus announced the sudden death, at Salt Lake City, Utah, on the 4th of June last, of our associate member, Mr. Spencer Smith, one of the oldest and most active members of the Society; whereupon resolutions commemorative of the deceased were adopted as follows:

"That by the unexpected decease of Prof. Spencer Smith the Academy has lost one of its oldest and worthiest associates, a man of high intellectual attainments, a true devotee to science for science's sake, a zealous explorer after truth in natural philosophy and natural sciences.

"That by his services as our Secretary for many years, and by his unremitting attention to the interests of the Society, our departed friend has well earned the grateful remembrance of the Academy, and that his loss will be long felt in our midst.

"That his long and successful activity in this city, his devotion to the rational pursuits of life, his strict integrity and righteous character, have justly entitled him to the deep regrets of a large number of friends who deplore that his useful career has been cut off too soon.

"That as a last tribute to his merits we will follow his earthly remains to their last resting place, and communicate these resolutions to his family as expressions of sympathy with their sad bereavement."

Dr. G. H. E. Baumgarten donated to the library a collection of books, partly from the library of his late father, Dr. F. E. Baumgarten, and partly from his own, being two quartos, fourteen bound octavos, and twelve pamphlets.

Dr. John Green exhibited a mould fungus (*Aspergillus*) taken from the external auditory meatus of a man; it had set up a moderate degree of inflammation of the dermis of the meatus and of the *membrana tympani*.

June 20, 1870.

The President in the chair.

Five members present.

Lieut. Clifford presented for the museum some specimens of

Trilobites from the Grafton quarries on the Mississppi, below the mouth of the Illinois river, and minerals from the St. Louis Limestone.

Prof. William Eimbeck was elected an associate member.

August 1, 1870.

The President in the chair.

Six members present.

Resolutions reported by Dr. C. E. Briggs, commemorative of the late Prof. Charles A. Pope, M.D., of St. Louis, one of the founders, and most active members, and most liberal patrons of the Academy, who died in Paris, France, on the 5th of July, 1870, were unanimously adopted.

A communication was received through Dr. A. Wislizenus, embracing a paper, entitled "The Pleasures of Science," by the late Prof. Spencer Smith, which was read, and referred to the Committee on Publication, to be published at their discretion in the Transactions.

November 7, 1870.

The President in the chair.

Seven members present.

Mr. Auguste Steitz exhibited a fine specimen of the last lower molar tooth of the left side of *Elephas primigenius*, found forty feet below the surface, near the Missouri River and within one mile of Helena Montana, in excavating for gold mining works, lying above the gold-bearing quartz. He observed that many teeth and tusks had been found, but the tusks crumbled as they dried. Full skeletons doubtless existed in the same bed, but they had not been dug up, because they crumbled to pieces. Another tooth from the same locality had been presented to the Academy on the 21st of February last.

Dr. Engelmann exhibited the fruit of *Philodendron pertusum*, from Mr. Shaw's Botanical Garden. It was the fruit of an aroid climbing plant, with large palmate and perforated leaves. The fruit was about ten or twelve inches long, and two and a half inches in diameter, edible, and of a taste and odor which suggested that of the pine-apple.

November 21, 1870.

The President in the chair.

Four members present.

Publications received were laid upon the table by the Corresponding Secretary.

Lieut. Clifford exhibited several specimens of minerals (topaz, sulphuret of nickel, and fluor in cubic crystals), some fossils from the Lami-street sewer excavations at St. Louis, and moss agates from the vicinity of Fort Laramie, and a silicious cast of a shell.

Dr. Engelmann exhibited the large pods of Canavalia raised by him from seeds from Sonora, originally from the East Indies, not maturing in this climate, edible, and of a bean-like taste.

Mr. G. C. Broadhead communicated the following paper on the Mineralogy of Cole County, Missouri:

GENERAL GEOLOGY.

In the northern portion of the county is a limestone area of Carboniferous and Devonian rocks. But the greater part of the county includes formations in which most of the rich mineral deposits of Missouri are found. I mean the Magnesian Limestone series of the Missouri Geological Reports.

In Cole County we have the 2nd magnesian limestone, 2d sandstone, and 3d magnesian limestone. The base of the 2d magnesian limestone, as observed, occupies the tops of hills and the bluffs from Jefferson City to the south-west corner of Cole County, appearing low down, near the river, at Jefferson City, and rising rapidly to the tops of the hills within two miles. The 2d sandstone crops out along the Moreau and Osage, and the 3d magnesian limestone forms the main bluffs of the latter stream.

LEAD MINES.

The lead mines of Cole County occur in the lower beds of the 2d magnesian limestone, and include various deposits on South Moreau, Fowler's mines and Clark and Eaton's mines.

Clark and Eaton's Mines.—These mines lie due south of Hickory Hill, on the waters of Little Tavern Creek. The country around is hilly, the hills rising above the valleys from 200 to 300 feet, by long slopes, over which are scattered stunted oaks and prairie grass. Half-way down the hillsides the rough cellular beds of 2d magnesian limestone crop out; in this rock occur a few univalve shells.

The ore at these mines is pure galena (sulphuret of lead) associated with a gangue of heavy spar (sulphate of Baryta), calc spar, and magnesian limestone. Associated with the lead and gangue rocks are beautiful crystallized forms of iron ore, of the brown hematite variety, not occurring in sufficient quantity for economical purposes, but forming beautiful cabinet specimens.

We here also find minute quantities of blue and green carbonate of copper disseminated through the limestone and spar, and sometimes incrusting the lead, often forming very pretty cabinet specimens. *Sulphuret of Copper* is also found.

Fine crystals of sulphate of Baryta and Dogtooth spar are quite abundant at these mines. The carbonate of lime when broken in thin plates along the planes of crystalization exhibits a beautiful double refractive power.

The lead ore occurs in pockets and layers disseminated through the gangue rocks, and from appearances a good deal of mining has been done. From information obtained, I believe the mines well worth working. *They have paid well.* The ground lies well for drainage, the only thing necessary is an expenditure of capital to place the mines in good working order. The owners will then be fully remunerated.

At Fowler's mines I noticed lead, zinc and heavy spar, the latter in very clear amber colored crystals, also in blue lamellar forms.

The above is only a partial report of observations made at different times in Cole County.

December 5, 1870.

The President in the chair.

Seven members present.

Exchanges received were laid upon the table.

Dr. Wislizenus read a letter, giving descriptions of certain specimens of Indian pottery found in Perry County, Mo.

Dr. Wislizenus also noticed the gale blowing to-day (Dec. 5), which had been preceded by a marked change in the atmospheric electricity. About 3 o'clock P.M., yesterday, the electrical manifestations (which had been constantly positive) totally disappeared for twenty-four hours, reappearing only at 6 o'clock P.M. of to-day (again positive). The barometer showed no change until last night, when it fell as usually observed in such storms.

Mr. Regis Chauvenet was elected an associate member.

January 16, 1871.

The President in the chair.

Seventeen members present.

Dr. A. Wislizenus communicated his annual report of Meteorology and Atmospheric Electricity for the year 1870, illustrated by diagrams, of which the following is an abstract:

YEARLY REPORT OF ATMOSPHERIC ELECTRICITY, TEMPERATURE, AND HUMIDITY, FROM OBSERVATIONS MADE AT ST. LOUIS, MO.

By A. Wislizenus, M.D.

1.—*Monthly Mean of Positive Atmospheric Electricity in* 1861–1870, *based on daily observations at* 6, 9, 12, 3, 6, *and* 9 *o'clock, from morning till night.*

ATMOSPHERIC ELECTRICITY.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	M'n of Year.
1861	16.5	12.1	9.8	8.8	7.8	4.0	3.7	3.4	3.0	7.1	10.0	14.3	8.4
1862	12.1	16.0	9.4	10.6	7.5	3.0	2.2	2.3	3.0	7.7	12.6	13.9	8.4
1863	16.9	15.9	13.6	8.8	4.7	2.0	2.8	4.4	4.8	12.5	12.1	11.5	9.2
1864	15.8	11.3	11.0	8.5	5.1	4.0	2.3	0.9	1.8	5.4	6.6	9.0	6.8
1865	12.2	9.5	5.9	3.3	2.4	3.4	2.6	5.9	1.2	5.3	10.1	6.4	5.7
1866	5.9	8.1	5.7	2.1	3.3	2.1	2.4	5.1	3.2	7.0	10.2	7.0	5.2
1867	9.2	8.2	6.5	3.3	2.9	2.8	2.7	5.2	3.5	3.0	4.2	4.2	4.6
1868	4.1	5.0	2.5	1.7	1.1	0.4	0.5	0.4	1.4	2.6	4.3	6.3	2.5
1869	8.7	2.5	4.6	1.6	0.7	0.9	1.1	0.3	1.3	7.8	4.7	1.6	3.0
1870	8.6	10.2	5.5	6.9	5.0	1.3	0.8	0.4	0.1	0.1	5.9	8.7	4.5
Mean	11.0	9.9	7.4	5.6	4.0	2.4	2.1	2.8	2.3	5.8	8.0	8.3	5.8

2.—*Monthly Mean of Temperature and Relative Humidity in* 1861–1870 *based upon daily observations contemporaneous with those of Atmospheric Electricity.*

TEMPERATURE.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	M'n of Year.
1861	32.2	40.4	44.8	58.1	64.1	76.9	77.5	78.6	69.1	57.9	46.0	39.7	57.1
1862	28.9	30.2	43.2	55.0	69.7	75.1	81.2	80.7	72.1	57.3	42.6	41.3	56.4
1863	36.8	35.7	43.6	57.4	65.5	71.9	77.2	77.5	69.2	48.0	43.7	35.9	55.2
1864	29.2	38.3	40.7	51.4	69.4	78.9	83.5	78.8	72.9	53.1	44.9	30.4	56.0
1865	28.1	38.4	46.7	56.8	68.8	80.7	77.7	78.1	77.8	58.8	48.0	30.8	57.5
1866	32.2	33.4	42.2	61.2	66.3	75.3	82.2	76.8	64.0	59.3	46.6	33.3	56.0
1867	25.4	39.1	34.1	56.7	61.1	76.9	81.3	81.4	68.5	59.6	49.2	36.1	55.8
1868	26.0	35.8	51.6	53.6	68.4	76.9	88.0	77.2	65.7	56.5	44.9	29.9	56.2
1869	39.4	36.9	39.9	56.3	66.6	74.7	80.7	82.1	68.2	47.9	40.9	33.8	55.6
1870	33.1	36.6	41.3	58.8	71.9	76.2	85.0	76.3	72.1	59.7	48.5	31.6	57.6
Mean	31.1	35.9	42.8	56.5	67.2	76.3	81.4	78.7	69.9	55.8	45.5	34.3	56.3

RELATIVE HUMIDITY.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	M'n of Year.
1861	72.2	63.3	64.5	61.5	66.3	70.8	66.3	69.6	77.3	76.6	69.0	74.3	69.8
1862	85.3	73.9	70.8	67.0	57.3	67.0	66.8	64.3	74.2	67.2	69.5	74.6	69.9
1863	79.2	81.7	68.1	57.2	59.4	67.7	68.6	70.7	68.2	74.4	67.4	79.5	70.5
1864	75.6	62.7	70.0	69.8	56.4	61.5	62.8	69.0	64.1	67.9	74.2	75.5	67.4
1865	74.6	72.0	66.1	66.8	62.1	67.9	77.4	71.7	76.8	74.1	62.3	78.8	70.9
1866	75.1	70.6	69.1	60.6	59.7	66.0	68.2	66.7	81.8	71.7	72.5	76.8	69.2
1867	76.2	73.5	75.7	59.1	61.4	64.8	63.9	60.0	63.7	67.9	64.9	77.6	67.4
1868	72.4	68.6	67.7	61.9	64.7	66.7	61.7	61.8	72.9	69.7	68.1	75.1	67.1
1869	76.1	76.1	74.7	61.2	66.1	69.3	70.3	74.2	75.4	73.2	79.2	81.8	73.1
1870	76.2	67.2	67.0	56.2	59.1	62.7	62.2	73.4	73.3	74.4	68.8	75.2	68.0
Mean	76.3	70.9	68.8	62.1	61.2	65.8	66.8	68.1	72.7	71.7	69.6	76.9	69.3

3.—*Yearly Mean of Positive Electricity, of Temperature, and of Relative Humidity of the atmosphere at the hours of* 6, 9, 12, 3, 6 *and* 9, *from morning till night, based upon daily observations at those hours in* 1861—1870.

ELECTRICITY.

YEAR.	6 A. M.	9 A. M.	12 M.	3 P. M.	6 P. M.	9 P. M.
1861	8.5	9.9	9.9	7.7	8.5	6.8
1862	8.9	10.0	9.1	7.3	8.1	6.8
1863	10.5	10.6	10.0	7.5	9.1	7.4
1864	7.9	8.8	7.4	5.4	5.9	5.5
1865	6.4	7.1	6.0	5.3	5.4	3.8
1866	5.5	6.2	5.2	4.5	5.2	4.4
1867	5.2	5.6	4.9	4.2	4.3	3.8
1868	2.7	3.0	2.7	2.2	2.5	1.9
1869	3.3	3.5	2.8	2.4	3.2	2.7
1870	4.7	5.3	4.3	3.6	5.0	4.9
Mean ...	6.4	7.0	6.1	5.0	5.7	4.7

TEMPERATURE.

YEAR.	6 A. M.	9 A. M.	12 M.	3 P. M.	6 P. M.	9 P. M.
1861	48.9	54.9	61.6	63.6	59.3	54.3
1862	48.9	55.0	60.9	62.3	58.0	53.6
1863	47.5	53.6	59.7	61.0	57.2	52.2
1864	48.0	54.1	60.5	62.2	58.1	53.0
1865	50.4	55.8	61.8	63.3	59.3	54.7
1866	48.4	54.6	60.3	61.9	57.9	53.4
1867	48.4	54.2	60.0	61.4	57.4	53.3
1868	49.2	54.8	60.4	62.1	57.4	53.5
1869	48.4	54.2	59.8	61.4	57.2	52.7
1870	50.2	56.2	62.3	63.5	59.0	54.6
Mean ...	48.8	54.7	60.7	62.3	58.1	53.5

RELATIVE HUMIDITY.

YEAR.	6 A. M.	9 A. M.	12 M.	3 P. M.	6 P. M.	9 P. M.
1861	86.4	71.3	60.3	57.2	65.1	77.3
1862	85.3	70.6	60.0	57.5	67.6	78.0
1863	86.8	71.4	60.2	58.0	66.7	77.9
1864	83.9	69.3	57.7	55.0	64.0	74.8
1865	84.7	71.7	61.3	59.0	68.3	78.9
1866	84.9	70.1	60.6	58.6	67.4	78.8
1867	83.1	68.4	57.9	55.0	64.6	75.4
1868	80.5	68.1	57.9	55.9	65.0	75.4
1869	86.9	73.8	64.6	62.4	71.2	80.0
1870	82.9	69.2	58.1	56.6	65.9	75.2
Mean ...	84.5	70.4	59.9	57.5	66.6	77.2

The President, George Engelmann, M.D., delivered his annual address as follows:

ANNUAL ADDRESS OF THE PRESIDENT.

Gentlemen:—Our constitution requires me to lay before you a candid exposition of the condition of our Academy at the present time, and, should it prove to be not as favorable and as flattering as we fondly hoped when, fifteen years ago, we laid its foundation, to probe the causes of the unsuccess and to propose remedial action.

The history of this Academy is that of many similar institutions. Begun with a great deal of zeal (in the commencement of the year 1856), members were numerous and full of good cheer and promise; the meetings were well attended, scientific papers were read, discussions followed, and in the succeeding year, 1857, the first number of our Transactions could be published. A Museum and a Library were founded, partly by the liberal contributions of some members, partly by the donation of the old stock of a similar institution, the "Western Academy of Natural Science," which preceded our Academy full twenty years (1836), in the then small town of St. Louis.

To the first number succeeded a second, third and fourth number of our Transactions, which together made a fine volume of valuable scientific matter, the greater part of it original additions to different branches of learning, and illustrated by 21 plates, and completed in the year 1860.

These publications attracted the attention of the scientific world, and brought us the most liberal exchanges from nearly all the learned societies in America and in Europe, and in fact the whole civilized world. Through these exchanges we have amassed a Library of great value, which money could not buy. The Library fortunately has escaped destruction by the fire of May, 1869, which swept off our large and valuable Museum.

We have continued to publish our Transactions, and have been able to issue a second volume, in three numbers, from 1863 to 1868, not inferior to the first in scientific value.

Those who take an active interest in our doings know how these volumes are made up, and how they are published. None of the contributors (nor any of the members of the Academy) are men who are so situated that they could make the pursuit of science the object of their lives. All of them had their profession or their business to attend to, and had to labor, as the trite saying is, for their bread; few leisure hours only could they devote to that labor of love, their purely scientific studies. And the results of these labors were given to the world by the aid of the small annual contributions of the members, and by such subscriptions as the more liberal among them, at times of necessity, chose to make.

We were happy to have with us as the scientific staff of our Academy, enlivening our meetings and furnishing the most valued contributions to our Transactions, men like Prout, like Shumard, like Seyfarth, whose names and whose papers told for us in the world of science, not to speak of a dozen others who worthily united with them. But some are dead, others have removed from here, and few remain to keep to the work, and (this is the greatest difficulty we labor under) scarcely any have come to St. Louis to step into their places, and, worse still, no new generation grows up to take up the work when the pioneers of this Academy will have departed.

We fortunately never had to pay rent for a hall to meet in, else we could not have gone on at all. Over ten years, Dr. Chas. A. Pope, and through him Col. O'Fallon, both now deceased, furnished us, in the building of the Medical College on Myrtle Street, a hall of meeting, a Library room, and a large hall for our Museum. This liberal grant was continued by Prof. Hodgen when he succeeded in the possession of the building, until its destruction by fire. Since then the Board of Public Schools, with whom we had been long before in treaty, afforded us a temporary abode, the place of meeting we now occupy, in this Polytechnic building, and gave room to our books in the great library hall of the Public Schools, where our volumes are now put up with, but separately from, the School Library.

A Museum hall we have not as yet been able to obtain from the Board, though hopes are held out. The consequence is that specimens flow in slowly, and that they have to be kept in private hands of members until they can be put up publicly.

There are drawbacks that money could remedy. Money could build up a Library, money can build up a Museum, money can, by paying competent curators, keep it in proper condition, and make it a means of instruction and an ornament to the city. And money may, if properly applied for, be obtained in so rich a city as St. Louis, where a kindred institution, the Mercantile Library Association, has just celebrated its 25th anniversary with the most glowing prospects of future and increased success.

But what money cannot do is to get us men of science, men who are willing to devote their labors, at least that of their leisure hours, to the building up of such an Academy as we had in view fifteen years ago, and still have in view, though the vista may now be more distant, though success may seem to be less easily attainable, may to some doubtless even appear to be impossible in this city of St. Louis.

If we compare similar institutions of learning, we find in Europe that they are mostly organized and kept up by governments; in this country, those that flourish are certainly supported by cultivated public spirit, and, through this spirit, by liberal private aid. The size of a city, the riches of a community alone, could not do it, else splendid New York would have the most magnificent institution of the kind. But quiet Philadelphia has one paramount to any in this country, with a Museum superior in some points to any in the world. Sober Boston has an Academy only secondary in rank to that of the last named city, not to forget the treasures of its neighboring Cambridge. Then there are numerous eastern cities and western ones too, not to speak of the struggling California Academy or the new one of Kansas, boldly stepping forth on the scarcely broken soil of the prairie.

In the series of our Transactions we have certainly an important bond with the scientific world. But San Francisco threatens to come up with us, and Chicago has by its splendid volumes far surpassed us.

Our meetings during the past year have been regular; but few members, only half a dozen perhaps, usually bring their scientific contributions to our mart. Few papers have been read, and scarcely any material has been furnished for the commencement of a third volume of our Transactions; but though no number has been published since 1868, our exchanges come iu regularly and with the true liberality of science.

Many new members have joined us during the year, but most of these do give us only their passive countenance, and but few of them meet with us in our semi-monthly exercises.

We are, as has been stated, at this hall provisionally allowed us by the Board of Public Schools free of charge. Our exchequer is empty, but we may say that our finances are in a fair condition, as for the first time in many years we are now free of debt, our Treasurer having paid the last instalment due the "Missouri Republican" office, for the printing of the last number of our Transactions, after a liberal deduction had been allowed.

The number of associate members amounts now to 72, who pay their instalments.

This is the present status of our Academy. You must perceive that without some essential change it will cease to live, and these present members who continue their scientific labors will become connected with the institutions of other cities and the results of their studies will redound to the credit of other places.

As a means to revive our Academy, it seems to be absolutely necessary to revive the interest of the public in its existence and its doings; to convince them that such an institution is as much the means to promote higher culture as it is the proof of the existence of such culture among us, and that it is an ornament to our city. It is further necessary to draw to us all such active forces as may exist among our population—and this is the great and most important point: to make an effort to influence the education of the growing generation so as to imbue them with a greater love for science, and in particular for natural sciences, than has hitherto been experienced, so as to raise up among them zealous and active workers in the great field.

Is it not strange that most of us, living as it were almost on the borders of civilization, surrounded by the vestiges of a grand and imposing nature, should so little care for the external objects which really influence our welfare and our very existence, for their laws of development and being, and their bearings on innumerable practical questions.

Much more might be said on the value of education in these branches, hitherto with us almost entirely neglected, and of its importance in the culture of the mind paramount to that in the classics, and its importance equally great in practical points of view.

Leaving this subject now, I close by recommending you to elect a set of officers, who, with a popularity equal to their zeal and scientific standing, will be able to interest our citizens in the promotion of our unselfish objects more than the present officers were able to do, and for yourselves regularly to attend our gatherings, and each of you to try and bring his share to heighten the scientific interest of these meetings.

The Corresponding Secretary and Treasurer presented their annual reports, and the accounts of the Treasurer were referred to an auditing committee.

The annual election of officers of the Academy resulted in the choice of the following:

President—John B. Johnson, M.D.
1st Vice-President—Louis Charles Boisliniere, M.D.
2d Vice-President—Edwin Harrison, S.B.
Corresponding Secretary—Hon. Samuel Reber.
Recording Secretary—Charles V. Riley.
Treasurer—Dr. Enno Sander.
Librarian—J. J. Bailey.

February 6, 1871.

Dr. J. B. Johnson, President, in the chair.

Ten members present.

The Corresponding Secretary reported his correspondence and exchanges.

Dr. Briggs, from the Auditing Committee, reported that the Committee had examined the accounts of the Treasurer and found them correct.

The President appointed Dr. George Engelmann chairman of the Committee on Publication.

Dr. E. Sander read a letter from a correspondent announcing the discovery of a skeleton of a Mastodon in the State of Mississippi.

Dr. Engelmann presented a fragment of shell rock (coquina) from St. Augustine, Florida. It was a recent conglomerate of shells with some corals loosely cemented, and could be easily worked with a saw or hatchet. He exhibited, also, a specimen of white printing paper, of good quality, made from the fibre of *Abutilon Avicennæ*, a common barn-yard weed of the family of Malvaceæ, perfectly naturalized in this country, from Asia *via* Southern Europe, but not as completely naturalized in Europe as here.

February 20, 1871.

The President in the chair.

Eleven members present.

The Committee on Publication reported, through their chairman, that there was not a sufficient number of papers in their hands to make a new number of the Transactions.

Books were donated as follows:

By Mr. Aug. Steitz, "Mining Statistics West of the Rocky Mountains for 1870."

By Mr. C. V. Riley, "The American Entomologist," Vols. I. and II., and "Annual Report on the Noxious, Beneficial and other Insects of the State of Missouri."

By Mr. Bailey, a Catalogue of the Public School Library, including a Catalogue of the Library of the Academy of Science.

Mr. Steitz exhibited some specimens of gold nuggets and crystals from Montana.

Mr. Richard Hayes read a paper on "Earthquakes, their Causes and Periodicity," which was referred to the Committee on Publication.

Dr. Engelmann remarked that in nature many changes are going on before our eyes, which are due to the growth of innumerable microscopic fungi, though at one time ascribed to chemical change. It was interesting to observe how the knowledge of these facts had gradually increased during the last thirty years, for, in the works of chemistry of forty years ago, a body was described under the name of *ferment*, and its chemical properties considered, and it was then looked upon as an unaccountable and mysterious thing. They knew then that beer when filtered would not ferment, but could not tell why. We now know that it is because the fungus is kept out. Alcohol, or freezing, also destroys the fungus and produces the same effect. No fungus can grow in substances which do not contain nitrogen. The raising of bread is not due to the fungus, but to the carbonic acid produced by the fungus. These fungi are very minute vesicular bodies, and their true botanical nature was only recently discovered. He described the two modes of propagation, by bud and by sexual organs. The yeast fungus is only known to propagate in the first manner. He stated that the fungi found in decaying organisms were the cause of the decay.

Mr. C. V. Riley admitted that such was the general belief among botanists and mycologists, but cited some instances of rot in fruits and vegetables which led him to believe that fungi were sometimes the effect instead of the cause of the rot.

Dr. J. B. Johnson questioned whether they might not be the effect rather than the cause, just as certain fungi are known to follow the injuries caused by the itch mite (*Acarus scabiei*), on the human subject.

Mr. H. T. Marée de Beauregard, of St. Louis; A. Hager, State Geologist, and H. N. Spencer, M.D., of St. Louis, were elected associate members.

March 6, 1871.

The President in the chair.

Eight members present.

Exchanges received were laid upon the table.

Dr. Engelmann exhibited three specimens of the *Abutilon Avicennæ* (Indian Mallow), the common weed which is coming into use for paper-making, as stated at a former meeting. They differed but slightly—one being from St. Louis County, one from the south of France, and one from Italy.

Mr. C. V. Riley asked if Dr. Engelmann had any explanation of the fact, that so many of our commonest plants and weeds were introduced from abroad, and had become naturalized here, while so few of our plants had become naturalized in Europe. He had shown in his second report that no less than 233 distinct species, excluding from consideration all cryptograms, all doubtful cases, and all cases where the same plant is supposed to be indigenous on both sides of the Atlantic, had been introduced into this country from Europe, and that no less than forty-three were most pernicious weeds.

In insects, the same facts obtained; for while dozens of our more injurious species are of European origin, but two or three American species had ever become greatly multiplied there.

Dr. Engelmann thought that no theory was necessary, as such a state of things was to be explained by the fact that some plants are more vigorous than others. He was also disinclined to believe that there was such a contrast.

Mr. Riley undertook to account for it on the Darwinian theory, that from the greater competition and struggle for existence that had gone on in Europe under the civilized conditions of man, their species were, many of them, better able to thrive under similar conditions here than our own indigenous species.

Dr. Engelmann feared such theories would lead us astray.

Dr. Wislizenus attributed the greatest increase of European plants when introduced into this country to the fact they had more room here than in their native soil.

Dr. Engelmann exhibited cones and bunches of *Pinus flexilis* from Montana, first discovered by Dr. James of Long's Expedition in 1820. The seeds were used as food by the Indians.

Messrs. Wm. N. Symington, John H. Tice, and S. A. Bailey, were elected associate members.

March 20, 1871.

Vice-President, Dr. Boisliniere, in the chair.

Thirteen members present.

Publications and letters received were reported by the Corresponding Secretary.

A letter from Mr. Charles Becke, of Ems, Austria, asking for an exchange of botanical specimens, was referred to Dr. Engelmann for an answer.

A paper from Dr. A. Hager, of Fort Snelling, Minn., was read, entitled "Tables for Reducing Barometrical Observations to the Freezing Point," and referred to the Committee on Publication.

Dr. Engelmann exhibited ears of common corn, which contained some grains of sugar-corn, though none such had grown in the neighborhood of the stalk. There had been sugar-corn, however, in the vicinity of the corn from which the seed was taken, and it was presumable that the impregnation had taken place in the mother plant.

Specimens of cinnabar ore from the New Almaden Mines of Santa Clara County, California, were exhibited by Dr. Briggs.

Messrs. A. J. Conant and Daniel P. Potter, and Alexander J. P. Garesché, Esq., were elected associate members.

April 3, 1871.

The President in the chair.

Fifteen members present.

Mr. C. C. Whittelsey mentioned the deposit, by a storm (which occurred on the 15th of March) in various parts of Ohio, of large quantities of a yellow substance which was generally supposed to be sulphur. He suggested that it was the pollen of some tree.

Dr. Engelmann remarked that it was the pollen of some species of Pine, most probably of the long-leaved Pine, as that was the only species he could think of which was in bloom at the time. This Pine occurs abundantly in Alabama, Mississippi, and also on Red River, and the pollen is often transported at this season by storms coming from those regions. He illustrated on the blackboard the singular form of this pollen, which could always be distinguished from the pollen of ordinary deciduous trees by being trilobed, instead of, more or less, spheroid. The lateral lobes seem to constitute air cells, which assist in floating the pollen through the atmosphere. It also contained oily particles, and burned when ignited, so that the popular idea of its being sulphur was a very natural one.

Mr. Edwin Harrison observed, that while in the Rocky Mountains last summer he had noticed, about the 8th of July, portions of a lake covered with what he at first took to be sawdust, but on closer inspection it proved to be pollen.

Dr. Spencer had seen pollen fall in New Orleans.

Dr. Wislizenus gave an account of the researches of Prof. Ehrenberg, of Berlin, who made a special study of the deposits of storms, and hoped that members would send the Professor samples of pollen and other materials known to be so deposited.

Mr. C. V. Riley called attention to the subject of Mimicry and protective resemblances in animals, and especially in insects. He instanced more particularly the mimicry by an otherwise defenceless butterfly, of one whose great numbers and wide distribution indicate that it enjoys peculiar advantages. He illustrated the only such case known in North America, namely, the imitation of *Danais archippus* by *Limenitis disippus*, exhibiting specimens of the insects, and showing that the protection afforded to the *disippus* by this mimicry enabled it to multiply and become much more numerous than its congener, *Limenitis ursula*, the only other species of the genus in the Mississippi Valley. He ventured to account for this imitation on the theory of Natural Selection, as expounded by Darwin.

Mr. C. C. Whittelsey believed the only way to account for such phenomena was to attribute them to design. There was but one force in the universe, and that is will—human will and design, or Divine will and design.

April 17, 1871.

The President in the chair.

Twenty members present.

A note was received from the Corresponding Secretary, saying he was too ill to attend the meeting, and had deposited the publications received in the Library.

Mr. C. V. Riley, State Entomologist, presented a copy of his "Third Annual Report on the Noxious, Beneficial and other Insects of the State of Missouri"

Dr. W. M. McPheeters mentioned a singular freak of electricity, by which a tree was shattered from below, and lifted out of the ground, leaving a large hole. It seemed to show that electricity rushed from below upward as well as from above downward.

It was observed by Drs. Engelmann and Wislizenus that the case could be thus accounted for, and that, though exceptional, there were other authenticated instances of the kind on record.

Mr. Richard Hayes believed that upward electricity was more common than was generally supposed. He had himself seen lightning going up from a pine tree.

Dr. Engelmann remarked that some trees attract lightning more than others, and among them was the oak.

Mr. Edwin Harrison mentioned a curious case where the lightning struck a rick, wet at top, and, making a hole through it as large as a man's fist, continued its course for some distance under ground.

Dr. Wislizenus cited a case where a house was enveloped for a moment in flames, both inside and outside. The inmates thought it came from below, but it was afterward traced from above.

Mr. John H. Tice accounted for the case mentioned by Dr. McPheeters by supposing there was water near or in the tree.

Dr. S. G. Moses exhibited a tooth of *Elephas primigenius* from Sulphur Springs, El Paso, New Mexico.

Dr. Engelmann remarked upon the earliness of seasons, that since 1833, we have had here two springs earlier than the present, and several almost as early. The mean temperature of March and April, during that time, was 50°. The earliest season occurred in 1842, though the springs of 1834, 1842, 1851, 1860, and 1871, may be called unusually early seasons. At first, the present season bid fair to be earlier than that of 1842, but the severe drouth has rendered it at present later. He had noticed the flowering of some of the more common trees in the order of their earliness, viz: soft maple, elm, peach, sweet cherry, plum, then pear about the same time, apple, quince, and lastly, locust or acacia. On the 23d of April, 1834, a severe frost destroyed all the young fruit and foliage of orchard and forest, and we have since that time had two instances of late frosts in May.

Dr. Wislizenus mentioned another peculiarity of the present season, namely: its storminess as well as its lack of rain. Rain guage so far, 1¼ inches: in ordinary seasons it is 8.29 inches.

Mr. D. T. Snyder was elected an associate member.

May 1, 1871.

Dr. Boisliniere, Vice-President, in the chair.

Thirteen members present.

Exchanges received were laid upon the table.

Dr. Wislizenus gave a summary of his Meteorological Observations for March and April: Mean temperature for March, 53.03°; average for 30 years, 44.4°. Mean temperature for April, 61.2°; average for 30 years, 56.1°. Rainfall in March, 1.21 inches; average for 30 years, 3.81 inches; in April, .3 of an inch; average, 3.96 inches.

During the frost on the morning of the 22d of April, he had noticed a difference of 13° in a difference of elevation of 100 feet.

Dr. Engelmann remarked that the black locust tree was in full bloom. In thirty-eight years, only one instance had occurred when this tree had bloomed in April at St. Louis, and that was in 1842, in which year the season was two weeks earlier than this.

Dr. Wislizenus exhibited a larva which was found shining in a cobweb after having been mutilated. Mr. Riley said it was the larva of our commonest "fire-fly" (*Photinus pyralis*), and gave an account of its transformations.

Mr. Judd presented a tooth of a Mastodon, found in Illinois.

Mr. E. F. Hobart was elected an associate member.

May 15, 1871.

ALBERT TODD, Esq., in the chair.

Publications received were laid upon the table.

Mr. C. V. Riley exhibited some silk-worm cocoons, spun by worms fed upon the Osage Orange (*Maclura aurantiaca*). He had experimented with this plant, and had been quite successful. The worms were exceedingly healthy, and the silk seemed to be of fair quality. He also asked for the appointment of another recording secretary, as he was about to leave for Europe. Mr. Hayes was appointed.

Mr. Hayes stated that he had observed several shooting-stars a about 9 o'clock on the evening of the 7th instant, and in a narrow space up to 11 o'clock he had counted nine, some of which were quite brilliant, and one more so than the planet Venus. We were now approaching the belt of shooting-stars, and from the 24th to the 26th of May quite a number might be expected to be seen.

Dr. S. V. Summers was elected an associate member.

June 5, 1871.

Vice-President WISLIZENUS in the chair.

Thirteen members present.

Exchanges received were laid upon the table.

Mr. Conant presented some Indian relics taken from a mound at Grand Rapids, Michigan. Among them was a knife and several needles made of copper, and a small, round, stone-shaped piece of copper, the use of which he did not know. He had seen a stone pipe from the same mounds, of beautiful workmanship, and bluish-gray in color, not red as usual. He remarked that articles of copper had been found in Mexico which the form of crystalization proved to have been brought originally from the copper mines of Lake Superior.

Dr. Wislizenus reported the mean temperature for May at 68.9°, the usual average being 66.3°. Highest, 95°; lowest, 40.5°. Rainfall, 3.01 inches, the usual average being 4.94 inches.

Messrs. William Twining and J. B. Merwin were elected associate members.

July 3, 1871.

The President in the chair.

Foreign exchanges received through the Smithsonian Institution were laid upon the table, and a letter from the Institution of Archives, Florence, Italy, asking for an exchange of publications, was appropriately referred.

Dr. Engelmann presented a specimen of coal from Colorado Territory. This coal had been found in several places on the eastern base of the Rocky Mountains. He stated that it had proved, upon examination, to be entirely destitute of bitumen, and could not be used in the manufacture of gas, though it was useful for fuel under locomotives and for other purposes. He was of the opinion that it belonged to a much later period than the other coals of the United States, probably the Cretaceous. It had been found in large masses in many localities.

In answer to inquiries by the President, Dr. Engelmann stated that the large trees of Calaveras County, California, belonged to the order of coniferous trees, of which the common cypress, juniper, &c., were species. They bore close relations to fossil specimens found in the Tertiary formations, not only in this country, but in Europe, confirming the already well-established fact of the similarity of the vegetation of the Tertiary period on the two continents. The age of these great trees had been overrated. One of the largest felled had about 1,200 rings, so that the age was 1,200 years. The impression had gone abroad that no young trees of this species were ever found, but this was a mistake. As in other forests, it was after the old trees had fallen down that there was room for the young ones to spring up. A second species of this Californian genus, the redwood, attained the size of twenty or twenty-five feet in diameter, and is very important timber. Our ordinary forest-trees are probably very few of them over two hundred years old.

Dr. J. B. Johnson said he had examined the immense trees of Calaveras County. After visiting them two or three times they begin to grow upon you. He rode into the hollow of one a distance of ninety feet.

Dr. Johnson mentioned the snow-plant or blood-flesh flower. It was very peculiar in its character, and no one had been able to propagate it. It has no green leaves. Placed in a box, it will remain vigorous two or three weeks and then perish.

Dr. Engelmann explained the impossibility of cultivating this plant, the *Sarcodes*, from its being a parasite; we have similar parasites, but of a wax color, in our woods, the most common and striking of which is *Monotropa uniflora*.

October 2, 1871.

The President in the chair.

Ten members present.

The Corresponding Secretary reported that the exchanges received had been deposited in the Library.

A communication from Dr. T. A. Cheney, of Leon, Cataraugus County, New York, dated September 18, 1871, relating to the recent discovery of Mastodon remains at Jamestown, New York, and asking for missing numbers of the Transactions of the Academy for the Georgic Library under his charge, was referred to Dr. Wislizenus with instructions to return the proper answer.

Mr. C. C. Whittelsey informed the Academy that a large number of geological specimens and fossils belonging to the Museum were to be found at the Washington University, and that he had in his possession a large meteorite, also saved from the fire; and Prof. Hager was appointed to take charge of them.

Dr. Engelmann noticed the metereological characteristics of the past summer:

The past season has proved an extraordinary one in a meteorological aspect. After a very dry summer last year, the autumnal and winter months brought us nearly an average quantity of rain, but from the beginning of March to October 2 the drought in this neighborhood has been unprecedented, at least within the period of his observations, which extended over 33 years. In every month since then less rain has fallen than the average, and in two months, April and September, less than ever observed before during the same time; and usually, when in other seasons there was less rain in one month, the quantity that fell in the preceding or succeeding months to some extent made up for the deficiency. But this year we have had seven months with only two of them, May and August, with a bare sufficiency, the other five with an absolute scarcity of rain. The following table will show this to be the case:

	Average quantity of rain.	Quantity in 1871.	Proportion.
March..............	3.81 inches.	1.14 inches.	1-3
April	3.96 "	0.25 "	1-16
May................	4.94 "	3.40 "	2-3
June	5.66 "	2.87 "	1-2
July................	4.17 "	1.14 "	1-4
August	4.15 "	3.00 "	3-4
September...	3.25 "	0 02 "	1-16

Thus the average quantity of rain in spring is 12.71, and in summer 13.98; while the quantity in the spring of 1871 was only 4.79, and in the summer of 1871 only 7.01.

In thirty-three years we had only one spring, namely that of 1860, which approaches the past one. In that spring there was only five and a half inches of rain, but it was followed by twelve and a half inches of rain in summer. One summer, that of 1854, had less rain than the past, namely, not quite six inches, but then the spring had over twenty-one inches of rain. In the six months together we never before had less than eighteen or twenty inches of rain in the dryest seasons, while this year the quantity was not quite twelve inches.

The three autumnal months are usually dry here, the average fall of rain amounting to nine and three-quarters inches, and observation shows that a dry summer is commonly followed by a dry fall. The first autumnal month, the past September, proves the rule for the present season, and it is to be feared that the next two months will not change it.

The fear has been expressed that this region is growing dryer from year to year, and that drouths will become the ordinary condition of our country, and it is a fact that this neighborhood, at least, is dryer than it used to be. Even without draining, ponds disappear, and lakes that used to abound in fish and fowl have become cornfields. No doubt this state of things depends more especially on the more general cultivation of the soil, together with the felling of timber, but dry seasons have alternated with wet ones for the last thirty years. In 1842 we had only 32 inches of rain, in 1853 not quite 31, and in 1860 less than 30; while in 1848 we had 65 inches; in 1859, 61 inches, and in 1858 over 68 inches, which is the greatest quantity since 1839, when my observations of the rainfall commenced. Since 1859 I have never thus far observed as much as 47 inches in one year.

Another peculiar feature of the past spring and summer was their high temperature, and, in consequence, the early development and maturity of the vegetation. Every month from March to August was warmer than the average of thirty-seven years, as the following indicates:

	Average.	1871.	Warmer than Average. 1871.
March..................	44.0°	49.5°	5.5°
April......	56.1	60.4	4.3
May........	66.2	67.2	1.0
Spring................	55.4°	59.0°	3.6°
June.......	74.7°	78.8°	4.1°
July....................	79.1	79.2	0.1
August................	76.7	78.5	1.8
Summer......	76.8°	78.8°	2.0°

In the last thirty-seven years we have had three years in which the spring was warmer, and four in which the summer temperature was higher than in this year. In one of them—1860—the spring, as well as summer, was warmer than this year.

The years of warmer springs were 1842, 1844, 1860; warmer summers, 1838, 1854, 1858 and 1860.

It must be remarked that the heat of the past summer was, nevertheless, not excessive, the high average being produced rather by an absence of great changes and occasional low temperatures.

September made an exception to the rule which had prevailed through the spring and summer. The changes were considerable, and the mean temperature of the month, 66.8°, was considerably lower than the average of this month, 69.2°.

Mr. J. R. Gage was elected an associate member.

October 16, 1871.

DR. GEORGE ENGELMANN in the chair.

Eleven members present.

Publications received were laid upon the table.

Mr. C. V. Riley gave an abstract of a paper prepared for his report, entitled "On the Cause of Deterioration in some of our Native Grapevines, and the Reason why European Vines have so generally failed in the Eastern half of the United States." He showed that one of the principal causes of this deterioration and failure was attributable to the workings of *Phylloxera vastatrix* Planchon, a plant-louse, which formed galls on the leaves and knots on the roots; but whose presence on the roots had not hitherto been suspected in this country. Also, that it is identical with the grape-root insect which is causing so much alarm in the south of France; and that there is every reason to believe that it was originally taken there from this country, where it is indigenous on our wild vines.

November 6, 1871.

Dr. George Engelmann in the chair.

Fourteen members present.

The Corresponding Secretary submitted a communication from the Board of St. Louis Public Schools, the nature of which is explained by the following resolution of the Board:

"*Resolved*, That the Polytechnic Building Committee in conjunction with the Architect and the Chairman of the Building Committee be authorized to fit up the southeast corner room of the fourth floor of the Polytechnic building with suitable cases for the reception of the Mineral and Zoölogical Cabinet of the Academy of Science and the Public School Library, the expense of said cases not to exceed $500."

On motion, this proposition of the Board was accepted, and Messrs. Hager, Lips, Hayes, and Engelmann, were appointed a committee to take charge of the matter in conference with the Public School authorities.

Dr. Wislizenus exhibited a corn-cob, showing a very marked fasciation. Dr. Engelmann said it was not uncommon in plant-stems, as, for instance, in Ailanthus. In the common tomato and coxcomb it occurs regularly and is propagated by seed.

Messrs. W. P. Heston and E. H. Currier were elected associate members.

November 20, 1871.

Albert Todd, Esq., in the chair.

Fifteen members present.

The committee appointed to confer with the School Board reported that they have received assurance from the Architect of the Board that the cases would be provided at as an early a day as practicable and in accordance with the plan recommended by the committee.

Mr. A. D. Hager presented in the name of Messrs. Belt & Kive a valuable collection of minerals from this State, which had been on exhibition at the recent fair.

Dr. Engelmann exhibited several Aroid plants grown in the hot-house of Shaw's Botanical Garden. The Aroid is a tropical family of plants, and in the tropics they grow to enormous dimensions, and often have a climbing habit. The species which occur in this latitude are several species of Arum or India turnip and Acorus calamus, the well-known aromatic calamus root. A beautifully variegated leaf of another Aroid of the same genus (Calladium) was also shown.

On motion of Mr. Riley, the Corresponding Secretary was instructed officially to inform the Board of Public Schools of the acceptance of their proposition in relation to the Cabinet, and to return them the thanks of the Academy.

Mr. Andrew A. Blair was elected an associate member.

December 4, 1871.

The President in the chair.

Nine members present.

Mr. Wm. N. Belt was elected an associate member.

December 18, 1871.

Dr. Engelmann in the chair.

Thirteen members present.

Dr. C. E. Briggs stated that in Brooklyn, N. Y., when the trees were destroyed by the measuring-worm, they were replaced by the Ailanthus, which succeeded admirably.

In answer to inquiries, Dr. Engelmann said he did not think the Ailanthus was poisonous, though an unpleasant odor was exhaled by the male flowers, and by the leaves when bruised.

Mr. C V. Riley said he had never been more favorably impressed with the Ailanthus than while passing through the cities of New York and Brooklyn last summer. It was wonderfully hardy, and the pistillate trees were really beautiful, without material odor, and were more elegant in growth than the staminate trees. It was very free from insects, only two species, viz.: a brown worm, the larva of a pretty little moth, described and figured in his first annual report as *Œta compta*, and the imported Japanese silk-worm (*Attacus cynthta*). He attributed the failure of tree growth in the city of St. Louis, in a great measure, to insect depredation, severe heat, drouth, smoke and gas.

Dr. Engelmann observed that while the Black Locusts all died, the White Elm, Silver-leaf Maple, and Sycamore, seemed to thrive well.

Dr. Curtman had noticed that the Osage Orange did well, and was not affected by insects, and he thought it deserved more attention than it had received.

Dr. Engelmann gave an abstract of his observations on the freezing of the Mississippi River at St. Louis; it had been frozen over 13 times in 40 years, and four times two years in succession. In the winter of 1845-6 it closed on the same day as this year, and this was the earliest date. It had been closed, during his observation, six times in December, five times in January, and twice in February. Longest time closed, about one month.

Mr. William Lucas was elected an associate member.

January 4, 1872.

Dr. L. C. Boisliniere, Vice-President, in the chair.

Twenty members present.

The Corresponding Secretary submitted circulars from the American Museum of Natural History of New York, from the President of Harvard College, and from the University of Strasbourg, in relation to exchanges, publications, and specimens.

On motion of Dr. Briggs, the Secretary was instructed to send a full set of the Transactions to the University of Strasbourg.

On motion of Albert Todd, Esq., the following resolution was adopted:

"*Whereas*, It is reported that the Managers of the St. Louis Public School Library offer to bind the unbound books of the Society without expense to it;

"*Resolved*, That this Society accept this offer, when duly made, and authorize the Committee on Binding to arrange with said Managers therefor, and report to the next meeting."

On motion of Dr. Engelmann, it was ordered that the Committee on Publication be instructed to ascertain whether there be any possible chance of publishing another volume of the Transactions during the present year.

The Treasurer's Report was accepted and referred to an auditing committee. The report showed a balance of cash on hand of $143 ; debts, none ; dues from members, $343.

The annual election of officers resulted in the choice of the following:

President—James B. Eads, C. E.
1st Vice-President—Albert Todd, Esq.
2d Vice-President—Geo. Engelmann, M.D.
Corresponding Secretary—Wm. T. Harris.
Recording Secretary—Charles V. Riley.
Treasurer—Dr. Enno Sander.
Librarian—John J. Bailey.
Curator—A. D. Hager.
Committee on Publication—Dr. G. Engelmann, Wm. T. Harris, C. V. Riley.

January 15, 1872.

The President in the chair.

Twenty members present.

The President, on assuming the chair, delivered his inaugural address as follows:

INAUGURAL ADDRESS BY THE PRESIDENT.

GENTLEMEN OF THE ACADEMY OF SCIENCE:—The Charter of your Association, granted fourteen years ago, contemplates the creation of an Institution in St. Louis, for "the advancement of Science and the establishment of a Museum and Library for the illustration and study of its various branches." Through the labors and influence of several of the scientific gentlemen first enrolled among its members, aided by the liberality of older kindred societies and private individuals in America and Europe, the Institution thus created grew apace during the earlier years of its existence, and accumulated many valuable records and scientific works, which formed the nucleus of what would have grown to be by this time a valuable library. Liberal donations of objects of interest in great variety, illustrating many of the most important departments of science, flowed in from private citizens and corporations, both at home and abroad, with such generous profusion, that its Museum began to be one of the most attractive features of our city. After a few years of such encouraging prosperity, the building in which the Library and Museum of the Academy were contained, on Myrtle street, near Seventh, was unfortunately destroyed by fire, and these valuable collections perished in the flames.* This misfortune coupled with the knowledge that the loss was not even covered by any cash value of insurance, together with the fact that the still more sad and desolating calamity of civil war had just swept through the land, cast such discouragement upon its members, that for several years little effort was made to restore its prosperity. The rapid increase of membership and the lively interest which have recently marked the history of the Academy give, however, good reason for its friends to hope that it will soon rank among the most useful, attractive and creditable institutions in the country.

Your Constitution declares that the Academy shall embrace the departments of Zoölogy, Botany, Geology, Mineralogy, Palæontology, Entomology, Chemistry, Physics, Mathematics, Meteorology, Comparative Anatomy, and Physiology. By the liberal provisions of your Charter, the scope of your investigations may be extended to such other branches of science as the members controlling the Institution may deem proper.

It will be seen, therefore, that the fields from whence are to be culled the treasures with which your records and museum are to be enriched, may really embrace the entire universe.

The majority of mankind, even of those possessing more than mediocrity of intellect, are so constantly occupied with the daily industrial and commercial pursuits of life, that they know but little of what Science is accomplishing at the present day. They are still less aware of the great aggregate of patient labor that has been performed by those who have chiefly contributed to her advancement; and, I regret to add, that they have but a faint idea of the immense benefits that flow to the human race as a result of scientific investigation and discovery.

Could a correct appreciation of the great mental improvement and physical amelioration that have come to man through the aid of Science be but once established in the popular mind, your Academy would not lack public encouragement; it would be promptly and liberally endowed by the State of Missouri herself; the greatest interest in its success would be felt by our people at home, for it would be recognized as one of the most certain means of elevating and improving the condition of the human race. No institution in Missouri more richly deserves the patronage of the State, because no other one can be made more capable of increasing the intelligence of the people, and of directing them how to reap the largest degree of benefit from the immense fields of wealth so profusely spread out around them.

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* The entire Library and a small portion of the Cabinet only were saved.

There exists no reason save that which is to be found in the indifference of our own citizens, why an Institution like this, created for the diffusion of useful scientific knowledge among men, and located in the midst of a region of unparalleled resources, and rich in the promise of future greatness beyond any example of the past, cannot be built up to an eminence equaling, if not surpassing, that of any similar institution in Europe. It numbers already among its members men of science, whose contributions to its published records have awakened profound attention, and elicited the most respectful comments from foreign academies; and whose talents and learning are acknowledged in the most enlightened circles of Christendom. These gentlemen, and other members equally zealous, but less known perhaps to fame, would, if encouraged, cheerfully devote much of their time in communicating to the scientific world at large the results of their own valuable experience and investigations; and likewise aid in arranging and collating the scientific data that would be promptly furnished in return by men eminent in science in other parts of the world. In this manner, here in our own midst, the results of scientific inquiry everywhere might be continually unfolded, and its discoveries could be from time to time presented in simple and charming vesture to those whom it should be the aim of all governments to improve and elevate; those who are daily toiling in the development of the material interests of the nation, and who constitute the nation's reliance in her hours of trial—the working classes of the country. It should be one of the chief purposes of government to encourage, in every judicious manner, the dissemination of such scientific facts among this, the largest portion of our population, as will give them a general knowledge of the principles involved in the physical development of the human race; the preservation of health; the nature of disease; the peculiar qualities and composition of the natural elements with which they are surrounded; and, in a word, to supply them with whatever important truth science can impart of value in the preservation of life, the promotion of happiness, and the attainment of the highest perfection in the various departments of human industry.

Unless the immutable laws which regulate existence be understood, they cannot be intelligently obeyed in the preservation of health, nor advantageously applied in accomplishing the purposes of life. One of the grand objects for which the human mind seems specially designed, is to comprehend the sublime phenomena with which it has been surrounded; hence all wise governments should encourage such institutions as are particularly designed to accomplish this evident purpose.

The wonders that are presented by science for the contemplation of men are frequently so startling as to be deemed by the mass of mankind only the idle fancies of those who first bring them to our notice. Science, however, only recognizes those theories as established truths, when every one of the particular phenomena to which the theory is applicable can be satisfactorily explained by it, and by no other. It is only by keen observation and thoughtful study of the phases of nature that Science advances. The recorded knowledge of those who have gone before must be carefully examined and compared with the experience and observation of the present. Even then years of seemingly unrewarded labor, in almost impenetrable darkness, sometimes ensue; but such stores of facts are at last accumulated that she suddenly ushers us into the glorious presence of a new-born day. In its pure light the mists which hung over our vision melt away, and we see revealed some grand law of nature hitherto unrecognized. Such, for instance, was the law of gravitation, discovered by Sir Isaac Newton, and by which the movements of the heavenly spheres are explained to us. The development of the theory of the conservation of matter, and the correlation of forces, is another illustration of the discovery of, perhaps, a still grander truth; one which Faraday pronounces " the highest law in physical science which our faculties permit us to perceive."

Indeed, some of the results of scientific inquiry have been so amazing, that the powers of the human mind seem almost elevated by them to the verge of omnipotent wisdom.

The discoveries in Astronomy are especially calculated to raise our conceptions of the power of man's intellect to a degree that is well nigh impious. Fortunately, however, for our humility, that department of science, more perhaps than all others, is best calculated also to elevate, to the highest possible point, our ideas of the power and wisdom of the Creator. What grander illustration, for example, of the wonderful power of intellect can be imagined than that exhibited in the discovery of the planet Neptune?

Studying the perturbations of the planet Uranus in its orbit, two eminent mathematicians, Leverrier and Adams, were led, each unknown to the other, to investigate their cause. They knew that the attraction of gravitation could alone account for these irregularities, and they believed the inducing force was an unknown planet. They had nothing but the eccentric orbit of Uranus and its mass as the data by which to find the orbit, and the place in that orbit of the disturbing body. Yet before that unknown world, ninety-four times greater in bulk than this earth, had been recognized by human eye, the equations of Leverrier enabled him to track its majestic sweep around the distant verge of planetary space with such unerring certainty, that he was enabled to indicate almost the exact place in the firmament in which it was to be discovered. He wrote to Galle, in Berlin, that at that date it could be found in a certain part of the heavens. The very first night after his friend received this letter, he turned the telescope in the observatory of Berlin as directed by Leverrier, and the mighty planet stood triumphantly revealed, within a single degree of the place indicated.

Sometimes scientific discovery pauses in apparent hopelessness in certain fields for centuries; in others it advances with slow but constant pace, each step being due to the successive or united labors of many minds; whilst in others, again, it moves onward with strides so rapid and startling as to challenge the admiration of the world. Some of the phenomena of electricity and magnetism were known for ages before any forward step was made to unravel their mysteries. In the investigation of the laws of light and heat it has, in these latter years, made marvelous advances.

Some of the recent discoveries in this field are so wonderful, and at the same time so beautiful, that I feel tempted to explain a few of them this evening, very briefly however, for the benefit of those of our members who may not have had time to become acquainted with them.

Newton discovered that when a beam of light was passed through a denser medium than the air it was refracted or bent, in its passage through the denser medium, out of a direct line. When the beam was passed through a glass prism, he discovered that some of its rays were bent more than others, and thus became separated beyond the prism, and that when thus separated these rays were of different colors, and when thrown upon a screen the colors were ranged in the order in which we see them in the rainbow.

The colors thus produced by the dispersion or separation of the rays of a beam of sunlight, are usually known by the name of "The Solar Spectrum."

Newton found, also, that by passing these colored rays back through another prism, suitably placed, they became combined again, and then appeared, as before, in a single beam of white or colorless light.

In this alternate analysis and synthesis of light did Newton ponder. He had made the first great step in the investigation of its marvelous phenomena, but even his giant intellect could advance no further in solving its mysteries.

The anatomy of the silken tresses which grace the brow of a rustic maiden are to her no more mysterious than were those pencils of light to the mind of Newton. She may spread out her flowing wealth in the sunshine, and wonder at its lustrous beauty, but she can no more number each one of its single fibres than could Newton count the threads which came to him in that beam from the distant orb of day. To her the mystery of its growth, the cunning workmanship of its roots, the delicate architecture of its fairy-like chambers, and the pristine fluid that for a few brief years will circulate within its tiny channels and keep the snow-flakes of age from dimming its raven sheen, are no less unknown, than were the scores of fascinating truths we now possess respecting light unknown to that great philospher. Yet this was the first grand step toward those wonders which have culminated within the last twelve years in the astonishing revelations of the spectroscope.

Subsequent philosophers, investigating the solar spectrum thus spread out by Newton, discovered that when the thermometer was exposed in the variously-colored rays in succession, from the violet to the red, the mercury rose gradually and attained its greatest height within the red rays. Continuing still further with it in that direction, the remarkable discovery was made, that the mercury rose much more rapidly beyond the red where no color whatever was visible. Thus was the curious fact discovered, that the sun emitted certain rays incapable of exciting vision, yet possessing far more heating power than any of those revealed to us by sight. The temperature was then tried at the other end of the spectrum, beyond the violet, but here there was scarcely a trace of heat to be found. But on placing certain substances beyond this end of the spectrum, what was equally as startling as the existence of the obscure rays of heat beyond the red, was the discovery that there were invisible rays beyond the violet, which possessed remarkable chemical power. These are called the actinic, or chemical rays, and are those which are most valuable to the photographer.

It must be remembered that all illuminated bodies possess the power of reflecting the rays of light. By illuminated bodies are meant all white and colored objects revealed to us by sight; as it is only by the rays of light which fall upon them, being reflected from their surfaces, through the eye, upon the delicate nerve tissues of the retina. that their presence is revealed to us. All objects which do not reflect light are black. In comprehending the art of the photographer it is important to remember these facts. Hence it matters not whether certain chemical solutions are exposed in the direct sunlight to these invisible rays, or whether these rays are reflected from the face of a human being, a house, the moon, or other illuminated object upon such solutions. Their action will work the same chemical changes. These chemical rays, reflected with the others from illuminated objects placed before the camera of the photographer, produce an atomic change upon the sensitive solutions with which his plates are prepared, and thus form upon them images of such objects as are in the field of the lens at the time.

The colored rays of the spectrum possess chemical power also, but. like their heating power, it is less than that possessed by the invisible rays.

The phenomena exhibited by the invisible heat rays at the red end of the spectrum are no less remarkable than those manifested by the chemical rays. A correct idea, however, of the cause of these phenomena cannot be well comprehended without some knowledge of the Undulatory theory of Light, now almost universally accepted as the only one by which all of its various phenomena are believed to be explained.

The analogies in the phenomena of light and sound are so numerous that a brief explanation of some of those of sound will enable us to comprehend more easily those of light. Sound and light are reflected in the same manner, the angles of incidence and reflection being equal. Sound, like light, is refracted when passing through media of different densities; each may be doubled in intensity, or destroyed, by interference; and each is propagated by the undulations or vibrations of the conducting medium.

The phenomena of heat and light are likewise so closely allied that a theory which is applicable to one will probably explain every phenomenon of the other. Heat is reflected, refracted, transmitted and polarized in the same manner as light.

All sonorous bodies create sound by imparting their vibrations to the air when they are themselves thrown into vibration. When they vibrate in a vacuum, without contact with objects outside of the vacuum, they produce no sound, because they cannot affect the air.

Many other substances convey sound equally as well as the air, but air being the only element usually in contact with the ear, it is the natural medium for man. The metals, water, wood, and many other substances, are excellent conductors of sound.

If it were possible for us to see the particles of air when they are set in motion by a harp-string making about eleven hundred vibrations per second, we would see them spaced off in equal distances of about one foot in length, in every direction from the harp-string. In every alternate foot or space we would see them moving towards the string, and in each intermediate space we would see them moving from the string. The next instant the atoms in all these spaces would have their motions reversed. Each alternate set of atoms would be seen approaching and compressing each other, and then instantly rebounding from each other and compressing the set on the opposite side. These motions to and fro would be found to correspond exactly in time with those of the harp-string creating them. It would be seen that the impulse from the harp-string would be first imparted to the set of atoms nearest to it, and by this set it would be imparted to the next and so on out to the most distant ones in the system. Hence eleven hundred vibrations would have to be made by the string before the air eleven hundred feet distant would be set in motion. These vibrations of the air, when they fall upon the tympanum, create the sense of sound. They travel at the rate of about eleven hundred feet per second, the speed varying with the density and temperature of the air. The to and fro movement of the atoms in each of these eleven hundred spaces, or waves of air, is called the swing or vibration of the atoms. This swing is of much greater amplitude near the string, and diminishes as the vibrations are more and more distant. Hence the impulses upon the ear will be much more energetic near the string than at a distance. The note sounded will therefore be louder. It will still be the same note, however, whether the string be distant or near, because each wave created by it is of exactly the same length, and hence the waves fall in exactly the same periods. It is the rapidity of these impulses on the ear that determines the pitch of the note. If the harp-string were shorter, or if it were lighter, or if it were more tightly drawn, its vibrations would be more rapid. Then the waves would be shorter, and more of them would be required to make up eleven hundred feet in a second of time. Consequently, as the waves travel at the same rate without regard to their size, they would come into the ear more rapidly and a note of higher pitch would be the result.

The same note sounded by a rapidly approaching steam whistle on a locomotive has a higher pitch to the stationary listener before, than it has after the whistle has passed and is retreating from him. If the listener be himself on a train rapidly meeting the one on which the whistle is sounding, the change of pitch at the moment of its passing the hearer will be much more marked. The current of steam issuing from the contracted opening in the whistle is thrown into rapid vibrations by being directed against the sharp edge of a hollow metalic cylinder. These vibrations are at once imparted to the air just as they would be if made by a harp string. If the whistle itself be moving, the sound waves will be shorter in advance of it than in its rear. The more rapidly it moves the greater will be the difference in their length; hence if it be approaching, more waves will enter the ear in a second of time than if it be retreating.

The tympanum is thrown into vibrations corresponding with those of the air, and when these fall in regular periodic succession at a rate not less than sixteen per second, nor more than thirty-eight thousand per second, they create the sensation of musical sounds. When the vibrations are irregular, the sense of noise is the result. Without stopping to explain how these vibratory motions of the tympanum are conveyed from it, by the four minute bones within the ear, to the fluid contained in the complicated organ called the labyrinth, and from thence to the nerves, I will simply refer to the wonderful little organ discovered in the labyrinth by Marchese Corti, and which Tyndall pronounces to all appearances a musical instrument similar to a lute; with three thousand microscopic fibres stretched in such a manner that some one or other is actuated by the various vibrations within this great range of periods. These vibrations are thus taken up from the labyrinthine fluid and transmitted to the nerve filaments which traverse the labyrinth, and by these the sensations are conveyed to the brain. An ordinary lute string may be roused into vibration by a note from the voice, or by an organ peal, when the periods of vibration of the air producing the note and the periods of vibration of the string concur. If there be discord between the note and the string, the latter cannot be roused. If you sing into an open piano, the strings in unison with the voice are thrown into vibration, but none other. A feeble note, because of its coincidence with the periods of a sonorous body, may rouse it into sound, while a far more powerful note, because of its non-concurrence, would produce in it no excitement whatever.

If two tuning-forks of exactly the same pitch be placed at a considerable distance from each other in the same room, and one be struck, the other will immediately respond to it. If there be discord between them the one at rest will remain silent.

The ear is attuned to a wide range of sounds. The slightest musical tremor which falls upon it, within the range of eleven octaves, excites some delicate fibre within the ear whose periods of vibration synchronize with it; and the sense of music is thus awakened in the brain. Each one of the great multitude of wavelets sent forth from a grand orchestra finds in the delicate lute of Corti some chord in unison with it; thus the concord of sweet sounds is analyzed and each tremulous ripple in the air faithfully reported to the brain. If vibrations strike the tympanum but find no responsive chord within the ear, they are powerless to excite audition. Those less than sixteen and more than thirty-six thousand per second find no chord in this marvelous lute attuned in harmony with them, and hence they fall upon the ear unheard.

Light and heat are transmitted by the vibrations or undulations of a fluid far more attenuated than the air or any known gas. This fluid fills the illimitable regions of space, and is known by the name of the luminiferous ether. By its wonderful tenuity it is able to pass almost without hindrance through the molecular structure of the densest substances known. To use the illustration of Thomas Young, who was chiefly instrumental in establishing this theory, "this fluid passes through the solid matter of the earth as a breeze does through a grove of trees." With our ideas of the solid and compact structure of certain bodies, it is hard to comprehend the possibility of any fluid possessing such tenuity as to enable it to pass almost instantaneously through glass, crystal, metals, and stones, yet the creation of an etherial vacuum seems an utter impossibility; while the evidence of the existence of the luminiferous ether within the most perfect atmospheric vacuum that man has yet devised, is absolutely irrefragable. Hence we must admit that the atoms of matter are not in such immediate contact as to prevent the passage of this fluid through them.

The length of the waves of light, and their periods of vibration, although so infinitely small and inconceivably rapid, have nevertheless been accurately determined. They are known to be transmitted at the rate of about one hundred and ninety thousand miles per second; or from the sun to the earth in eight minutes. The length of the waves that produce what are called the visible or colored rays, have been accurately ascertained. How this can be done I have not time now to explain; but when it is remembered that the length of a wave of red light is only the $\frac{1}{39000}$ part of an inch, and of a violet wave only the $\frac{1}{57000}$ part of an inch; and that 699,000,000,000,000 of the violet waves strike the retina in a second of time, we can comprehend what a triumph of Science is exhibited in ascertaining these minute facts so positively as to be capable of indubitable proof. Four hundred and seventy four·millions of millions of the waves of red light enter the retina per second. Less than this number of heat rays enter the eye per second, but the rapidity of their vibration is not sufficient to excite vision. The chemical rays are still more rapid, but because of their great rapidity the retina is not affected by them. They are therefore invisible to us.

When the ethereal waves fall too rapidly or too slowly upon the retina, they fail to throw the atoms of the nerve tissue into periods of vibration which coincide with them, and are. therefore, unable to excite vision; just as a powerful musical note fails to awaken into responsive vibration a tuning-fork, a harp-string or other sonorous body whose vibratory periods do not concur with it.

All waves of light and heat travel at the same speed, hence the shorter waves beat more rapidly upon the objects on which they impinge than the longer waves. It must not be supposed, however, that the ether itself is moving at this immense speed. A sea-fowl floating upon the surface of a lake rises and falls with each wave that rolls into the shore, but the bird simply makes a slight movement to and from the shore with each wave, without being borne in upon the beach. This shows that the waves are only the undulating motions of the fluid and do not indicate the existence of a current in the fluid itself.

According as the ethereal waves break more or less rapidly on the retina, the various sensations of color are created. The waves more rapid than the red create the impression of orange; those still more rapid, of yellow; and as they increase in rapidity, the sense of green, blue, indigo and violet are created; the violet rays being the most rapid of all that affect the retina. Thus color is to the eye what pitch in music is to the ear. Hence color may justly be termed the music of the spheres. The red corresponds with the low musical notes and the violet with the higher ones.

The ear, though less sensitive, is, however, far more comprehensive in its range than the eye, the eye being limited to a single octave of wavelets, whilst the ear embraces eleven. Each octave is produced by double the number of waves of the octave below it.

The ultimate particles of matter do not seem to be so closely compacted, even in the densest metals, as to prevent a freedom of movement among themselves to such an extent as to admit of a vibratory or molecular motion. This motion reveals itself to us by the sense of heat. Heat is simply *molecular motion.*

If we imagine an atom of matter surrounded by other atoms, yet not so closely as to prevent a certain degree of movement, and the first atom have motion imparted to it, it will, if perfectly elastic, rebound when it has reached the limit of its motion in one direction, and then, if it were not retarded by friction, the luminiferous ether, or some other influence, it would rebound with undiminished force in the opposite direction, and thus repeat its vibrations forever.

A tuning-fork makes a definite number of vibrations in a given time, whether the vibrations be of great or small amplitude, and we have good reason to believe that the vibratory swing of an atom of matter always requires a certain period of time also for its movement, whether the extent of vibration be great or small. This amplitude of vibration may vary very greatly however. When the hand is laid on iron, if the amplitude of the vibrations be small, the piece will appear cold. If the amplitude be great, it will appear hot, and it will then impart to the ether in contact with it, and to the atoms of the hand, a motion corresponding with its own periods of vibration. This vibratory motion of the atoms, or molecules of matter, is revealed to us by the sense of heat, either by direct contact with the substance, or by the impinging upon our bodies of the ethereal waves which are set in motion by the heated body. Therefore, when we approach an object whose atoms are in more violent vibration than our own, we experience an increased sense of warmth, caused by the atoms of our body having an increased degree of motion imparted to them from the increased amplitude of the vibrations of the ether.

When the amplitude of the vibrations become so excessive as to overcome the attractive force by which the atoms are held together in the solid form, the substance then assumes the liquid state. If the motions of the particles be still more highly agitated the fluid will assume the gaseous form.

This vibratory motion is simply so much *force* imparted by the hotter body to the ether, the air, or other cooler body in contact with it, and, unless the excessive motion in the warmer body be kept up by some other force, its vibrations gradually subside to that condition which corresponds with the temperature of the adjacent or surrounding bodies. When it falls below that, from any cause, the vibratory motion of its particles will receive additional motion from the vibratory atoms of the adjacent ones.

That molecular motion or heat is simply a form of *force*, may be proved by causing the warmth in the hand to be converted into mechanical effect or visible motion.

For instance, if the hand be held near the bulb of a thermometer, the force or heat radiating from it will cause the mercury to rise. Or this force, stored in the hand as heat, may be converted into another form of force, and this still into another kind, and this latter form, being equally invisible, may be made to produce a visible mechanical effect. Thus, if the hand be held near a thermoelectric pile, the heat discharged by the hand will be converted into electricity, this will in turn induce still another form of force, magnetism, and this will cause the needle connected with the pile to be deflected, and so produce visible dynamic force, or motion.

To our countryman, Benjamin Thompson, better known as Count Rumford, belongs the credit of first proving that heat is simply molecular motion. This he did by boiling water with the heat developed by the friction of a blunt or dull drill, made to revolve by horse-power in a brass cannon which he was boring out, the cannon and drill being immersed in a vessel containing the water. Finding that he could continue to create the heat as long as he kept up the friction of the drill, and that neither the drill nor the brass was consumed in the operation, he rightly assumed that "anything which any insulated body or system of bodies can continue to furnish without limitation, cannot possibly be a material substance." Thus the theory of caloric, as taught in the early part of this century, was overthrown. Heat, or, as it was then termed, caloric, was supposed to be a highly attenuated, mobile and imponderable fluid contained within other matter, or attracted by other matter, and capable of being extracted or given off by such matter, just as moisture is absorbed by, or evaporated from, a piece of sand-stone.

The friction of Rumford's drill excited in a high degree the molecular motion of the two metals, and this motion was manifested as heat, and by it the water was boiled. The force developed by the horse might at first be deemed the primary one which produced the heat in the cannon, but a little reflection would lead us to see that quite as much water could be boiled by the direct combustion of the provender consumed by the horse during his labor, if this food had been judiciously burned under the water. We must therefore consider the sun as the prime motor, for the provender was simply the result of the energy of the sun's rays, by which the constituents of the hay or grain, the carbon, hydrogen, and the alkaline earths, were converted into vegetable forms suitable for the wants of Rumford's horse.

Although in the manifestation of heat many millions of millions of these atomic vibrations of matter occur in a second of time, science enables us with great probability, if not with absolute certainty, to estimate the rapidity of them in many substances. The phenomena attending the absorption of light by these substances proves that the periods of their vibrations concur or synchronize to a certain extent with the periods of vibration of the waves of light.

We see that the waves of sound will rouse into vibration sonorous bodies whose periods concur with those of the sound waves. Now, a moment's reflection will suffice to show that this can only be done by a loss of force on the part of the sound waves. Let us imagine, for example, the waves of sound of a certain rate of vibration directed against an intercepting screen composed of a great mass of harp-strings, all of the same pitch. If these were in accord with the sound waves they would all be at once roused into vibration. The result would be that the whole force of the sound waves would be expended on, or taken up by, these strings. In such an event none of the waves would be transmitted through the screen. Such a screen might be said then to be opaque to such a note. But to sound waves of a different rate of vibration such a screen would not be opaque; its strings would not be roused into activity; the force of the sound impulses would not be absorbed or taken up by them, and the sound would then be transmitted beyond the screen. Heat and motion are convertible terms. If these strings be thrown into motion, they become warmer than when at rest. Hence when the screen is opaque, the force of the sound waves will increase its heat by rousing the strings into motion. If it do not intercept the sound waves it is because its strings remain at rest; they take up none of the force of the waves, and therefore they are not heated.

Suppose the various sound waves of an orchestra were directed against such a screen as I have described; a person placed beyond the screen, and protected from all waves of sound except such as passed through it, would be unable to hear the particular note to which the harp-strings were attuned, whilst all the others would reach his ear.

If such a screen were composed of three or four sets of strings, each set being differently attuned, then the person so placed would fail to hear the three or four notes in accord with the different sets of strings when such notes were sounded by the orchestra.

Now let us apply this illustration to the phenomena of light.

When the waves of light fall upon a body whose periods of molecular vibration concur with them, the force of the waves is expended in increasing the amplitude of the vibrations of the molecules of the body, just as the waves of sound would throw into vibration such harp-strings as they were in accord with, and hence an increase of heat is developed. Through such a body it is more difficult for those waves to pass whose periods coincide with these vibrations, whilst the other waves not concurring with them, would be less retarded.

This enables us to comprehend why some of the waves of light will pass through certain substances, and maintain their respective periods of vibration and consequent energy beyond them, whilst others are taken up and absorbed by the vibrations of these substances, and therefore can give no evidence of existence beyond such intercepting media.

When a beam of light falls upon a body which absorbs a portion only of those rays which excite vision, the others which pass through will produce the effect of color. When all the rays of light play upon the retina, the sense of white or colorless light is produced. White may be produced also by several pairs of colored lights. Yellow and blue are examples of colored lights which combine to produce white. Such colors are termed *complementary colors*. If instead of blue and yellow *lights* we combine *pigments*, the result is quite different. This would produce green.

The waves of light and the obscure heat rays both pass freely through a crystal of rock-salt, the periods of its molecular vibration being such as scarcely to intercept them at all. Hence rock-salt is said to be transparent to the rays of light and transcalescent to the rays of heat.

Clear glass is only transparent to the rays of light, while to the rays of heat it is nearly opaque. Hence a glass screen placed in front of a fire permits the light rays to pass freely, but intercepts the heat rays. Rock-salt would not be heated sensibly by the passage of either class of rays. The obscure rays of heat arouse molecular vibrations in the screen and are absorbed, and hence persons seated beyond the screen are protected from those rays. The glass becomes heated by absorbing them, but this heat is radiated from it not only in the direction of the rays but in all other directions, so that those behind the glass only receive a small portion of the heat which is radiated.

Ice will transmit very freely the waves of both light and heat through it; and Faraday has even exploded gun-powder in the focus of a lens of ice.

The air we breathe is almost perfectly transparent to the rays of heat and light, but it is quite different with the invisible vapor of water held in suspense in the air. The heat rays are absorbed to a large extent by this vapor, while the rays of light pass freely through it. Hence in climates favored by the sea-breeze, the air is so saturated with moisture that while the light of the sun is undimmed by it, his intense heat rays are to a large extent intercepted. At night when the earth would rapidly radiate the heat received during the day, this vapor interposes a protecting shield again, and prevents the intensely cold nights that would result from this loss of heat. Thus countries over which the trade winds pass have equable climates and experience but little difference in the temperature of night and day. In the elevated regions of high mountains this vapor is condensed by the cold and becomes visible to us in fogs and clouds, and finally falls in the form of mist, rain and snow. The atmosphere, when thus relieved, permits the heat rays to pass through it so freely that they attack the human form with such intensity, even amidst snow and ice in the highest altitudes, that the face and neck are soon blistered when exposed to them, although the mercury in the shade is at the time near the freezing point. Immense volumes of vapor are daily raised from the equatorial regions of the Atlantic by the action of that portion of the heat rays which are not intercepted. Hence the air in those regions is constantly being charged with vapor as it comes from the East deprived of it by the African continent. Being thus charged in its passage across the Atlantic, it is swept over the South American Continent by the action of the earth's rotation, and gives to the countries east of the Andes a delightful climate of great evenness of temperature, in which vegetation, protected by this humid screen from the scorching rays of the sun, is continually reproducing itself in never-ending cycles of marvelous exuberance. Having reached the high and cold ridges of the Andes, the trade winds thus burdened with vapor give up their load at the eastern slopes of the mountains, and the resultant rains fill the channels of the mightiest system of rivers on the earth. On the Pacific slope of the same range of mountains, the rivers are insignificant, and rains are almost unknown; whilst Africa, unblest with vapor-laden breezes to intercept the heat waves which the sun is incessantly sending forth, possesses, in the same latitude, the most terrible climate endured by man.

Iodine, bromine and lamp-black intercept the rays of light, but permit the obscure heat rays to pass freely. This quality is called *diathermancy.* A lens of rock-salt coated so thickly with smoke or carbon as to cut off every ray of light, will yet transmit the heat rays so freely as to create a high degree of temperature in its focus.

Certain substances have the power of reducing the rate of the wave periods of the luminiferous ether. Thus the chemical rays which are too rapid to excite vision, if passed through gla s alloyed with uranium, are reduced in their periods so that they become visible to us as green rays. This phenomenon was demonstrated to you in the beautiful and instructive lecture of Dr. Curtman last January. When these rays fall upon certain substances, disulphate of quinine, for example, the body is made luminous. This is because the vibrations of the atoms of the quinine, being of slower periods, the rays have their periods correspondingly lessened and thus become visible. This phenomenon is called *fluorescence.*

On the other hand, the obscure heat rays may be made visible by concentrating them through a lens upon a refractory substance; the molecular vibrations become so much increased thereby as to produce luminosity. This is called *calorescence.*

If a hollow glass lens be filled with a solution of iodine and placed in the sun, the few rays of light passing through the glass edge of the lens will converge and indicate its focus. Let the lens be fixed, and the location of the focus marked, and when this is done paste around the glass edge of the lens black paper or cloth, so that no ray of light can possibly pass through it. Within the dark shadow of this obscure lens, in its invisible focus, the heat rays will have such power that refractory metals may be raised to whiteness, fusible metals melted, and gunpowder exploded.

Perhaps one of the most marvelous facts connected with this phenomenon is, that while these ethereal billows possess such wonderful dynamic energy that their concentrated impulses can excite the atoms of metals into such violent clashing as to effect a dissolution of their compact masses, they dash harmlessly upon the far more delicate reticulations of the optic nerve, simply because their periods of vibration do not correspond with any of those of the atoms of the nerve tissues.

Doctor Tyndall concentrated the rays from an electric light by a glass lens. and in this beam he interposed, in a glass vessel, a solution of iodine and bisulphide of carbon by which every ray of light was cut off. The heat rays, however, which constituted nine-tenths of the whole beam, passed freely through, and in the dark focus thin plates of tin and zinc were readily fused and brown paper set on fire. Into this focus he fearlessly placed his eye. The heat upon the eyelids was unbearable, and to protect them from it he cut a circular aperture through a card slightly larger than the pupil, and through this opening these powerful rays were actually thrown upon his retina without the least harm. A removal of the iodine would have permitted the concentrated rays of light to have entered the pupil, and the instant destruction of the retina, by its atoms being roused into excessive vibration, would have been the result "Nothing," says this eminent philosopher, "could more forcibly illustrate the special relationship which subsists between the optic nerve and the oscillating periods of luminous bodies. The nerve, like a musical string, responds to the periods with which it is in accordance, while it refuses to be excited by others of vastly greater energy which are not in unison with its own."

I have endeavored to give you, very briefly, an idea of the theory adopted by the most eminent men of the present day, as that which clearly explains the phenomena of light and heat. I have also tried to give you some account of a very few of the wonderful properties possessed by the invisible rays which outline each end of the prismatic colors of the solar spectrum. I will now briefly refer to some of the marvels discovered. by the spectroscope in the variously tinted field comprising the visible portion of the spectrum.

Dr. Wollaston was, I believe, the first to discover that the colors were not continuous from one end of the spectrum to the other, but that the continuity of the tints was interrupted by dark vertical bands which seemingly severed them at several places in the different colors. These dark bands soon attracted the attention of many scientific observers. Frauenhofer devoted so much labor to the mapping of them, and to their description, that they are known as Fraunhofer's lines. In the spectrum their respective positions are invariably the same.

Let us imagine a small circular saw, laid flatwise, and having only six or eight large teeth projecting at intervals from its periphery, and upon these teeth as many prisms placed with their sides vertical and their angles corresponding with the angles of the teeth of the saw, and we will then have the chief feature in the arrangement of a spectroscope.

If a beam of light, admitted through a small vertical slit about one-sixteenth of an inch wide, be caused to fall upon the first prism in the series, it will be bent in its passage through that prism, and its rays will be separated also in consequence of the different lengths of the various waves composing the beam. As these fall upon the second prism they will be still more refracted or bent and still more widely dispersed.

These effects will be increased by each prism of the series through which the beam is successively passed, and in this manner the lines in the spectrum may be spread out with great distinctness for careful investigation. In this way the colors are of course ranged horizontally and not one above the other.

By the arrangement of several prisms as described, the lines have been more accurately studied. Some of these bands are composed of several smaller bands, while others are composed of innumerable dark threads. The amount of labor expended in carefully mapping out these lines, locating them accurately upon charts and measuring their relative distances from each other, and in various other scientific observations of them, is really wonderful. Among these laborers, besides Fraunhofer, are to be named Kirchhoff, Bunsen, Angstrom, Janssen, Lockyer, and several others.

These dark interruptions in the solar spectrum were rightly believed to be caused by rays from the sun, which from some cause failed to reach the earth with an intensity equal to that of the brilliant ones revealed by the vividco ors of the spectrum.

To Kirchhoff belongs the glory of having solved the enigma of these missing rays, and in their solution Science has received a power of analyzing both terrestrial and celestial matter, surpassing in delicacy of test and exceeding in amplitude of research all that the wildest dream of the imagination could have suggested.

It seems incredible that the ingenuity of man should have enabled him to perfect an instrument by which he can detect with absolute certainty, in the slightest dust brushed from his clothes, a trace of metal so minute that one hundred and eighty millions of such particles would weigh but a single grain; and with the self-same instrument analyze with equal certainty the chemical constituents of worlds so infinitely remote in the regions of stellar space, that the human mind utterly fails even to conceive distances so profound.

I will endeavor to explain some of the wonderful revelations of this marvelous instrument, for which we are mainly indebted to Kirchoff.

The spectrum of the electric light exactly resembles that of the sun except that Frauenhofer's lines are absent from it. Incandescent metals produce continuous spectra like the electric lamp, but the *vapors* of such metals do not create continuous spectra. They simply produce one or more independent bright lines.

By so arranging a prism that a beam of sunlight was passed through its upper end, and a beam from an electric lamp through its lower end, Kirchhoff produced the two spectra upon the same screen, the one immediately above the other; the location of the colors in both exactly coinciding. He then brought the vapor of burning sodium in the path of the electric beam, and immediately a bright yellow line was seen in the electric spectrum exactly coinciding in position with the dark D line of Frauenhofer in the solar spectrum. (This line is located between the orange and the yellow, and it has since been found to be composed of two distinct bands.)

When magnesium, iron, calcium, and several other metals, were burned separately, each one marked the electric spectrum with differently located threads of bright light, exactly corresponding in position with dark threads in the solar spectrum. Some of these threads were located in one color of the spectrum and some in others. Some of the metals produced several threads of light in two or three colors, as for instance iron, which has always several threads in the green and two in the violet. When the beam was passed through the vapor of several different metals at the same moment, no confusion occurred, but the lines of each metal were distinctly visible and each in its appropriate place in the spectrum. This discovery established the fact that there was a direct connection between the causes which produced these threads in the solar spectrum and those which caused them to appear at the will of the experimenter in the spectrum of the electric light. But in the one they appeared as dark lines, and in the other as bright ones. Here was a discrepancy that had to be explained before it could be asserted positively that the dark D line, for instance, in the solar spectrum was produced by incandescent sodium in the sun, just as the same bright line was caused in the electric spectrum by the vapor of burning sodium.

I explained that the waves of light are absorbed with great energy by matter whose periods of molecular vibration concur with the periods of the ethereal waves. A body therefore absorbs with special facility such rays as it can itself emit. If we bear in mind that the energy of the vibrations of matter generally affect only their amplitude, and not their rapidity, we will see that incandescent sodium will emit rays whose periods of vibration are the same as those emitted by the gaseous flames of sodium, and that if the rays of incandescent sodium be transmitted through sodium vapor, they must be absorbed by the vapor.

This remarkable fact was demonstrated by Kirchhoff by interposing the vapor of burning sodium in the spectrum of incandescent sodium, by which the bright D lines became at once black.

The inference is therefore unavoidable that the nucleus of the sun is composed of certain incandescent metals, some of the rays from which are absorbed by the gaseous products of the same metals surrounding the sun.

If they could come to us without being intercepted, the solar spectrum would appear uninterrupted by these dark lines. These absent rays are absorbed by the vapors of the different metals which emit the rays, and we have in their stead only the fainter rays emitted by these different vapors themselves. These really produce bright lines also, but they appear dark in the spectrum because of the presence of the more intensely brilliant ones which reach us without interception from the nucleus of the sun.

The fact that the rays from an incandescent metal are absorbed with great energy by the vapor of the same metal, seems to be an additional proof that the periods of vibration of the atoms of the metal, and those of the vapor are not altered in rapidity by the change from the incandescent to the vaporous form, but only in amplitude of vibration.

Roscoe tells us that the spectroscope has shown that common salt or chloride of sodium is the most widely disseminated substance known in the world. The mist raised from the agitated surface of the ocean by the winds is carried up into the aërial regions; the watery portions are soon evaporated and the infinitely minute particles of salt are left suspended in the air, and by it are borne over the most distant regions of the earth. (This action of the winds must not be confounded with the *evaporation* caused by the sun, for this does not carry up the salt.) These salt atoms seem constantly present in dust, and Roscoe asserts that a book laying for two hours on a table will collect sufficient to be detected by a spectroscope, if the dust be brushed off and burned in the light of the instrument. The one hundred and eighty millionth part of a grain thus burned will produce visibly the bright yellow D line of the spectrum!

To detect the suspected presence of a metal or earth in any substance under analysis, two separate beams are used to produce two different spectra, one being by an arrangement of the spectroscope, shown immediately above the other. If the presence of copper, for example, is suspected in the substance to be examined, a piece of copper is burned, and a piece of the substance to be analyzed also. The vapor from each is brought into the paths of each of the beams of light at the same moment, The characteristic green lines of copper will appear at once in the one spectrum; and if copper be present, in the minutest quantity, in the sub tance to be examined, the other spectrum will be marked with lines identically the same in color, position, and number; if it be absent, these lines cannot possibly be produced. The spectra are viewed through the telescope forming part of the instrument, and by it they are magnified and are thus thrown upon the retina.

Bunsen in 1860, having occasion to examine the alkaline earths contained in the waters of two springs at Dürkheim, observed that their vapor gave certain bright lines in the spectrum never before observed, and he at once argued that they must have been caused by the presence of some unknown metals.

Acting upon this idea, this eminent chemist evaporated forty-four tons of the water, and obtained from it two hundred grains of the new metals, Cæsium and Rubidium. Cæsium produces two beautiful blue lines in the spectrum, and Rubidium, as its name implies, two bright red ones. It is found in many vegetables, especially in tobacco, and in beets, and also in certain minerals.

More recently, Mr. Crooks, in England, discovered by the spectroscope another new metal, Thallium. This metal produces a bright green line in the spectrum. Another new metal, Indium, has since been similarly discovered. It produces a bright blue line.

The various gases yield, by the spectroscope, lines equally as characteristic as the metals and alkaline earths. Hydrogen, for instance, gives one line of red, another of blue, and one of indigo.

The location of the various lines of all spectra are very nearly indicated by their colors. Thus the blue lines will appear in that part of the electric spectrum occupied by the blue color, the yellow lines in the yellow part, and so on of the others.

In the manufacture of Bessemer steel, the spectroscope is used to examine the vapors emitted by the converter in which the molten metal is being decarburized. By it the presence of various substances in combination with the iron are detected. By the Bessemer process five tons of pig iron in the converter are made into steel in twenty minutes. The carbon in the iron is completely burned out by the oxygen of the atmosphere which is driven in a blast through the molten mass. The heat thus generated is intense, but quickly subsides after the carbon is consumed, and it is of great importance that the blast be then immediately stopped. If this be delayed ten seconds the mass becomes so viscid that it cannot be poured from the converter. If the blast be stopped too soon, the metal will crumble like cast iron when it is under the hammer. The spectroscope reveals the moment when the carbon lines disappear from the spectrum, and thus furnishes an exact scientific admonition, where the quickness of vision was previously the sole dependence for success. When all of the carbon is burned out, the exact quantity requisite for the quality of steel desired is immediately returned into the converter by pouring in a certain amount of molten spiegeleisen (*specular iron*), the percentage of carbon in which is definitely known. It is necessary to burn all of the carbon out of the iron first, as it contains too much for making steel, and it is impracticable to know when exactly enough has been consumed. Hence, all must be removed so as to enable the steel maker to introduce the exact percentage required.

By the spectroscope we are enabled to declare with absolute certainty that several constituents of the sun, the planets, and the fixed stars, are identical with those composing our earth. It has also established the fact of the gaseous constitution of the nebulæ and comets, and has supplied us with a knowledge of celestial chemistry, such as the most ardent enthusiast would scarcely have dared to anticipate. In it we have a realization of the poet's dream—

> "What skillful limner e'er would choose
> To paint the rainbow's varying hues,
> Unless to mortal it were given
> To dip his brush in dyes of heaven."

With his celestial pencils charged with the glowing tints of heaven, the scientific artist now creates the perfect rainbow at his will; nay, more, with skillful eye he scans its wonderous texture, and reads, amidst its blending shades, the sublime story of the constellations. Thus does Science unfold her bow of promise to mankind. One that is rich in the assurance of still grander truths ere long to be revealed.

Following step by step the sequences of cosmical phenomena, science leads the human mind continually to the confines of that profound void within which rests the apparently insoluble problems of creation. The spectroscope, surpassing the romantic marvels of the lamp of Aladdin, illuminates her pathway within this mysterious region, and, guided by its wonderful revelations, she leads us onward in search of the priceless truths so coveted by adventuring human wisdom.

Amidst prismatic hues she traces out the mysterious language of the spheres, and points us not unhopefully to those yet unsolved enigmas which seemingly transcend all reach of human intellect. Can she explore the dim "recess of wisdom and of wit," and tell us of the secret and material springs from whence immortal thought is born? Can she unravel the miracle of life, or penetrate the profound silence which infolds the genesis of force and matter? Who that is enrolled in membership of our infant Institution shall win for himself eternal fame, by pointing the way through one of these unexplored and awful mysteries?

Dr. J. B. Johnson announced that he had recently learned, in conversation with a gentleman, that the latter had it in his mind to give a lot of ground to the Historical Society, knowing that it was necessary that the Society should have a place for their papers, documents and other valuable contributions that might be made to them. He had asked him if he would have any objection to allowing the Academy to assist the Historical Society in putting up the building, and he said he would be very glad to give a lot of 50 by 109 feet deep in the central part of the city, providing the Historical Society and the Academy of Science would erect a building upon it. Dr. Johnson added that it was likely that a gift of twelve or fifteen thousand dollars might be bestowed upon the Academy, and suggested the appointment of a committee with authority to act upon the subject.

On motion, Dr. J. B. Johnson was appointed such committee.

The Corresponding Secretary reported that he had deposited the exchanges received in the Library.

Prof. Hager read a paper on "Petroleum, its History, Geological Position and Probable Origin." Referred to the Committee on Publication.

February 5, 1872.

The President in the chair.

Twelve members present.

Dr. Charles O. Curtman made a communication on "Light in vacuo."

After a few introductory remarks on the close relation of the different dynamical agents to each other, and the production at will of any mode of motion from the others, the subject of light was briefly discussed. Its compound nature, marvelous velocity in traversing space, and still more wonderful quickness and minuteness of oscillation. Then the solar spectrum was explained and compared with that derived from various terrestrial sources, especially that of electric light. The visible part of the spectrum, consisting of various degrees of refrangibility, color, wave, length, and velocity, was shown to be accompanied by invisible spectra of rays called respectively *calorescent*, which exist beyond the least refrangible red, and *fluorescent*, beyond the most refrangible violet. Modes were pointed out for making visible those rays which, under ordinary circumstances, do not affect our eye, and which must be brought to oscillate synchronously with the visible rays before being seen as variously colored light. The electric light being very rich in fluorescent rays is well adapted for experimenting with them, being so easily controlled by the operator.

A number of experiments were then made, illustrating the foregoing remarks. The electro-magnetic force was applied to the production of mechanical motion in various ways. By means of the Ruhmkorf's Induction apparatus, long and powerful sparks were at first transmitted in open air. Afterwards, through tubes of several feet in length, exhausted of air by means of a large air-pump, they were shown to increase amazingly in length and in brilliancy of color. The tube was filled with turpentine vapor instead of air and again exhausted, when the light lost most of its red rays and became almost white, and stratification of alternate luminous and dark portions was plainly visible. Afterwards, a number of tubes were exhibited, which had been previously prepared by filling them with various gases and vapors, and after almost complete exhaustion, had been permanently sealed, the communication with the interior space being effected by platinum and aluminum wires—*Gessler tubes*. Into these tubes were also introduced pieces of Uranium glass, or they were surrounded by glass capsules filled with various fluorescent solutions, so as to exhibit the different phenomena of fluorescence. Others contained some of Becquerel's phosphorescent sulphides, which continued to emit colored light after cessation of the primary illumination. The remarkable difference between the luminous appearances at the positive and negative poles was rendered strikingly distinct by various tubes and by changing the direction of the electric current. Tubes with diaphragm in centre, having both ends filled with different gases, showed the currents inflected upon themselves with the negative halo at both terminals. An electro-motory apparatus was then supplied with tubes and connected with the batteries, one for propulsion, the other for illuminating the tubes, when beautiful figures of revolving light shone with great brilliancy of tints Some tubes filled with oxygen had by repeated use permitted the oxygen to combine with the metal of the electrodes and become so vacuous that even the strongest battery power was unable to force a passage and illuminate the tube, showing that the presence of matter is necessary for the transit of the oscillations of the forces of light and electricity.

Prof. W. B. Potter, Messrs. E O. Schwägerl, John H. Terry, James Player, Ira Terry, H. M. Thompson, J. B. Carson, W. C. Glasgow, E. F. Aehle, and Dr. Walter Coles, were elected associate members.

February 19, 1872.

Dr. ENGELMANN, Vice-President, in the chair.

Twenty-nine members present.

Correspondence and exchanges received were reported by the Corresponding Secretary.

Dr. Wislizenus read an abstract of his observations on Atmospheric Electricity during the past year, and compared the results for the year with the average of the past ten years as observed by him.

On motion of Mr. Conant, a committee, consisting of Messrs. Reber, Riley, and Green, was appointed by the chair to take into consideration a thorough revision of the Constitution and By-Laws of the Academy.

Col. Henry Pomeroy, Messrs. J. R. Meeker, W. H. Pulsifer, J. K. Cummings, Hon. Henry T. Blow, Colonel Cook, and Messrs. R. B. Bonner, and Gerard B. Allen, were elected associate members.

March 4, 1872.

The President in the chair.

Seventeen members present.

The Auditing Committee reported that they had examined the accounts of the Treasurer for the last year and found them correct, and their report was approved.

Exchanges received were laid upon the table.

The Corresponding Secretary laid before the Academy a communication from Dr. G. A. Maack, of the Museum of Comparative Zoölogy at Cambridge, Mass., asking for the loan of certain specimens of fossil mammalia in the possession of the Academy, with permission to make casts of them.

Dr. Engelmann stated that the specimens referred to had been destroyed in the late fire, with the exception of one choice specimen of the skull of *Bos cavifrons*, which the Secretary was instructed to place at the service of the Cambridge Museum.

Mr. C. V. Riley presented for publication a paper by the late Benjamin D. Walsh, deceased State Entomologist of Illinois, entitled "Descriptions of North American Hymenoptera." He paid a feeling tribute to the author, and stated that as Mr. Walsh's associate in the publication of the *American Entomologist*, sundry manuscripts had been sent to him in the summer of 1870 by Mr. Wm. B. Pettit, who had charge of Mrs. Walsh's affairs. These manuscripts were forwarded to Mr. E. T. Cresson, to be deposited in the archives of the American Entomological Society, of which he was then secretary. Among them, these descriptions of Hymenoptera were found ready for publication, and, by request, Mr. Cresson, who makes a specialty of this Order of insects, consented to edit the paper, and let it be published in the West. He stated that it was written on both sides of the sheets, and from numerous interpolations and additions, was evidently intended to be copied; but Mr. Walsh's writing was so peculiarly distinct and careful, that the printer would have no difficulty in following it; and he believed the paper would form a valuable addition to the Transactions as it was to American Hymenopterology.

Referred to the Committee on Publication.

Dr. Engelmann presented twigs of a new Pine, showing blossoms and young cones. This new species had actually been discovered in South Carolina, which had been so thoroughly explored by botanists. The celebrated botanist of South Carolina, Mr. S. Elliott, was evidently aware of its occurrence, but does not seem to have been certain as to its distinctive character. Dr. Engelmann proposed to name it *Pinus Elliottii*. It grows along the coast under the influence of a saline atmosphere. The wood is valuable for timber, and is used there. The tree is remarkable for its long coarse leaves, which occur in 2s and in 3s, and for germinating the same fall that the seed ripens. In some respects it resembles the Long-leaved Pine of the South, and still more the Maritime Pine of southern Europe (*P. Pinaster*), and seems to be confined to South Carolina, and perhaps Georgia and Florida. He explained the character of the pollen in pines generally, and how fertilization takes place mostly by the agency of the wind, and illustrated the hygrometric nature of the mature cones.

Prof. R. Pumpelly, Chancellor W. G. Eliot, Prof. M. S. Snow, and Messrs. John B. Thompson, B. V. B. Dixon, R. J. Rombauer, Geo. W. Belcher, and M. L. Harter, were elected associate members.

March 18, 1872.

The President in the chair.

Nineteen members present.

Dr. Briggs presented some fine specimens of gold-bearing quartz from California.

Mr. Edwin Harrison donated a large photograph likeness of Prof. Louis Agassiz.

Dr. Wislizenus reported an abstract of his Meteorological Observations for the last three months:

The winter had been remarkable for its steady cold weather, yet the thermometer had at no time sunk below 3° below zero; while in previous years, it had been observed to fall 20° and 22° below zero. It had been peculiar for its extreme drought. The following table shows the temperature and rainfall for December, January and February, compared with the average for the last 30 years:

TEMPERATURE.—	December, 1871	29.0° F.	Average	33.8°
	January, 1872	27.1	"	32.4
	February, 1872	31.4	"	35.3
	Average	29.2		33.8

RAINFALL.—	December, 1871	1.12 inches.	Average	3.16 inches.
	January, 1872	1.15 "	"	2.14 "
	February, 1872	2.02 "	"	2.66 "
	Total	4.29		7.96

Messrs. H. E. Paulin, Louis F. Soldan, Hugh McKittrick, and Enos Clark, Esq., were elected associate members.

April 1, 1872.

ALBERT TODD, Esq., Vice-President, in the chair.

Thirteen members present

Exchanges received were laid upon the table.

Mr. A. D. Hager, State Geologist of Missouri, read a paper on "Fish Culture; its History; Peculiarities of the Salmon and Trout, and Artificial Propagation." Referred to the Committee on Publication.

Mr. C. V. Riley inquired of Mr. Hager if he knew anything of the little web-worm which made what is known as the death-web of young trout, and which was supposed by Mr. Seth Green, of Mumford, to be one of the worst obstacles to trout-breeding. The worm is the larva of a species of Buffalo gnat (*Simulium*), and he had named it *Simulium piscicidum*. Mr. Riley gave an account of its singular transformations, and showed how it spun its web. The young trout were said to get entangled by thousands in this web, and thus die; but there was difference of opinion as to whether the worm really had anything to do with the death of the young fish. Prof. Hager answered that he had never been troubled with anything of the kind.

Mr. Richard Hayes made a statement with regard to the recent hurricane at St. Louis as follows:

In regard to the tornado which occurred on the night of March 30th, last, he stated, that on the next day he commenced at Seventh street to trace it towards the west, by keeping as near as he could on the southern edge of its path, and following it as far to the westward as any trace of its violence could be seen; and on returning, he traced the northern edge as far as possible to the eastward, so that by means of field notes taken at the various points, he was enabled to describe its exact limits, and the various phenomena within them. Beginning the description on Grand avenue, at the head of Lafayette avenue, where the force of the wind was only strong enough to break down the weakest fences and a few decayed trees, not much violence was indicated until, in its course, it reached as far to the east as Toney street. Here it crossed Park avenue, and became more violent. On the south side of Park avenue, the west chimney of a house was blown off in such a manner as to fall northwardly, notwithstanding its largest dimension was from north to south, thus indicating the whirling motion of the wind. On the north side of the avenue were several houses whose chimneys and walls had been injured. Further eastward on Carolina street, the houses suffered more or less, and on reaching Missouri avenue, he found three houses with their eastern gable walls blown eastward, and two of them had their west walls blown westward. There were no chimneys projecting from these walls, so as to expose a large surface to the action of the wind. Pursuing the same general course, its northern edge crossed Chouteau avenue just west of Mississippi avenue, and its southern edge crossed it at Grattan street. At Tayon avenue its width extended from Singleton street to Chouteau avenue. This was its widest part. It crossed Fourteenth street at the Pacific Railroad. On Randolph street, house No. 1309 had its west end partially thrown down, although the next house west of it is not more than four or five feet distant, and rises ten or twelve feet above it, thus completely sheltering it from the progressive motion of the wind. When it reached the market on Seventh street, it took off the northern half of its roof on the western side, and carried a large part of it across the street, demolishing some of the houses on the eastern side. Here it was where the principal injury to human life occurred, as the market was thronged with people at the time. Here, too, it seemed to have spent its violence, though its track was distinctly marked till it reached the river near the foot of Market street.

In East St. Louis, it took off a small part of the roof of the Elevator, also destroying the circular engine-house of the Vandalia Railroad, the walls of which were thrown outward, except a small portion of the western side. Further on, it lifted a small two-story frame house from its foundation, carrying it about three feet to the northeast. After this, but few signs of its violence were visible.

Throughout the entire length of its course, the northern edge was sharply defined and perfectly straight, having a bearing of N. $73\frac{1}{2}°$ E. The southern edge was not so well defined, and was somewhat irregular. The width of its path was from 500 to 800 feet. Its violence seemed to be most intense in low grounds, where its path also became narrower than on the higher lands. Its circular motion, as indicated by the position of the debris, was opposite to that of the hands of a watch placed upon its back. It crossed four railroad tracks, each at an angle of 22°, without being in the least deflected by them. It also passed numerous telegraph wires at various angles, without any apparent change of its course.

Prof. C. M. Woodward, N. DeVere Howard, M.D., and Mr. Henry K. Foster, were elected associate members.

April 15, 1872.

Vice-President Albert Todd in the chair.

Nine members present.

Dr. Englemann noticed the statement of Mr. Hayes at the last meeting, that the course of the tornado was not changed or in any way affected in crossing the railroad tracks. It had been supposed by some that railroads had some influence on storms by conducting the electricity. But the soil itself was a perfect conductor of electricity, and this fact should be borne in mind. He had himself observed in the past that these hurricanes were always most severe in the lowest places, and he cited Millcreek Valley as an example. They passed over the country in the form of a whirling inverted cone, and the lower part of the cone had the greatest force.

Mr. Joseph Shippen was elected an associate member.

May 6, 1872.

Dr. Engelmann, Vice-President, in the chair.

Eleven members present.

Publications received were laid upon the table.

Mr. C. V. Riley presented to the Academy a copy of his fourth annual report on the Insects of Missouri.

Mr. Riley stated that he had in his possession a specimen of Menobranchus, taken from a water-pipe in the city, which he would turn over to the Academy whenever it could be properly cared for.

Dr. Engelmann remarked that there were several species of these animals known in this country, but only one species known in Europe. They belonged to the lowest order of reptiles, and were the only actual amphibia endowed with lungs as well as gills, which are classed among the lowest batrachia approaching the fishes. We have at least two distinct animals of this nature here in our waters: one is the Menobranchus which lives in our river and is occasionally discovered in the water-pipes of the city; the other and the smaller is the two-footed siren found in the lakes and rivers. Two others, the Salamandrops and Amphiuma, are found in the United States. A fifth one, the Axoltel, is found in the lakes of Mexico; while a single one, the Proteus, lives in the subterranean waters of Austria. Four allied forms live in the tropical regions of South America and in Africa. It is a singular fact that these ten almost embryonic animals constitute, as now understood, ten monotypic genera.

Mr. Hager presented a piece of oak-wood from Frederick, County, Me., stained with green, and stated that it was taken from a live and apparently healthy tree, and that the ashes from such wood (of which he exhibited samples), when made into lye or soap, stained the clothes yellow.

Dr. Engelmann thought the stain must be produced by a mineral substance, and most probably by iron.

Dr. Johnson said he believed that trees, like animals, had the power of appropriating or of assimilating different substances.

Dr. Engelmann objected to the term *assimilate*, and stated that whenever plants do not elaborate their fluids by the ordinary means, a simple mechanical mixture takes place.

Mr. Mallinckrodt undertook to analyze the coloring material of the wood presented.

May 20, 1872.

The President in the chair.

Seventeen members present.

The Committee on the Constitution made their report, and were discharged.

The amended Constitution, as reported, was then taken up, discussed, and adopted by sections.

The Committee on Publication reported that a sufficient number of papers had been referred to them, or were now being prepared, to make a number of the Transactions of about 300 pages, illustrated by some ten or twelve plates, and that they were ready to commence printing as soon as the Academy should place the necessary funds at their disposal. They found that the expense of such a number would be from $1,600 to $2,000, according to the number of copies printed. It was thought 1,100 or 1,200 copies would be enough. It was recommended that it should contain the revised Constitution, an abstract of the history of the Academy, and a complete list of members. It was further suggested that a subscription paper should be circulated for subscriptions in aid of the funds in the treasury.

The report was accepted, and the matter of the size and number of copies to be printed was left to the determination of the committee.

On motion, Dr. C. E. Briggs and Mr. R. Hayes were added to the Board of Curators.

Dr. Engelmann exhibited a living specimen of the Black Spruce (*Abies nigra*) fresh from the Adirondacks of New York, infected with a diminutive parasite of the mistletoe family, which he had named *Arceuthobium minutum*. All the species of this genus inhabit Conifers. One occurs on Junipers in the Mediterranean and Caucasus regions of the old world. A second was found by Humboldt on Pines on the highest mountains of Mexico; and several more have been found since on our Rocky Mountains and westward, mostly also on Pines. The peculiarity of this species, discovered about the same time last summer, by two different persons in different parts of the State of New York, besides its spring flowering (all the others being autumnal), consists in the occurrence of the sexes in distinct colonies in different trees, male and female plants never, thus far, having been found together on the same trees; and in the great abundance of individuals on these trees, where the flowering plants almost always occupy the three year old branchlets, while the two year old ones exhibit germinating plantlets like small knots. The necessary inference is that these parasites are propagated, or we should rather say multiplied, by stolon-like fibres, almost analogous to the mycelium of Fungi, spreading under the bark of the growing branches and always from the older to the younger ones, rather than by seeds, which, though abundant enough, could not produce such a copious and regular crop, and invariably of one or the other sex only. Dr. Engelmann had been elaborating a monograph of this curious genus, which he would offer to the Academy for publication.

Mr. Lucius H. Cheney was elected an associate member.

June 3, 1872.

Vice-President Albert Todd in the chair.

Fourteen members present.

Dr. J. B. Johnson made a report concerning the lot of ground which had been offered to the Academy in conjunction with the Historical Society, on condition that the two societies would erect a suitable building thereon. He introduced Capt. Silas Bent and Genl. N. Ranney, from the Committee appointed by the Historical Society, who were present to confer upon the subject.

Genl. Ranney, being invited to address the Academy upon the matter, in the course of his remarks, announced that our fellow-citizen, James H. Lucas, Esq., was the donor of this liberal gift, and paid a fitting tribute to his generosity.

A committee, consisting of Dr. J. B. Johnson and Albert Todd and C. C. Whittelsey, Esqs., was appointed to tender to Mr. Lucas the thanks of the Society for his liberal offer, and to accept the lot on the conditions mentioned.

Dr. Engelmann exhibited specimens of an evergreen fern (*Polypodium incanum*), which grows in the south and even in the woods around Cairo, mostly on the bark of trees, but does not reach as far north as St. Louis. It has the property of shriveling up and apparently dying, but opens again when moistened. These pseudo-parasitic plants, unlike the true parasites, do not absorb nourishment from the plants to which they fasten, but live on whatever collects in the crevices of the bark, etc.

Mr. C. V. Riley exhibited some large and handsome specimens of a Japanese silkworm, (*Antheræa yama-maï*) reared from eggs imported from Japan. Of all the species of silk-producing insects that have been experimented with here, or in Europe, during the last few years, as substitutes for the Mulberry silk-worm, which has been so badly attacked by an epidemic, he said this one gave the greatest promise. It was a large green worm, with silvery spots, and feeds on the leaves of different oaks. The cocoons were as large as a small hen's egg, and the silk was valuable, strong and lustrous, and was much used in Japan. He had had very good success in feeding them this year.

Mr. Riley also exhibited specimens of wild sage (*Artemisia tridentata*) from Utah, handed him by Dr. Engelmann. They were peculiar from the fact that there were three distinct galls growing from them. As the plant was rare, these galls were doubtless undescribed.

Mr. Mallinckrodt reported that he had analyzed the green oak-wood presented at a former meeting by Prof. Hager, and found in the ashes a large percentage of iron ; and he believed the green appearance to be produced by tannate of iron, as the only acid that could be in the wood was tannic acid. There was also found in the ashes carbonate of lime, carbonate of potassa, and traces of soda, magnesia, manganese and silicic acid. The tannic acid, in combination with the iron, would produce the green color.

Mr. Richard Hayes read a paper giving a list of the Earthquakes mentioned as occurring during the year 1871, on 151 different days. Referred to the Committee on Publication.

June 17, 1872.

ALBERT TODD, Esq., Vice-President, in the chair.

Eight members present.

Dr. J. B. Johnson, from the committee appointed at a former meeting in relation to Mr. Lucas' donation of a lot of ground to the two societies mentioned, presented a deed therefor duly executed.

On motion of the Hon. Samuel Reber, the following resolutions were unanimously adopted:

"WHEREAS, The Hon. James H. Lucas, and Marie, his wife, have generously donated to the Missouri Historical Society and the Academy of Science of St. Louis a lot of ground, on the south side of Locust street, in block 515, of the city of St. Louis, by deed dated June 8, 1872: Now, be it

"*Resolved*, That the profound thanks of this Society be, and are, hereby tendered to the Hon. James H. Lucas and his wife for their noble donation to this Society.

"*Second*, That the President is hereby authorized and directed to subscribe his name to such deed, as such President, in proof of the grateful acceptance of said gift by the St. Louis Academy of Science."

A committee of five, consisting of Dr. Engelmann, Judge Reber, Mr. Riley, Dr. Johnson, and Dr. Forbes, was appointed to confer with the Committee of the Historical Society for the purpose of getting subscriptions for a building and obtaining plans and estimates.

Mr. M. L. Gray informed the Academy that the late Dr. B. F. Shumard's collection was now offered for sale in St. Louis, and, on his motion, a committee, consisting of Drs. McPheeters and Engelmann and Mr. Malinckrodt, was appointed to effect a purchase, if possible, for the Academy of Science.

September 2, 1872.

Dr. ENGELMANN, Vice-President, in the chair.

Mr. C. V. Riley read a paper for publication, entitled "On a new genus in the Lepidopterous Family, *Tineidæ*, with Remarks on the Fertilization of Yucca." Referred to the Committee on Publication.

The Secretary presented to the Academy, on behalf of Mr. Edwin Harrison, a life-size photograph of the late Dr. Benjamin F. Shumard.

September 16, 1872.

ALBERT TODD, Esq., Vice-President, in the chair.

Fourteen members present.

The Corresponding Secretary reported exchanges received and deposited in the Library.

Letters were read from the Mercantile Library of Baltimore, and from the Illinois Museum and Library, asking for copies of the Transactions of the Academy, and were referred to the Librarian to be complied with as far as practicable.

Dr Engelmann read a communication from Mr. G. C. Broadhead, of the State Geological Survey, concerning ancient mounds and circumvallations discovered in the County of Saline, Missouri. He stated that when recently at Miami, he had visited an interesting locality four miles southward of that place, where he observed an ancient walled fortification on high ground in a dense wood. It was about a quarter of a mile in diameter, somewhat circular, but varying with the ravines making from the hill, and becoming re-entrant at such places. Around this space extended a double wall and a double ditch, with a flattened ridge on either side, showing in the cross section, first, a low ridge 10 feet wide and 1½ feet high; then a depression 10 feet wide and 3 feet deep; then a ridge 8 feet wide and 3 feet high; and then a depression 6 feet wide and 3 feet deep, rising into another ridge 8 feet wide and 3 feet high. The two last mentioned ridges extended entirely around the included area, and were built wholly of earth taken from the ditches. No rock was seen near. Black-oak trees three to five feet in diameter were growing over the walls, ditches, and inner area, and the whole surface was covered with a dense growth of luxuriant bushes, vines, and trees. The ridges had evidently been originally much higher, and the ditches deeper. The hill faced the eastern edge of the Petite Osage Plains. On the neighboring fields, human bones, spear heads, and remnants of pottery, had been plowed up, and he had, himself, picked up arrow-heads and spear-heads of flint in the same neighborhood.

Dr. W. M. McPheeters presented specimens of petrified wood of the stumps of trees found thirty miles northwest of Pike's Peak, and a quantity of ores and fossils brought from Colorado Territory by the Rev. Dr. Forman.

Dr. McPheeters doubted the correctness of the theory of the formation of such petrifactions of wood, by the substitution of mineral substance in place of the decayed tissues. He thought that an incrustation would be formed in such manner as to prevent decay, and that some other theory must be resorted to for an explanation of the phenomenon.

Dr. Engelmann accounted for it by supposing a submergence and a subsequent upheaval of the land, many such trees showing evidence of having been submerged.

Dr. Engelmann exhibited a plant of the genus Yucca, familiarly known as Adam's needle and Spanish bayonet. He had discovered the mode of its fertilization, and gave an abstract of a paper on the subject which he desired to present to the Academy. The paper was referred to the Committee on Publication.

November 18, 1872.

Vice-President Albert Todd in the chair.

Seventeen members present.

Dr. Engelmann said he wished to make some statements with reference to the fossil-wood presented to the Society at its last meeting. He had submitted it to several tests, and had found it perfectly fire-proof, and chemical tests proved the fibres to be silex. He would further state that some of those present thought the wood could not be petrified as some of it was rotten, and crushed under the fingers. The wood was rotten, and its structure in a measure destroyed. It felt like a fine, mealy powder; nevertheless it did not change in the red heat. The sound wood, as well as the rotten material, was changed into silex. The sound wood showed the structure to be coniferous, distinct from our pine wood and more allied to the California red wood. It is an interesting fact that these trees are found in great abundance in the fossil state, not only in America but over both northern continents. He thought that most probably this fossil-wood belonged to the Tertiary geological period.

Dr. Engelmann said he understood it was the intention to have a joint meeting of the Academy of Science and the Historical Society, to take into consideration the propriety and means of erecting a four-story building for the joint use of the two societies. He saw but few members of the Historical Society present, and he supposed they had not been informed in regard to the meeting.

President Todd said several members of the Historical Society had met at the time appointed, but there were not enough present to form a quorum. He was sure the Historical Society was desirous of meeting with them, and that if any action was resolved upon, and they notified, there would doubtless be no difficulty about a joint meeting.

December 2, 1872.

Pursuant to notice, a joint meeting of the members of the Academy of Science and of the Missouri Historical Society was held on this evening, at which some twenty-five members of the two societies were present, and John H. Terry, Esq., was called to the chair.

After some discussion in relation to the best mode of raising funds for the erection of a suitable building upon the lot of ground recently donated to the two societies, and procuring plans for such building, the following resolution offered by W. H. H. Russel was adopted:

Resolved, That the present joint building committee be continued, and are hereby empowered to devise, select and report thereon at the next first meeting of the two societies, and that said report be submitted in writing, and that said committee be allowed further time to report.

S. B. Johnson, Silas Bent, and Albert Todd, on the part of the Historical Society, and Dr. McPheeters, Mr. Lynch, and Enno Sander, on the part of the Academy of Science, were appointed a Finance Committee to solicit subscriptions.

December 16, 1872.

Mr. J. R. Meeker in the chair.

Mr. C. V. Riley presented for the museum a well-preserved skin of a rattlesnake, measuring over six feet in length, and having twenty-eight rattles. He observed that the statement was recently made in *Chambers' Journal* that the poison of the rattlesnake was pressed from a gland, or sac, in the gum, at the base of the fangs, and ran down the outside of the tooth, and not, as was generally believed, through a channel in the centre of the tooth. He did not attach any weight to the statement.

The rattles of the rattlesnake had been a stumbling-block to the Darwinians, as it is generally taken for granted that they must prove a serious detriment to the snake by frightening away any prey that might come within hearing. The theories lately put forth by Prof. N. S. Shaler and J. G. Henderson, in the "American Naturalist," give us, however, a different impression on this subject. It is there held that the rattle serves as a lure to birds, who mistake the noise for the drumming of the *Cicada*. This would be an explanation, perhaps, satisfactory to some; but there is added another and more natural explanation of the rattle. It is this: that since the rattle is never resorted to except when the snake is greatly agitated, the vibrations of the tail are then intended to serve as a dread alarm-note to strike terror to the heart of an assailant, who may be, and frequently is, immensely stronger than the snake, and could crush it at a blow. The dread of the bite of the snake serves as a powerful curb upon the enemy, and many animals which, on the first impulse, would run at and kill it, are deterred by the fear of the terrible bite, the effect of which they know by instinct. Again, should these views prove unsatisfactory, that proposed by Mr. F. W. Putnam, at a late meeting of the Essex Institute, viz: that the rattle serves to call the sexes together, would still prove its advantages to the snake. The best antidote against the bite consisted in large doses of whisky.

Mr. Riley also exhibited a small worm, an inch in length, and of the thickness of a sewing-needle, which was coughed up from the lungs of a patient of Dr. Clemens, of this city, from whom he had received it. From the double-segmented appearance of the abdominal joints, being apparently twenty-jointed, it was evidently the larva of some species of *Scenopinus*, a two-winged fly, something like the common cheese-fly. These larvæ usually live on decaying animal and vegetable matter. The lung must have been far advanced in decomposition to allow the larva to flourish and come to full growth within it.

A communication was received announcing the death of Dr. M. L. Harter, an associate member of the Academy.

Messrs. J. F. Wielandy, C. A. Frederickson, Adolph Schmidt, William E. Guy, W. R. Hodges, S. T. Rowley, Charles E. Mitchell, P. G. Robinson, and Rev. Charles Peabody, were elected associate members.

January 6, 1873.

The President in the chair.

Twenty-five members present.

Minutes of previous meeting read and approved.

The Corresponding Secretary reported the receipt of a number of exchanges which were properly catalogued by him. He also announced the application on the part of the Illinois Museum of Natural History, and of the Baltimore Academy of Science, for copies of our Proceedings. On motion, he was instructed to grant copies to the Societies mentioned, and to the Recording Secretary.

Dr. Engelmann communicated the following meteorologica observations:

Though our present winter commenced pretty early (on November 20th the thermometer indicated 9°, and on November 30th 2°), and the first three weeks of December were colder than common, we were scarcely prepared for such a severe spell of cold weather as came over us from Friday, December 20th, till Saturday, December 28th. From Saturday evening until the following Friday morning the temperature sank every day to or below zero, and Monday, the 23rd, at 5 p. m., till Wednesday, the 25th, at nine a. m., for forty hours, the temperature remained below zero. The same has happened in St. Louis during the last thirty-seven years (my meteorological observations in St. Louis extend through that period—more than a third of a century) only once, and that during the cold spell of new year of 1864, from the evening of December 31, 1863, to the morning of January 2, 1864. The lowest temperature occurred in the night from December 23 to 24, probably in the early hours after midnight. With me, on the outskirts of the city, two miles from the river, it reached 19.5; in the city itself different observers noted 14.17 degrees below zero. On the new year's day of 1864 the lowest temperature observed by me amounted to 22.5.

During the cold spell of the past weeks the temperature remained below the freezing point from Saturday night, December 14, to Sunday noon, December 29—over 14 days.

The past December was, on the average, by far the coldest I have observed here in 40 years. My observations gave me the mean for the month 23.5 degrees, those of the signal service 25 5; but even this last temperature is several degrees lower than I have ever noted it before.

The mean temperature of December in St. Louis is nearly 34 degrees; this last December was the ninth on which I have found it below 30; the coldest of these were those of 1838, 1845, 1859 and 1868—while in two instances, 1857 and 1862, it was over 40 degrees.

But coming to a more pleasant and hopeful view of this question of cold and chilliness, I find that my records exhibit the fact that cold Decembers have in all the above enumerated instances been followed by mild Januarys, and that every winter which began with such a severe December turned out, on the average, a moderate or even a mild one. Let us hope that the coming months will not falsify so favorable precedents.

It may be proper to add that the winter temperature within the city of St. Louis appears to be getting milder and milder as the city enlarges, and as hundreds of thousands of fires warm the houses and send their smoke upwards to form a dismal and dark, but sheltering canopy over the city. The outskirts are not as warm in winter, and I may add not as warm in summer, as the heart of the city. And from isolated observations we must conclude that the temperature in the country, even at a moderate distance, is, in many localities at least, still more extreme in heat as well as in cold.

Dr. Engelmann also stated that he had received a copy of the London *Lancet* containing an interesting account of a fossil man found at Mentone, on the coast between Genoa and Nice. The conditions under which it was found, and the associated remains of animals, many of which are extinct, indicated great antiquity;

and the specimen was, perhaps, the most perfect of its age that had yet been found. It was over 6 feet in height, and though unmistakably human, possessed some peculiarities of interest. It was being carefully exhumed under French care, and further developments might soon be looked for.

Prof. J. Luce presented specimens of a very fine carbon found at Belleville, Ills., and made some remarks as to its nature.

Mr. Riley offered the following resolutions, which, after brief remarks in their favor by himself and Mr. Harris, were unanimously adopted:

" *Resolved*, 1. That after the 1st of January, 1873, the Journal of Proceedings of the St. Louis Academy of Science be published in instalments of 16 pages, and that it be the Recording Secretary's duty to prepare these Proceedings for the press, the pages to be numbered in Roman numerals.

" 2. That the Transactions of the Society be likewise printed in instalments, i.e., that every paper or communication presented to the Society be published forthwith, when so ordered by the Publication Committee, and that 50 separate and paper-bound copies, or less if desired, be at the disposal of the author.

" 3. That the Transactions be paged in ordinary numbers, and that it be the duty of the Corresponding Secretary to send the signatures to subscribers and members every three months, or as often as three or four signatures have accumulated.

" 4. That it be the duty of the Publication Committee to take charge of the signatures, and, whenever sufficient material shall have accumulated to make a fair-sized volume, to prepare an index and order all the copies remaining in possession of the Society to be bound."

The Treasurer submitted his Annual Report, showing that the balance on hand January, 1872, was $143.50; amount of subscriptions collected during the year, $648; expended, $150; balance on hand, $639.50. Including the subscriptions to fall due on March 1st, there will be in the Treasury, after their collection, $1,400. The number of paid associate memberships was 120.

The report was referred to an auditing committee, consisting of Messrs. Forbes, Todd, and Engelmann, and found correct.

President Eads called Mr. Harris to the chair, and made the following remarks:

Gentlemen of the Academy of Science:

Another year has been scored on the records of your youthful institution and in contemplating the results achieved in this brief period, you have much cause for congratulation and encouragement.

The contributions to science made by several of your members during the past twelve months. in different departments of investigation, have been characterized by so much novelty, have shown such comprehensive and careful observation, and in most instances have been presented to the scientific world with such simplicity of language and originality of thought, that increased attention on the part of kindred societies throughout America and Europe has been directed towards this prolific field of inquiry, and the most respectful consideration is accorded to the facts announced. The reports made from time to time by your efficient Corresponding Secretary give flattering assurances of a lively interest in your observations. and a cordial desire for your success on the part of older societies and *savants* abroad.

Your financial condition is also very encouraging. You are clear of all debt; your revenue is constantly swelling, and you have a moderate surplus on hand.

The remarkable increase in the number of new members has given substantial evidence that an earnest spirit of scientific inquiry has been developed among our own citizens, to an extent never before witnessed. The long roll of names of intelligent gentlemen, now numbered as members of the Academy, assures me that its darkest hours have passed by, and I see the warm tintings which mark the dawning of a glorious day, at length, brightening its future.

Already one generous patron (Mr. James H. Lucas), doubly blest with the wisdom to appreciate and the wealth to advance your high purpose, has stepped forth unsolicited, and with princely munificence donated a valuable lot of ground centrally located, on which to erect a building for the safe-keeping of your records, library and museum; and in which scientific truths and phenomena may be hereafter explained to our citizens.

Other liberal and intelligent friends of education stand ready to contribute of their abundance in aid of the erection of this temple of science, the intrinsic value of which to this city cannot be overestimated.

No one can compute the benefit which would result to this community from the annual delivery of a comprehensive course of lectures in our midst upon the physical and natural sciences, demonstrated with such necessary apparatus, illustrations and specimens as it is the intention of this Academy to possess. One lecture on electricity or light, on zoölogy or botany, or upon any of the great departments of science, when given by one thoroughly informed upon the subject, and demonstrated with the necessary means, will oftentimes convey to the student a clearer comprehension of it than he could acquire by the study of a whole volume written upon the same topic. Frequently an error which has trammelled the mind for years has been dissipated in a moment, by simply exhibiting the phenomenon itself whilst explaining the laws that control it.

The difficulty of retaining in the memory scientific facts acquired by the study of the subject in books alone, is well known to every one; but when they come to us accompanied by some visible or tangible evidence, the mind is indelibly impressed. In this way, too, the pursuit of knowledge becomes more attractive. Whenever a few of the chief principles in any department of science are clearly explained and understood by the student, the fascination of the subject begins at once to appear. He feels that he is no longer a drudge, but that his labor is one constant source of pleasure. A world of novelties are developed in succession before him, and with delight he moves forward to examine each in its turn. When all the facts which have been garnered by others have been studied and mastered, he wanders forth into unexplored by-ways eagerly searching for new truths, or treads again the old familiar fields to seek such treasures as may yet be undiscovered.

In all civilized lands we find a class of intelligent men who assume to disregard everything scientific. This affectation comes simply from a want of reflection. The lives of all men, even of those having but a small share of common sense, give the lie to such pretension. In sickness, the patronage bestowed upon the mountebank springs from an innate respect for a higher degree of knowledge than that which the sufferer feels himself possessed of. In every department of industry, and in all the avocations of life, men who speak thus lightly are nevertheless continually manifesting by their actions their deference for science. Indeed, the blessings, comforts and facilities which attend mankind in every nook and corner of civilization, and which are the direct results of the teachings of science, are so multitudinous, that no man of ordinary intelligence can fail to be impressed with their number.

The civilization of to-day is in reality mainly founded upon our knowledge and application of physical science. To this cause are we almost wholly indebted for the superior refinements, methods of life, and multiplicity of appliances for increasing our happiness. Nor does the glory of science end with these magnificent and tangible evidences of her power. To her is chiefly due that moral force which characterizes civilized life. She pervades all departments of intellectual labor, and all theories and forms, whether of law, commerce, agriculture, social economy or government, are subjected in some measure to her crucial tests. Even Sacred Writ accepts just such interpretations as her inexorable laws demand. Through her teachings we are learning to correctly estimate the value of experiment and observation, and to demand that evidence shall precede belief. Already has the startling fact dawned upon the human understanding, that man's welfare on earth is wholly dependent upon his implicit observance of certain immutable laws; and only through the most perfect knowledge of these, can he hope to yield that invariable obedience which secures the highest degree of human happiness. Science, which we have been too prone to look upon simply as a means of advancing our material prosperity, here proves our friend in a higher cause. She alone can unfold these vital laws to man.

Her domain, embracing as it does the entire cosmos, is so boundless however, and the mental scope and lifetime of man so limited. that it is only by some judicious co-operative system, in which individuals confine themselves to special departments of investigation, and in which careful records are preserved to convey to future workers their observations and discoveries, that mankind can hope to attain the earliest possible insight into all the mysteries of nature.

"One science only will our genius fit,
So vast is art, so narrow human wit."

We see, therefore, the importance of encouraging such institutions as this, where investigations in all departments of natural and physical science may receive such aids through experiment, demonstration and observation, as genius when fostered by wealth can accomplish, and where the records of the past and the details of present discoveries in the world of science can be temptingly placed within the reach of every inquirer.

What purer philanthrophy can we conceive of than that which has for its aim the most thorough instruction of our fellow-men in the comprehensive knowledge of those unalterable moral and physical laws, on the observance of which, and their proper application, depends the amelioration of mankind? This is the noble purpose of your institution.

The acquisition of wealth usually quenches man's love for his fellow. The pursuit of knowledge, on the contrary, awakens one of his noblest attributes. The cultivation of the mind inspires the wish to benefit our neighbor; and the desire increases in proportion as knowledge supplies the power to elevate and improve his condition.

Let us labor then in the confident assurance that, as our knowledge of the laws which control the universe increases, the welfare of mankind will in like manner also increase. Hence, as the mighty scheme of creation unfolds itself to the undertanding, and the intellect is filled with sublimer truths, a more intelligent comprehension of the power and wisdom of the Creator will develop a more enlarged and effective philanthropy. Science, while thus leading man upward and onward to the very threshold of omnipotence, will inspire him with a holier love of God and humanity.

The annual election of officers resulted as follows:

President—Capt. J. B. Eads, C. E.
1st Vice-President—Hon. Albert Todd.
2nd Vice-President—Geo. Engelmann, M.D.
Corresponding Secretary—Hon. Nathaniel Holmes.
Recording Secretary—C. V. Riley.

Treasurer—Dr. Enno Sander.
Librarian—Jno. J. Bailey.
Curator--Rich. Hays.
Committee on Publication—Dr. G. Engelmann, W. T. Harris, C. V. Riley, and N. Holmes.

Mr. J. Luce, J. L. Sanborn, and J. N Judson, were elected associate members.

January 20, 1873.

Vice-President ALBERT TODD in the chair.

Eleven members present.

Books and pamphlets received were laid upon the table.

A revised but unprinted copy of the Constitution and By-Laws was presented, and an amendment to Art. 4, Sec. 5, offered by Mr. Todd, was laid over to be acted upon at the proper time.

Mr. Riley presented a piece of stone showing very perfect petrifactions of the spines of an Echinite. It was taken from the bottom of a small stream near Kirkwood, where the specimens were tolerably common. He also presented a piece of wood which, though encountered at the bottom of a well 30 feet below the surface of the ground, at Centralia, Ills., was scarcely carbonized at all.

Judge Holmes made the following remarks on

THE FOSSIL MAN OF THE MENTONE CAVE.

In the London *Lancet* of Dec. 7, 1872, p. 818, an account is given by J. Henry Bennet, M.D., of a complete human skeleton, discovered by the French Geologist, M. E. Rivière, in the bone caverns at Mentone, on the coast of the Mediterranean between Nice and Genoa, and now deposited in the geological museum at Paris. The more notable facts stated are these: skeleton six feet in length, skull dolicocephalic, not negroid; teeth nearly complete and worn flat; orbital cavities peculiar in length and diameter; found lying in an interior part of the cave at a depth of 19 feet in the undisturbed deposits, with implements of flint, stone, bone and deer-horn accompanying it, and with remains of the extinct mammalia of the Post-Pleiocene period above, around, and below it. The facts seem to be well authenticated.

The significance of this discovery lies in the fact that it furnishes the first indubitable or undoubted instance of a human skeleton being found in deposits contemporary with animals of the extinct fauna of the Post-

Pleiocene period (*Elephas primigenius*, *ursus spelæus*, &c.), and of nearly if not quite the oldest known age of flint and bone implements of human workmanship. Not that this evidence was necessary to establish the existence of man in that age; for that fact was already conclusively proved by the flint, or stone, and bone implements, of unquestionable human workmanship, previously found in caves, and still older deposits in both France and England. Nor, indeed, that no other human bones contemporary with the same extinct animals were known before; for the Engis skulls found by Dr. Schmerling, and the Neanderthal skull described by Dr. Fuhlrott, had long ago furnished very satisfactory evidence of that fact, though at the time of their discovery geologists were not prepared to admit the possibility of such facts being true. And the fossil jaw-bone reported to have been found with the oldest flint implements of the valley of the Somme, in France, might be taken as another instance, if skillful geologists and especially so able an observer as Mr. John Evans, the distinguished English geologist, had not cast a slur upon it as a possible case of imposition, or as not having been seen *in situ* by any scientific geologist. Probably in such a matter the oath of a dozen ordinary workmen would not be taken as any proof of the fact; but here, now, is an instance which it is not possible for any rational man to dispute.

Secondly, it is significant in being six feet in length, dolicho-cephalic, and not negroid in type, and in being peculiar in its orbital cavities. So far as can be judged from the engraving, it resembles somewhat the Neanderthal skull, and is even suggestive of the boat-shaped skulls of the older English barrows. But since the age is fixed as that of the Post-Pleiocene animals, going back, within a few strata of the end of the Pleiocene period—to a period so vastly remote in time as scarcely to admit of any comparison with ethnological data in respect of the distribution of races or colors, or any possible classification, in point of race or color, with the comparatively modern men of the present science of Ethnology—we are carried back far beyond the category of nations and Ethnology proper, and are taken into the purely zoölogical province of Anthropology.

Nevertheless, in view of all that is known upon the question, it would seem as yet to be highly probable that these oldest men of Europe proceeded, originally, from the Southeastern Asiatic centre of human origins, the seat of the Asiatic Simiadæ and the home of the reddish-yellow Orang, as all the later migrations into Europe certainly did, whether from High Asia or from the Peninsula of Hindustan, including perhaps the negroes of Africa; for it is possible that the negroes came into Africa along the coasts of Hindustan, Beloochistan, and Southern Arabia, as they are known to have reached the ancient Colchis, through the valley of the Euphrates, at a comparatively recent period; but it is altogether more probable that they came into Africa by continuous land or islands which have been sunk in the Indian Ocean since the beginning of the human period. The geological fact of such sinking of Southeastern Asia whereby a part of the continent became islands, since the Tertiary period, is well established. The affinities of the native languages of Madagascar with the Kawi speech of Southern Asia, and the use of the same implement for blowing the fires in smelting iron in Madagascar as that used for the same purpose in the Asiatic Islands, being a hollow cane worked on the principle of the air-pump, instead of the skin-bellows in modern use in the interior of Africa, strongly point in the same direction. On the other hand, modern researches concerning the most ancient peoples of Babylon, Southern Arabia, Egypt, and Africa north of the Sahara (as summed up by Lenormant and Chevallier), all go to show that those regions were peopled by streams of migration across the lower Indus from Hindustan of the reddish-brown or yellowish types, the Cush of the Bible. Yet it might be hazardous to say, in the present state of our knowledge, that it is impossible that the negroes of Africa may have originated in the African centre, the tropical home of the African Simidæ and of the black chimpanzee and gorilla.

Twenty years ago, geologists did not admit that man was older than the recent alluvial deposits. The discovery of flint implements in the Valley of the Somme convinced them that he must be carried back to the Post-Pleiocene age of the mammoth and cave bear. As to time, not to speak of other recent discoveries, the scientific work of Evans on the "Flint Implements of Great Britain" is enough to demonstrate that the length of the human period has been so inconceivably vast that any attempt to reckon it in years, whether by thousands or millions, would be idle, and that it is expressible only by indefinite geological epochs. Mr. Evans compares the age of these implements in England with the period in which the original plateaus (where now are the basins of the Ouse and the Thames), as they were when first finally raised out of the ocean, have been denuded and cut down into the present basins and valleys of those rivers; during which, also, large areas of land and at least one whole river valley have been swept into the English Channel. Another measure may be conceived by ascending from the Iron Age to the Bronze Age, and thence to the Stone Age, and then considering that this age of simply flint implements may be divided into at least three vast periods, characterized, first, by rudely worked flints; then by flint skillfully chipped to fine edges; and, finally, by polished flints, ground smooth and sharp by rubbing them on grit-stones.

But geologists will have to trace these human remains still further back, and even far into the Miocene period, before they arrive at the anthropoid *Dryopithecus* of that age, which Mr. Darwin suggests as indicative of the point of transition, in the course of linear branching descent, from the anthropoid to the completely human type. And what objection can there be to that, if it pleased the Creator to take that length of time for His work and to do it in that way?

Mr. Conant followed with remarks, earnestly urging the importance of establishing an archæological museum in St. Louis.

Dr. Engelmann exhibited a small slab of a whet-stone, given him by Mr. Todd, and supposed to come from a petrifying lake in Ireland, and to be fossilized or petrified wood. He explained the difference between incrustation and fossilization, and showed that the specimen in question was nothing but a siliceous shale. Mineral and even animal substances often appear in layers, and are taken for fossil wood by superficial observers.

Mr. Morgan requested data relating to the Academy to be presented before the Vienna Exposition, and was referred to the Corresponding Secretary, who was instructed to give the requested information.

Dr. H. Z. Gill and Dr. W. Van Blarcom were elected associate members.

February 3, 1873.

Vice President ALBERT TODD in the chair.

Sixteen members present.

The Corresponding Secretary laid upon the table a number of publications lately received from foreign societies, and called the attention of members to several papers containing matters of new discovery and peculiar interest, of which he gave a brief abstract.

Dr. Engelmann presented a copy of the recent Report of the U. S. Signal Service, and observed that it contained much interesting matter, corroborating, in many respects, the observations that had heretofore been made in Europe, and especially in England and Germany. Owing to the vast extent of the United States as compared with the countries of Europe, the work of our Signal Service promised important results. It was the commencement of accurate meteorology in the U. States. The probabilities and predictions sent out each day had proved surprisingly correct, and were of great advantage to commerce. The map showed that corresponding barometrical changes took place over a great extent of country, not simultaneously, but progressively. He exhibited a map on which he had represented the mean temperature and rain-fall, abstracted from the Report, and stated that, during the recent severe cold, his minimum thermometer on the morning of January 29th marked 23° below zero.

Mr. W. T. Harris said he was gratified to hear the remarks of the Corresponding Secretary on the subject of the geological proofs of the antiquity of man. To the geological discussion of the antiquity of man we owed the great scientific contributions of the present day on the subject of Anthropology. It was that which had cleared the way for the study of anthropology or the natural history of man. The study of primitive man, as it is now carried on, adds every day to our knowledge facts of the greatest importance in determining the laws of psychological growth and development. He spoke from the stand-point of an educator. He supposed the physician feels more especial interest in the facts and discoveries of science relating to physiology and the sources of health and disease. The interesting phase to him was more especially that which throws light upon "primitive culture": and with the labors of such men as Lubbock, Milne-Edwards, Lartet, and Tylor, we are recovering one by one the lost threads that belong to those epochs of human history that antedate all written records. What histories our future historians will be able to write when natural science has once unfolded the law of sequence in the progress of human invention!—the discovery of the art of metallurgy, of the use of wheels and of taming animals!—the arts of using fire, of grinding grain and making bread, and of weaving!—each one of these arts marking an epoch in the growth of the race. When shown in their real sequence and in their correspondence to the unfolding of the spiritual faculties of men, they will throw a flood of light on the periods covered by written history, and more especially upon the science of pedagogy, which has for its province the elevation of the human being out of the stage of infancy—that age corresponding to unconscious, pre-historic, primitive culture—into an active participation in modern culture and civilization. Before the mind could be prepared for the scientific spirit that is necessary in the investigation of the natural history of mankind, there was necessary a fifty years' contest between geologists and theologians in regard to the meaning and significance of facts and of revelations. Out of this contest has resulted a great purification of scientific method—the utmost care in sifting facts and freedom from all exaggerations in announcing results.

Judge Holmes observed that, in respect of our knowledge of man. it was undoubtedly true that as archæological and philological researches had carried us far beyond the bounds of critical history, so geology carries us back far beyond the scope of ethnology proper as an account of existing races, and takes us into the sphere of Anthropology as a branch of purely zoölogical science. Zoölogy, he thought, was certainly one of the most metaphysical of the sciences, even if mathematics be more metaphysical. He was inclined to regard mathematics (in its scientific rather than in its practical aspect and in its highest reaches) as a science of universal dynamics, statics, and equilibrium, if not of pure reason or the laws of thought taken universally. When free force takes on fixity, or is fixed, in the atom (a thing conceivable, if not yet experimentally proved), and so becomes (as it were) "stored force," then the sphere of fixed fate, chance, mechanical laws and powers, and "the properties of matter," begins; and when science comes to reach beyond these properties of dead substratum and what it calls "physical laws" into the region of the total free force, pure reason, and ultimate causation, and so arrives at the end of that chain of causes which Bacon and the ancients said was tied to the foot of Jupiter's throne, then it is probable that science itself will become something like metaphysical science, and scientists and speculative philosophers will stand near together on the same platform, and perhaps the theologians themselves not be excluded.

Mr. W. J. Lee of Iron Ridge, Mo., was elected a corresponding member, and Messrs. John A. Scholten, Edward P. Curtis, and David Hughes, were elected associate members.

February 17, 1873.

Vice-President Dr. Engelmann in the chair.

Twelve members present.

The Corresponding Secretary read a letter from Mr. W. J. Lee of Iron Ridge, Mo., acknowledging his election as a corresponding member.

Certain charts and reports of meteorological observations were received from Mr. E. H. Singleton, U. S. Signal Observer, at St. Louis, with an offer to continue them monthly. They were directed to be filed for preservation.

Mr. C. V. Riley on behalf of Mr. James Harkness presented for the museum a probable Indian skull found at a depth of fifteen feet in one of the mounds near East St. Louis. The skull was somewhat peculiar in form, being decidedly dolichocephalic in type, and very low in the frontal and superior regions, thick, and heavy. The exact position where found and the accompanying circumstances were not communicated.

Mr. Riley exhibited specimens of *Acridium americanum*, the whole inner soft parts of which had been eaten away by the small red ant (*Myrmica minuta*), leaving nothing but the outside skin or shell. Just as ants will neatly clean the flesh from the internal vertebrate skeleton, so they had done in this instance from the external invertebrate skeleton.

Mr. Enno Sander presented from Dr. H. Johnson of Jacksonville, Ills., a piece of shale showing impressions, which were recognized by Dr. Engelmann as impressions of some plant.

The following amendment to the Constitution of the Society in relation to the office of the Treasurer was adopted:

Add to § 5 of Art. IV. these words: "And he shall deposit, in the name of the Academy of Science, all funds of the Academy coming to his hands, when amounting to twenty-five dollars, in such incorporate bank in the city of St. Louis as shall from time to time be designated by the Academy by resolution; and the same shall draw from said bank by check in the name of the Academy of Science, signed by him as Treasurer of said Academy, as needed for the payment of its debts or expenses."

Messrs. E. H. Singleton, U. S. Signal Observer, and Adolph Willhartitz, were elected associate members.

March 3, 1873.

Vice-President Albert Todd in the chair.

Twenty members present.

The Corresponding Secretary laid upon the table numerous publications received in exchange from other societies.

A communication was read from the Bureau of Education, at Washington, asking for statistics for use at the Vienna Exposition, to which the Corresponding Secretary was directed to return a suitable answer.

On behalf of Mr. W. J. Lee of Iron Ridge, Mo., a collection of iron ores from that locality was presented for the museum, for which the thanks of the Academy were voted to Mr. Lee.

Dr. Engelmann communicated the following observations on

ONE OF THE TWO COLDEST WINTERS IN ST. LOUIS, IN THE LAST 40 YEARS.

Two months ago I stated to you that, after passing through by far the coldest December witnessed by me here, we would probably experience a milder January and Febuary, as such had been my experience in all the winters the beginning of which had been unusually severe. Facts have proved these expectations futile. We have passed through one of the severest winters in my record which embraces just forty years. If I say we have passed through it, I mean *meteorologically*: for meteorologically our winter is calculated to last from December 15th to the last of February. *Actually* and practically we are in winter yet, and it will be weeks probably before the flower-buds of our Elms and soft Maples open, which in more favored seasons gladden us before the end of February.

The mean temperatures of our winters I find to be 33.6°, and the past winter marks only 26.3°, more than 7° less than the average. The only winter which, in my experience, can be compared with it in severity is that of 1855-6, which came up to 26.4°, you may say about the same average temperature as this winter. But, comparing the different months of both winters, we find December, 1855, up to 32.4°, only one degree below the average, while January with 20.1° was nearly 12° below the mean, and February with 26.6° nearly 9° below. January was by far the coldest month of that winter, from 3 to 4 degrees colder than in this winter.

In this winter, however, December and January were the cold months; and February, though cold and raw enough, and about 3½ degrees below the average, was far less severe.

The following little table will more distinctly exhibit these conditions:

	Winter of 1855-6.	*Winter of 1872-3.*	*Average of 40 years.*
December	32.4°	23.3°	33.4°
January	20.1	23.7	32.0
February	26.6	31.9	35.3
Whole Winter	26.4	26.3	33.6

Last December was the coldest ever experienced by me here: January was colder, as above stated, in 1856, and still colder in 1857 (19°.3). February was colder nine times within my experience than the one just passed.

Last winter was also remarkable for the uniformity of its low temperature; in December the mercury fell below zero on five days (between the 22d and 27th), in January on seven days (10th, 17th and between the 25th and 30th), and in February once (on the 2d). The highest temperature in December (54°) was reached on the 7th, in January on the 12th (53°·5), and once in February (18th) it rose to 65·5°, only to fall nearly 40 degrees before the following morning. The masses of snow spread uniformly over the northern and northwestern plains are believed to be the cause of this uniformity of cold.

The cold winter has destroyed our prospects of a peach crop for this and perhaps for the next year, and has treated almost as badly the grape crop; and has belated the development of spring: it is believed that this will include all the material damage done. The lateness of spring will, agriculturally speaking, be rather an advantage than otherwise.

In regard to human health, the severity of the winter has been injurious in many respects, and diseases of the respiratory organs particularly were prevalent and often fatal, while typhoid fevers were observed much less frequently than in other more open winters.

Mr. Gage, of the Geological Survey of Missouri, read a paper on "Iron," which he illustrated by the aid of numerous specimens of ores and irons which were donated to the museum. The paper was referred to the Committee on Publication.

Mr. E. H Singleton, U. S. Signal Observer at St. Louis, communicated his meteorological observations with a daily series of weather-charts for the last month.

On motion of Dr. Enno Sander, it was voted to print 100 copies of the diploma of membership of the Academy for the use of such members as desire to procure them, on payment of the usual fee of $3.00.

Dr. H. Johnson of Jacksonville, Ills., was elected a corresponding member, and Messrs. J. L. Tracy, J. L. Watkins, J. Thrailkill and Dr. A. Galney were elected associate members.

March 17, 1873.

The President, James B. Eads, in the chair.

Eleven members present.

The Corresponding Secretary laid upon the table various publications received from other societies, together with meteorological reports and weather-charts for the last month received from E. H. Singleton, U. S. Signal Observer at St. Louis.

Dr. Wislizenus read a Summary of his Meterological Observations at St. Louis for the past year, which was referred to the Committee on Publication.

Dr. Theodore Fay was elected an associate member.

April 7, 1873.

Vice-President Todd in the chair.

Five members present.

Exchanges received were laid upon the table.

April 21, 1873.

Vice-President Todd in the chair.

Seventeen members present.

Publications received were laid upon the table.

Several letters were read by the Corresponding Secretary relating to exchanges.

Ordered that the Minnesota Academy of Sciences be placed on our list of exchanges.

Mr. Gage presented some relics from an Indian mound in Illinois, and also exhibited a specimen of the shovel-fish found in the Mississippi river.

Dr. Engelmann remarked that it was a fish that inhabited our waters, and had been sometimes sold in our market. It was allied to the sturgeon, and known to science under the name of *Polyodon folium.*

Dr. Spencer exhibited a fang of the rattlesnake, showing the canal, and its termination near the point of the tooth, through which the poison is injected into the wound made by the bite.

May 19, 1873.

Vice-President Todd in the chair.

Thirteen members present.

Correspondence and exchanges were reported by the Corresponding Secretary.

Dr. Engelmann presented for the museum a collection of specimens in natural history received from the Agassiz Scientific Institute of Sacramento, Cal., through Dr. I. Logan, president of that society; for which it was voted that the thanks of the Academy be communicated to the society.

Messrs. N. H. Clark, Charles F. Bendire, E. C. Cushman, Samuel Knight, and Dr. R. Roemer, and Col. C. Shaler Smith, were elected associate members.

June 2, 1873.

President Eads in the chair.

Nine members present.

A letter was read from the Secretary of the Smithsonian Institution, dated May 31, 1873, informing the Academy that the Smithsonian Institution would take charge of the transmission of the Transactions of the Academy to foreign countries in the same manner as it had heretofore been done.

Mr. E. H. Singleton communicated his meteorological observations and weather-charts for the month of May, as made at the office of the U. S. Signal Service at St. Louis.

Mr. C. V. Riley read a supplementary paper on the Yucca moth (*Pronuba yuccasella*), the fertilizer of that plant, describing the chrysalis, and showing by illustration and description how admirably it was adapted to its wants and conditions, and how by a series of levers it was able to pry its way through the soil and issue as a moth just about the time the Yuccas bloom. Referred to Committee on Publication.

Dr. Engelmann remarked that the opinion had been everywhere expressed that the month of May past had been a very wet and unusually cool month, which only showed an aptitude to forget the past in our realization of the present; for the mean temperature of May was 65°, only one degree less than the average for May in this city. Only once (on May 4) the thermometer indicated less than 47°; on the morning of that day it fell to 40°; frost, we had none, nor did the temperature on any one day rise higher than 88°.

The quantity of rain was only 4½ inches, less than the average by about half an inch. The rains were frequent, occurred on fourteen days, but only two rains, both on May 26, could be called heavy. All the others amounted to at most one-third of an inch.

In May of last year, 1872, we had more rain than this year, but the mean temperature was one and a half degrees higher.

The unusual drought which has prevailed for the greater part of three years, has made us forget that April, May and June are usually our wettest months; and last year, dry as was its greater part, May, June and July had quite a sufficiency of rain. I observed more than 10 inches of rain in May, 1844 and 1858, both years of floods, and less than 3 inches in 1841, 1849, 1851, 1860, 1862, 1863, 1866 and 1870, eight years.

Mr. Richard Hayes gave an account of the recent hail-storm that touched this city, as follows:

In referring to the hail-storm which passed over St. Louis about thirty-five minutes past three o'clock on the afternoon of May 19th, I desire to state that, at the time of its occurrence, I was not in a position where I could observe it as carefully as I would have liked to do. On the next day, however, I proceeded to investigate the various phenomena that marked the path of its progress. I first went as far S.W. as any marks of hail could be seen upon the trees and fences, and traced its southern edge westward to the Tower Grove Park. Within the park but few signs of hail could be seen and I was informed that but little fell there. It must have commenced at that point as a hail-storm and proceeded in a northeasterly direction, its centre moving almost in a straight line, to somewhere near 24th and Carr streets, where it met with another which must have formed near the St. Charles road and Grand avenue. After the two met they moved on together in a more easterly direction, the centre reaching the river at Madison street. On the southerly edge of the southern part the wind blew almost directly from the west; between the southerly edge and what I have designated as the centre it veered more and more towards the south, and at the centre it blew directly from the south; between the centre and the northerly edge it blew from an easterly direction, and at that edge it came directly from the east. The characteristics of the northern part were similar to those of the southern, and the same may be said of the whole after the two parts united.

From these characteristics, it is clear that the storm began as two whirlwinds which approached each other and united near 24th and Carr streets, passing on to the river as one. Whether it crossed the river or not I am not informed. The violence was not very great, though considerable damage was done to the young leaves of the trees and flowers in several parts of the city. Window-glass was broken in some localities where the wind came directly from the south, but in others none was broken. The southern limit extended along a line drawn from Arsenal road and Grand avenue to Menard and Lafayette avenue and thence to the river.

Mr. C. V. Riley observed that it had been stated in an article by Mrs. Mary Treat, published in the *American Naturalist*, that she had made certain experiments with the larvæ of two insects, which were deprived of food for some time, and the conclusion she came to was that she could produce males by starving the larvæ, and females by feeding them to excess. He had himself experimented with the larvæ of some six species in which there is a great disparity of sex, and had obtained no such results: and he concluded that the results of Mrs. Treat's experiments could be accounted for on other grounds, and principally by the fact that the female in the Insecta is usually the largest and most vital, and requires the greatest amount of nourishment: so that, in starving a batch of larvæ, the females would be the first to succumb, and more males would naturally be obtained from larvæ thus treated.

In answer to a suggestion that the female sex appeared to be something like a case of arrested development, Mr. Riley said that he believed sex in insects as well as in all animals was always determined at the moment of conception, and that the production of queens or workers in the honey-bee was only a question of relative development, the workers all being undeveloped females or queens.

June 16. 1873.

Vice-President Todd in the chair.

Ten members present.

Publications received were laid upon the table.

June 30, 1873.

The President in the chair.

Twelve members present.

Exchanges received were laid upon the table.

It was ordered, on motion of the Corresponding Secretary, that a copy of vols. I. and II. of the Transactions be sent to the Imperial Observatory of Rio Janeiro, Brazil.

The Treasurer presented a bill for the printing of No. 1 of vol. III. of the Transactions, amounting to $943.63, which was ordered to be paid.

Mr. Hobart presented a photograph of a large skull of the Musk Ox which had been found in a well twenty feet below the surface of the ground, about ten miles west of Sauk City, Sauk Co., Wis., said to be the only specimen of the kind ever found in the limits of the U. States. On comparison with the skull of the fossil ox (*Bos cavifrons*) in our museum, from alluvial deposits in Chouteau's Pond, in St. Louis, it was found that but very slight similarity existed between them.

Mr. Riley exhibited a specimen of a large and curious spider (*Nephila plumipes* Koch) which had been sent to Dr. Engelmann from South Carolina, and remarked that it was peculiar from the diminutive size of the male as compared with the female, the body of the former being but one-quarter of an inch long, while that of the latter was nearly an inch longer. The female has also brushes of stiff hairs upon her legs, and loses no opportunity of displaying her superiority of size and strength by devouring her mate whenever she gets a chance. The silk of this spider may be drawn out of the abdomen in one continuous thread, and is quite strong and beautiful. Prof. B. G. Wilder had once reeled upwards of two miles of it.

Mr. Riley also explained the peculiarities of the Mexican honey-ant, presented by Dr. Engelmann. It was the *Myrmecocystus mexicanus* of Westwood (Entoml. ii. p. 225, note). The species has two kinds of neuters, those with ordinary sized abdomens, and those having the membrane of the abdomen much swollen and distended. These last do not quit the common nest, but devote their time entirely to the elaboration of a kind of honey, which they discharge into cells made somewhat after the plan of those of the common honey-bee.

He also exhibited a plant possessing flowers of such peculiar structure that large Sphinx moths were often caught in them by not being able to withdraw their tongues when once inserted. The plant was known as the *Physianthus albens*, rarely seen in cultivation in this country, though a very beautiful climber.

Mr. Henry Senter was elected an associate member.

October 6, 1873.

Vice-President ALBERT TODD in the chair.

Eleven members present.

A large number of publications received during the summer were laid upon the table, and among them the publications of three new correspondents, the Astronomical Observatory at Leyden, Holland; the Entomological Society of Belgium, Brussels, and the Royal Geological Institute of Hungary, Pesth, Austria. It was ordered that the Transactions of the Academy be sent to these societies in exchange.

Dr. Engelmann presented a specimen of sea-horse (*Hippocampus Hudsonicus*) from the mouth of the Delaware. It was very similar to that occurring on the shores of the Mediterranean.

October 20, 1873.

Mr. RICHARD HAYES in the chair.

Eight members present.

The Corresponding Secretary made a report of correspondence and exchanges received.

He called attention to a recent discovery reported to have been made by Mr. Wm. McAdams of Jerseyville, Ills., in the drift on Otter creek, about four miles south of that place. The drift had a depth of forty feet, and was situated at the base of a perpendicular bluff. Some interesting fossils were found in this drift; among which were several teeth of an animal related to the Pachyderms, resembling rhinoceros; a tusk, some 12 inches in length, much resembling that of the walrus, a number of large vertebra, and bones of an extinct horse and of rodents. The locality had been examined by Mr. Worthen, State Geologist, and it was said that some of the newly discovered fossils had been sent to Dr. Leidy of Philadelphia for examination.

Mr. Riley exhibited a specimen of the Spreading Adder (*Heterodon platyrhinos*), and said it was unusually common, as, indeed, were all kinds of snakes, the present summer, near Kirkwood, St. Louis county, and that he had observed that the coppery color about the head was noticeable only when the animal broadened and flattened its head, which it was prone to do when alarmed, the change of color being produced by the scales separating and exposing the coppery surface which is normally hidden.

Dr. Engelmann presented a mineral substance which might be mistaken for white sand, but was really granular gypsum. It came from the Mesilla Valley, New Mexico, where it covered an area ten miles in extent, making the country perfectly sterile.

Mr. Riley read a paper entitled "Descriptions of the early Stages of *Apatura Lycaon* Fabr. and *A. Herse* Fabr., with Remarks on their Synonymy," which was referred to the Committee on Publication.

Dr. Jno. C. Christien, W. M. Bryan, W. J. S. Bryan, and Geo. B. McClellan, were elected associate members.

November 3, 1873.

Vice-President Todd in the chair.

Seventeen members present.

A number of publications received from foreign societies were laid upon the table by the Corresponding Secretary, who called the attention of members to several papers containing matters of peculiar interest.

Among them was a paper in the Proceedings of the Phil. Society of Glasgow, by Dr. McAdam, explaining the cause of the explosions of flour-mills which had occurred in Scotland. It was attributed to the fine flour-dust floating in the air in the mill, being composed chiefly of carbon and hydrogen and thus resembling in composition an explosive carbon-oil, being set on fire by a candle, or by a spark from a nail or other substance getting between the mill-stones. Such accidents had not occurred in this country that he was aware of, but evidently might happen unless due precaution were taken.—Prof. Schiaparelli, in an elaborate paper on Comets, Shooting Stars, and Meteorites (in the Memoirs of the R. Istituto Lombardo, Milan), had come to the following conclusions: 1. That falling stars and meteorites were identical in their nature; 2. That they are not of planetary or cometary origin, but most probably come from stellar space, and in diverse directions; 3. That they do not originate in any one body; 4. That they tend to prove the identity of the chemical and molecular structure of all the bodies of the universe.—A paper in the Bulletin of the Anthropological Society of France, by M. Hamy, upon the fossal human skeleton discovered by M. Rivière in the caves of Mentone, near Nice, had satisfactorily ascertained that it belonged to the same Quaternary age as the skull of Cro-Magnon, and was contemporary with the extinct mammalia of that period.—M. Jules Marcou, in a pamphlet on "Australasia," had maintained that there were no good geological reasons why the existence of Man might not be carried back to the Triassic period, pointing to the probable land connection between Africa and New Holland and between South America and New Zealand in the Triassic and Eocene periods, and to the distribution of races in those parts as seen in modern times. This view (Judge Holmes thought) was contradicted by both the geological and the zoölogical evidences. On the theory of evolution and transition of type, since the type next lower than the human (in the Simiadæ) is not traced back beyond the Eocene, and received its largest development in the Miocene, or at least first reached to anthropoid forms in that age, it would seem to be altogether more probable that the transition to the completely human type took place in that age, or in the Pleiocene. The configurations of land and water that existed in the Tertiary period, especially in the southern hemisphere, he thought, should be more thoroughly studied and considered, as well as the possible migrations by sea and consequent mixtures of races, (or the spread of different races into the same islands or continents.) before such sweeping conclusions could be safely drawn.

Dr. Engelmann wholly dissented from the opinions of Prof. Marcou. He was inclined to think that the proofs failed to establish any theory of the evolution of man out of the ape. He could not believe that man lived in an age when only fishes and Saurians, among vertebrates, are known to have existed.

Some further remarks were made upon the subject by Messrs. Todd and Riley and Dr. Briggs, controverting the views of Prof. Marcou.

November 17, 1873.

The President in the chair.

Twelve members present.

Publications received were laid upon the table.

On motion of Mr. Albert Todd, the following resolutions were adopted:

Whereas, since the last meeting of the Academy, there has died one who was a sympathetic friend and a generous contributor towards establishing its success; therefore,

Resolved, 1. That the memory of the late James H. Lucas is forever entitled to the grateful regard and honorable esteem of this society.

2. That the Secretary send a copy of this proceeding to his bereaved widow, certified under the seal of the Academy of Science of St. Louis, with the respectful condolence of its members.

Dr. Copes, President of the New Orleans Academy of Sciences, being present, was invited by the President to address the society. Dr. Copes gave an account of the operations and vicissitudes of the New Orleans Academy for the last twenty years, and alluded to the contributions of its members to the progress of science and the useful arts; and particularly to the discovery by Mr. Lamb of a mode of charging water with heated steam so as to make it applicable as a motive power in engines for driving street-cars. He had been led to this invention by experiments on the use of ammoniacal gas as a motive force.

Capt. Roy, lately of New Orleans, being introduced, gave a more detailed statement of this invention and of its actual use in driving cars on street-railroads in New Orleans. An engine could be charged at the stations with sufficient power to drive the cars around a circuit of six to nine miles before being re-charged.

Capt. Roy also gave an account of the means that had been employed for deepening the outlets of the Mississippi river, with a statement of his views upon that subject, and in particular as to the effect of jetties, which he did not think could be made effectual.

Capt. J. B. Eads stated that the theory of jetties had been misunderstood: he believed they would prove successful at the mouth of the Mississippi. Sir Charles Hartley (whom he had lately had the pleasure of entertaining at his house, when in St. Louis) had succeeded in deepening the mouth of the Danube by the use of jetties. He saw no good reason why they might not be equally effectual at the mouth of the Mississippi.

An objection had been made that the effect of the jetties damming up the waters in the outlet where they were placed would be simply to cause the waters to flow off through the other outlets, leaving that one to be filled up only so much the faster. He did not believe that such would be the effect; but that, on the contrary, the weight and pressure of the water would tend at once to scour out the sands between the jetties to a greater depth, and so inevitably to deepen the channel. His observations by the use of diving-bells in the river, and upon the action of the current between the piers of the bridge at St. Louis, in filling, or scouring, the bottom as the river rose and fell, or carried a greater or less load of sediment with the change in the velocity of the current, had confirmed him in the certainty of his conclusions.

December 1, 1873.

The President. J. B. Eads, in the chair.

Twenty-two members present.

The Corresponding Secretary laid upon the table several publications received, and among them a pamphlet by Col. C. G. Forshey of Louisiana upon the "Delta of the Mississippi River."

Judge Holmes observed that Col. Forshey was of the opinion that the proper delta of the Mississippi extended up to within a few miles of Cape Girardeau in Missouri, though Sir Charles Lyell had taken the head of the Atchafalaya branch below Natchez as (geologically speaking) the head of the delta. In one sense, he was inclined to think Col. Forshey might be correct. The present configuration of the land showed a valley having its apex just below Cape Girardeau and expanding in width below to thirty and ninety miles (or say an average of sixty miles) between the highlands on either side. This whole valley, now an alluvial plain, had evidently been filled up by alluvial deposits from the river to a greater or less depth. In the Tertiary period, the Gulf had certainly ascended this valley thus far. This fact was proved by the existence of Tertiary deposits in South-eastern Missouri, and in Southern Illinois, at no great distance from the Mississippi and the Ohio. Since that time, there had been, not only a considerable elevation of the land, but some change in the level of the continent. This was proved, not only by the known upheaval of the Rocky Mountains in the Tertiary period, but by the fact that, as late as the Quaternary, a great inland fresh-water lake, or expansion of the Mississippi and Missouri rivers, existed, having the ridge crossing at Grand Tower as its probable southern barrier, and extending far up the Mississippi and its tributaries. The extent of this lake is evidenced by the extent of the fresh-water deposits or Loess. And now, if the existing elevations at Omaha, Kansas City, Quincy, St. Louis, Grand Tower, and the mouth of the Ohio, be taken into consideration, it will be apparent that the existence of such an inland fresh-water lake would be impossible with the continent at its present levels. A change of level is, therefore, quite certain: and, during this change, it is probable that the barrier at Grand Tower was gradually cut down, and the lake drained off. This is analogous to what happened on the Columbia river, and on other great rivers of the globe.

Dr. Engelmann remarked that the mouth of the Ohio was some 300 feet above the level of the Gulf, so that, as far back as the present configuration of the country existed, the gulf or delta, if such an inappropriate name should be chosen, could never have extended as high up as that point.

Judge Holmes replied that the gradual elevation of the continent, with a change of level, might explain how the bottom of the valley had been considerably raised, and that as the Gulf gradually retired down the valley the alluvial deposits from the river would follow the retiring ocean down to where the salt and fresh waters now meet; the river constantly raising its immediate banks above the general level of the alluvial plain.

Dr. Copes stated that, according to his recollection, the projection of the river deposits and delta into the Gulf was now going on at the rate of one mile in fourteen or sixteen years.

Mr. Riley exhibited a living specimen of *Menobranchus lateralis*, caught in Meramec river. Some years ago, he had caught the same species in Lake Michigan. He also exhibited flowers of the *Physianthus albens*, of which he had spoken at a former meeting, and which held captive by their tongues a number of different owlet moths (*Noctuidæ*) and some large Sphinx moths, especially *Deilephila lineata*. This climbing plant belongs to the Asclepiadaceæ: the brown, ovoid corpuscles, peculiar to the stigma of this family, catch in their cleft the moth's tongue or any thread-like body that gets into it, and, together with the pollen-masses connected with them, are torn off from their attachment. Firmly adhering to the tip of the tongue, they prevent its withdrawal whenever, in seeking honey, it gets into the narrow groove formed by the stiff antheral projections. A moth is sometimes thus held by a single corpuscle, and though, when once captured such a moth may break loose, it would seem to be always at the sacrifice of a part of its tongue, judging from the number of tongue fragments found in the flowers. The holding power of these flowers appears wonderful when we reflect on the size and muscularity of the larger Sphinx moths. *Nerium oleander* was known to catch Sphinx moths in Europe in a somewhat similar way, and *Œnothera grandiflora* by a different method.

Mr. Riley also offered a brief paper on the oviposition of the Yucca moth. Referred to Publication Committee.

December 15, 1873

Vice-President, Dr. Geo. Engelmann, in the chair.

Twelve members present.

The Corresponding Secretary laid upon the table exchanges and several publications received. He particularly called attention to the fifth volume on the Geology of Illinois, and to the second Geological Report of Missouri, giving digests of their contents. In one of the Indian mounds in Illinois a large copper knife had been found with a blade 14 inches long and 1½ wide. It is described by Foster in his work on Prehistoric Man in America. Associated with it were the bones of a mastadon. In the Missouri report were facts which showed that Silurian strata had been deposited against the Iron Mountain, so that the deposit of iron is older than the Silurian, and seems to carry us back to deposits analogous to the Laurentian in Canada.

A communication from the Geographical and Statistical Society of Mexico was received, asking for an exchange of publications. The society was placed on the exchange list.

Mr. G. C. Broadhead, State Geologist, exhibited specimens of limonite, or crystalized brown hematite, found in Adair county, crystalized in calcite veins in septaria. He also exhibited a fossil fish, found in a coal vein near Knob Noster, Johnson county, the only specimen found in this State.

Judge Holmes presented, in the name of T. B. Daley, a flexible strip of stone, found in North Carolina, where it is not uncommon. It is a diamond-bearing sand-rock, and is found also in Georgia, in Brazil and India. It is composed of grains of silex, held together probably without any cement.

The rest of the evening was taken up in eulogies on Professor Louis Agassiz, recently deceased, by Dr. Engelmann, Judge Holmes, Dr. Copes, and Mr. Riley; and a committee, consisting of Messrs. Holmes, Engelmann, and Riley, was appointed to draft resolutions expressive of the sense of the Academy upon his lamented death.

Dr. C. S. Bull was elected an associate member, and Dr. J. S. Copes, of New Orleans, a corresponding member.

January 5, 1874.

James B. Eads, President, in the chair.

Thirty-nine members present.

The Committee who were charged with the duty of framing resolutions expressive of the sense of the Academy of Science upon occasion of the lamented decease of Professor Agassiz, at Cambridge, Mass., on the 14th of December, 1873, begged leave to report the following, which were unanimously adopted:

That the members of this Academy have heard with profound regret of the great loss which this country, in common with the whole world of science, has sustained in the death of Professor Louis Agassiz, the distinguished zoölogist, whose valuable instruction and illustrious example have contributed so largely to awaken renewed interest in scientific studies in America, and whose many important works in Zoölogy, Palæontology, and Geology, have accomplished so much for the advancement of science in general.

That his labors in this kind have been so vast and various, and his merits so great, and both so well known, that it would be in vain for us to attempt to signalize them here, further than to record in this manner our high admiration of his abilities, genius, and character, and our gratitude for a life devoted with singular zeal and entireness to the lofty purpose of enlarging the bounds of human knowledge and increasing the good of mankind.

That as a mark of sympathy a copy of these resolutions be communicated to the family of the deceased.

A letter was read from Prof. Spencer F. Baird, of Washington, D. C., relating to the publication of condensed abstracts of the proceedings of scientific societies in the New York "Tribune." The matter was referred to the Recording Secretary, with liberty to furnish such abstracts of our proceedings as he might deem proper.

A letter was read from Dr. Joseph S. Copes, of New Orleans, acknowledging his election as a corresponding member.

A letter was received from Henry Dexter, Esq., of Cambridge, Mass., offering to furnish the Academy with a duplicate in plaster of Paris of his bust of Agassiz, at the price of $25. The Corresponding Secretary was authorized to order a copy.

Exchanges received were laid upon the table.

The Corresponding Secretary submitted his Annual Report for the year 1873, which was read and accepted.

By the report, it appeared that

The number of Societies and individuals upon our Foreign List of Exchanges is, at present, 196; on the Home List, 82—278 in all. During 1873, 12 were added to the Foreign List, and 5 or 6 to the Home List.

In July last, No. 1 of vol. iii. of the Transactions was issued from the press, and immediately distributed to foreign correspondents, through the Smithsonian Institution, and to home correspondents (including Canada and Mexico), through the mail.

During the year, a full set of our Transactions has been sent to each of the following new correspondents, which have been added to the lists:

1. The Astronomical Observatory at Leiden.
2. The Royal Institut de Géologie de Hongrie.
3. La Société Entomologique de Belgique.
4. La Sociedad Mexicana de Geografía y Estadística, Mexico.
5. L'Observatoire Impérial de Rio Janeiro.
6. The Chicago Public Library.
7. The Louisiana State University, Baton Rouge.

No. 1 of vol. iii. Transactions has been sent to the Academy of Sciences of Paris, France, by order of the Academy, with an offer to exchange publications, and to send a full set, if accepted.

Eighteen numbers of the Transactions have been sold for $18.50.

Two extra copies were sent to the

1. Royal Academy of Sciences of St. Petersburg.
2. Royal Academy of Sciences of Munich.
3. Royal Academy of Sciences of Vienna.
4. And 10 extra copies to the Smithsonian Institution, Washington, for distribution at discretion.

We have received publications in exchange, during the year, from 89 Foreign Societies, and from 24 Home Societies, on our List of Exchanges, and also donations of 64 volumes and pamphlet publications from about 50 individual donors, not upon the regular List of Exchanges.

From these Foreign Societies we have received about 480 volumes and numbers, and from the Home Societies on the list, about 80 volumes and numbers; making approximately, a total of—Foreign 480, Home 80, Individuals 64—624 volumes and numbers as an addition to the Library.

And besides these some volumes and numbers have been directly presented at the meetings of the Academy, which are not entered on my record, but go directly to the Librarian.

The number of corresponding members on our list (and still living so far as can be ascertained) is 115, of which three have been elected during the past year. The number already marked deceased is 30.

Of No. 1 of vol. iii. of the Transactions, there have been distributed through the Corresponding Secretary, to exchanges 279 copies, extras 16, —total 295. Copies sold, of all numbers, 18—total disposed of 313. Full sets donated to new Societies, 7 equal to 56 numbers—grand total (nearly) 369 numbers.

The expenditures for the year were $11.27 in excess of the receipts, the balance being carried into the next year's account.

Our foreign exchanges have been transmitted, both ways, as heretofore (almost entirely), through the Smithsonian Institution and its foreign agencies, without other expense to us than the cost of transportation between Washington and St. Louis. The Academy is under great obligations to the Smithsonian Institution for this gratuitous and very important service. Without it our system of exchanges would be scarcely possible with our present means.

The Treasurer submitted his Annual Report, which was referred to auditors, and, being found correct, was accepted. The whole expenditure during the year was $1138.24, and the balance in the treasury was $350.26. A year ago there was a balance of $639.50, and $849 had been collected. The printing of the Transactions had cost $957.44. The Treasurer had been allowed ten per cent. for collecting, and had defrayed the expenses of the office. There was $500 yet to be collected.

Mr. J. R. Gage, Assistant State Geologist, of the Missouri Survey, exhibited an interesting collection of pottery, arrow heads, and other relics from an ancient Indian mound in Issaquena Co., in the State of Mississippi, upon which he made some extended remarks, which, at the request of the Academy, he intends embodying in a paper to be published in the Transactions.

The President, on retiring from the chair, delivered his Annual Address as follows:

Gentlemen of the Academy of Science: — On this occasion, the first meeting in the eighteenth year of your chartered existence, I have the honor to congratulate you upon the improved character of your status as an academy of science. During the year last closed you have been able to recommence the publications of the Transactions of the Academy which had been suspended since the year 1868. Two hundred and ninety-five copies of the first part of vol. iii. have been sent to exchanges. For the most part, our Library is filled with valuable scientific works sent to this Academy from the numerous kindred societies at home and abroad that are recorded on our exchange list. From this source we have received the past year an aggregate of 600 volumes and numbers of scientific periodicals. The importance of sustaining the prestige of the Academy by a frequent publication of its transactions will be readily understood and appreciated. The resolution of the Academy to publish its proceedings as often as a sheet of sixteen pages is in readiness for the printer will be carried into effect, and the flourishing state of your finances gives assurance that in the future you will be able to meet the expense necessary for this purpose.

The continual accession of new members is a matter of further congratulation. The provision made for the preservation and exhibition of your Museum should encourage on all hands zealous coöperation in collecting specimens, and a few years of such effort would in a great measure make good the disaster which overtook the Academy's Museum in 1869.

While affairs are thus prosperous within our organization, the cause in whose name we assemble, Science—and more especially Natural Science—is in a state of extraordinary prosperity. Never before in the history of the world have so many first-class minds devoted their energies to its prosecution. Never before have brilliant discoveries followed in such rapid succession. Natural Science has from the first befriended the cause of humanity. By means of Science man has gained an empire over the powers of Nature, and the emancipation of the human race from want and suffering has been the result. The pursuit of Science in a free and disinterested manner, with the sole view of eliciting truth, has rewarded its votaries with the meed of usefulness, besides the satisfaction of arriving at truth. The illustrations of this are matters of daily occurrence. Few persons who listened to the lectures of Tyndall on Sound, and saw his minute and painstaking experiments, made with a view to discover the *rationale* of the so-called "singing flames," would have expected that from so whimsical an affair a useful invention would arise. Yet among the most valuable applications of Science to the Arts recently made, is an alarm-lamp which indicates to miners the presence of dangerous, inflammable gases in the mine. The vibration of the flame, acted on through wire gauze by the explosive gases, produces a sound varying in pitch and intensity according to the height and calibre of the lamp-chimney.

The cultivation of Soience for itself, as Tyndall informed us, is the great desideratum. No one can tell in advance which province of Science will prove the most useful in application. Free, disinterested investigation of Nature—the trivial manifestations of force as well as the most gigantic—is the surest course to discover the truth, and it is also the method that will prove the most useful to the well-being of man.

But the fruits of Science in giving to man the direct mastery over Nature are nowhere more desirable than to us who inhabit the valley of the Mississippi. What opportunities to study the laws of mineral formation has the citizen of Missouri! What immediate fruits will reward the patient enthusiasm of the investigator! How much does the improvement of the Mississippi river to-day need the elaboration of a scientific theory respecting the deposit of alluvium by rivers! A careful induction based on long and patient study of such deltas as those of the Ganges, the Nile, the Danube, the Rhine, and the Mississippi, would be worth to our commerce enough to pay for the endowment of all the scientific schools in this nation. The famous Vauban pronounced the bars at the mouth of rivers "incorrigible." But a thorough knowledge of the laws which control the transportation and deposition of the solid matter borne by these streams to the sea, and the action of the tides and waves upon their currents at their mouths, will simplify all the problems involved in the endeavor to deepen the channels through them.

A remarkable fact has been observed by savants, that the alteration of river courses in consequence of the rotation of the earth, an influence which would lead us to expect the continual erosion of the western bank of the Mississippi, is neutralized here on account of a gradual upheaval of the western chains of our continent, and the Mississippi system and likewise the Texas system of rivers—in short, all the rivers that flow into the Gulf of Mexico uniformly tend toward the southeast. This tendency is promoted by the gradual subsidence going on in the Appalachian chain of mountains. Whether these views are well-founded or not, they serve to call attention to the importance of noting the modification of local iaws of alluvial deposit by vastly extended surface upheavals and depressions. The local action of the waves of the sea, of the oceanic currents, of the tides, of the river freshets, must be studied, and, in addition to this, the behavior of the entire river system revealing the slow but inevitable influence of terrestrial rotation and vast upheavals or depressions.

When we look abroad upon Nature as presented to us by Science we realize more and more fully the words of Humboldt in which he describes it as a "whole moved and animated by internal forces," a vast process in which even the "everlasting hills" seem to move and to perceptibly crumble away under the disintegrating influence of the air and water. The gradual contraction of the earth's crust effects a local upheaval or wrinkle, while the perpetual process of the atmosphere undermines and levels all.

Foremost upon our attention to-day, the means and appliances adopted in the interest of the science of Meteorology force themselves. The establishment of the United States Signal Service and the daily collection and publication of the results of the scattered observations is one of the greatest events in the scientific world of to-day. Consider only how it has cleared up the theory of storms. The valuable researches of Redfield, Espy, Henry, Loomis, and Dové, are complemented and reduced to harmony by the generalizations of the Signal Service.

Cyclones are formed by the meeting of contrary winds. The grand "battle-ground" on which our cyclones arise—and all storms are proven to be cyclonic—is the circle of trade-wind influence, and this in summer is between the 10th and 12th parallels of North latitude. The tendency of the southeast trade-winds to invade the territory of the northeast trade-winds by sweeping over the equator into our hemisphere is the origin of cyclones, according to Maury. All collisions of contrary winds tend to produce a vortical whirl by reason of the influence of the revolution of the earth. A wind blowing southward is deflected to the west, and one blowing northward is deflected to the east. Hence the movement of cyclones in the Northern hemisphere is found to be opposite to the movement of the hands of a clock, while in the Southern hemisphere the movement is the same with the hands of a clock. Any vortical movement in the atmosphere, no matter how slight, produces an ascending current of air, and this relieves the pressure of the atmosphere from the barometer. Hence the law of storms says the winds blow from all sides towards a point where the barometer is low.

Again, the upward current of air in the centre of a vortical whirl carries up the warm moisture-laden atmosphere, which immediately becomes condensed, and a fall of rain or hail occurs. But, again, the condensation of vapor into rain-drops is accompanied by the evolution of heat, and this heightens the momentum of the ascending current. Hence the tendency of a small vortical movement in the atmosphere is to expand into a general cyclone. The ultimate result of the cyclone or storm is to restore an equilibrium between the upper and lower strata of the atmosphere in regard to temperature and moisture; the storm proceeds until the upper stratum has become warmer and more moist, while the lower stratum has become cooler and less charged with moisture. The vast movements of the air between the equator and poles to restore the equilibrium act continually to produce a tension between the upper and lower strata of air, and thus give occasion to the ever-recurring cyclones. Another remarkable feature in the theory of storms takes note of the fact that while there is more water in the Southern hemisphere than in the Northern, yet there is less atmosphere. The cause of this has been shown, mathematically, to be found in the fact that in the Northern hemisphere, where there is more land and more numerous and lofty mountain chains, the resistance to the deflecting tendency which arises from the earth's rotation is greater than in the Southern hemisphere. The consequence of the more rapid and regular movement of the winds in the Southern hemisphere is a greater depression there. The trade-winds blow from the Southern hemisphere with greater velocity and momentum, and overcome the northern trade-winds, forcing them several degrees north of the equator, permanently.

The subject of Meteorology, considered in its more general aspect, is one that influences many important phases of human interest. In some remote future, when the air-currents are thoroughly understood, aërial navigation may become entirely practicable. Even now, when so few of the conditions are known that the weather can be foretold for scarcely one week in advance, our commercial marine is greatly benefited. When it becomes possible to forecast the season for one or three months ahead, the farmer will be provided with the means to avoid the uncertainty attendant on his vocation. "Scientific agriculture" may then exist as a fact as well as in name.

Next among the important items which the scientific interest of the new year brings to mind is the approaching transit of Venus. On the 8th of next December occurs the first transit of Venus that has occurred since the improvement of the telescope. It is one hundred and five years since the last one took place. Extensive preparations are making in this country and in Europe for the most accurate mathematical verification of the several elements of the phenomenon. The moment of contact with the limb of the sun, if fixed accurately from different points of observation, will settle the question of the sun's distance. Indeed, the computation used until recently was based upon the observations made on the last transit in 1769, before the invention of accurate instruments. Photographs will be taken at the different stations at various stages in the progress of the transit. Spectroscopic observations will be made in several instances. The spectroscopic is more accurate than any other method for the measurement of the exact moment of the second or interior contact with the sun's limb. The German, Russian, English and American corps of observers, already selected, are training for the occasion by practising with the chosen instruments upon an apparatus used to represent the transit. Stations for observation will be chosen in Russia, Siberia, China, Japan, and on sundry islands in the Indian and Pacific Oceans. The importance of accurately determining the distance of the earth from the sun cannot be properly estimated unless one remembers that that distance is taken for the unit of measure in most of the calculations of Astronomy, and that a change in the standard accepted will involve a change in all the distances as recorded in our astronomical tables.

In my inaugural address before you two years ago, I spoke of the wonderful calculations of the elements of the orbit of Neptune by LeVerrier. On the morning of the 24th of March last, another confirmation by actual observation was made of the existence of a planet within the orbit of Mercury, to which the name of Vulcan has been assigned. Certain disturbances in the motion of the planet Mercury had long since led LeVerrier to calculate the elements of a planet interior to it, and with a period of revolution which he computed at $19\frac{7}{10}$ days. Certain well-defined circular black spots have been observed passing rapidly across the sun's disc, the same having been seen by a French physician in 1859, and by an observer in Manchester in 1862. Mr. Hind of the Twickenham Observatory, England, made calculations from these and other observations, and predicted its transit across the sun's disc on the 24th of March, 1873, and at that time it is said to have been actually seen by an observer at Shanghai, China.

It has been long suspected that Venus is accompanied by a satellite. If such be the case, it is more than probable that the observations at the time of the transit next December will detect the fact.

The brilliant discoveries made by the spectroscope on its first introduction have been eclipsed by still greater ones made within the past two years. The method of measuring the rise and fall of the hydrogen flames in the sun by the variation of the lines in the spectrum has made it possible to keep a record of the prominent disturbances on the solar surface for every day in the year not obscured by clouds. The observations of Dr. Huggins, of the Royal Astronomical Society, upon the movements of the "fixed" stars, have been before the public for some time. He finds by the variation of the lines in the spectrum that some stars are approaching us at rates exceeding fifty miles per second, while others are receding quite as rapidly. Sirius is at present leaving our system at a rate exceeding twenty miles per second. That there has been some remarkable change in the movement of this star in respect to the solar system we may well believe when we read Humboldt's statement, that observers who noted its appearance two thousand years ago describe it as a bright red star. Its rate of departure must have very much diminished during that time in order to shorten the wave-lengths sufficiently to change its color from a bright red to a light yellow.

Science has reached a stage wherein its own progress, reacting from the effect of mechanical inventions which it occasions, is very materially accelerated. To say nothing of such instruments as the spectroscope and the transit instruments, the improvements in the manufacture of object glasses for achromatic telescopes have rendered possible unhoped for achievements. One of the most skilful manufacturers of telescopes now living—our own countryman, Clark—has undertaken the construction of a refractor for the United States Observatory which will have a clear aperture of 26 inches! It should have double the power of the celebrated instrument at Cambridge which has done such eminent service, its defining power being superior to the great reflector of Lord Rosse.

But perhaps the most wonderful instruments invented to supplement our imperfect senses are those employed to render visible the contour of the electric spark or the lightning flash. Professor Rood's contrivance for this purpose is an ingenious combination of Becquerel's phosphoroscope with Wheatstone's photometer. By it he can measure the duration not only of the entire flash of electric light, but can follow it through its several stages, and measure each one even down to the ten billionth part of a second. He finds that the duration of the brightest electric sparks is but one twenty-five millionth of a second each. The singular property of phosphorescence, or the retention of light after exposure to it by such bodies as phosphorus, the diamond, and some others, is discerned by Becquerel's instrument to belong in a less degree to all bodies. A "seismograph" is an instrument for the automatic registration of earthquake shocks. Whenever the shock comes, it records all of its phases by means of a very delicate and complicated machine. Its direction, its intensity, whether vertical or horizontal, the number of shocks, the time of their occurrence and their duration, all are recorded. This apparatus is used in the Observatory of Mount Vesuvius. A similar device has been applied to register the history of the waves of the sea, and also for detecting and measuring atmospheric electricity.

The spectroscopic experiments on the Nebulæ have proved them, at least in some instances, to be of a gaseous instead of a solar nature. More wonderful has been the revelation regarding the nature of comets and meteoric showers. Schiaparelli identified one of the comets of 1862 with the August meteor shower. It requires six hours for the earth to traverse the cometary ring that intersects the earth's orbit at the point which it passes on the 10th of August. Further calculations have identified the comet of 1866 with the November shower of meteors, which has at times presented the startling phenomenon of a rain of falling stars. Thus the former terror and dismay which attacked the strongest hearts on the approach of a comet, and more especially upon the astronomical prediction of the return of the great comet of 1264 to cross the earth's orbit at a point near the actual position of the earth, seems to have been groundless. It was stated on high authority that a collision with a comet would "shiver the earth to atoms and diffuse it throughout space." But we now know that such a collision with a comet takes place every thirty-three years, and is only a grand display of fire-works. It takes place in fact, to some extent, twice every year, and possibly three or more times. However harmless such collisions are upon the constitution of our planet, we are convinced that the impact of such bodies upon our atmosphere must generate large quantities of heat, and thus have an important influence upon the general formation of cyclones. What the specific form this influence may be, it remains for the science of Meteorology to investigate and determine. Thus not only the phenomenon of the restoration of equilibrium between the upper and lower strata of the atmosphere demands the attention of the student of Meteorology, but he must note the disturbing elements that arrive from the remote regions of space. He must note especially the cyclones and vast upheavals in the sun which appear as spots and protuberances on its surface, and seem to be connected in some mysterious manner with the phenomena of the aurora borealis, of earthquakes, of the variations of the magnetic needle, and of the electrical currents moving round the earth. The doctrine of the correlation of forces, now adopted by all physicists, will perhaps, in time, lead us to the exact knowledge of conditions under which heat, light, electricity, and magnetism, undergo metamorphoses into each other.

The prevailing tendency of the science of our age is synthetic. It places before itself the problem of combination and generalization. While special analytic studies are pushed out on all hands by troops of physicists, each one desires to see the modifying result of his researches upon the net total of previous observation.

It is to be expected that the study of the physical conditions of the life of man will always attract most attention. At present this phase of Natural Science takes three directions. The first is that of the natural history of Man, its various tendencies being grouped together under the head of Ethnology. One class of observers, like Tylor and Lubbock, study the stages of man's prehistoric life through what geological evidence comes to light. Another class investigate the question of the transmutation of the species under natural conditions and organic reaction or adaptation. Darwin and his extensive school, together with their opponents, occupy this field. Secondly, there is the physiological school, which likewise includes two classes, one—headed by Virchow, Huxley, Bastian, and others—studying the subject of cell-growth and spontaneous generation; another branch noting carefully the correlation between the mental and physiological phenomena. This school is represented by Bain, Maudsley, and others. Then there is another class devoted to Sociology in its various phases: Quetelet studying the subject through statistics, Spencer noting the divergence of the human institutions from the basis of animal instinct, Bagehot discussing the physics of political movements.

From these contributions to the science of Man very many useful modifications have already come into our social organization. The treatment of the Insane has radically changed; Criminal Jurisprudence has been modified; Medicine has been incalculably enriched by the germ theory of disease; the science of Education is undergoing transformation from the effect of the same causes.

In Molecular Physics great progress has been made since the law of transmutation from motion in masses into molecular motion has been developed and applied. But it deserves mention that a recent writer in the *Popular Science Monthly*, Judge Stallo of Cincinnati has criticized with trenchant acumen the several subsidiary hypotheses which have been introduced by scientific men for the purpose of explaining or rendering intelligible the abstract mathematical results of scientific research. The old scholastic caution "not to multiply hypothetical existences without the most obvious necessity for them" is sound and well-founded. The hypotheses of atoms, and of an extremely attenuated ether for the transmission of the waves of light, when made use of for any other purpose than that of a convenient scaffolding for the purpose of clear exposition, becomes dangerous and subversive of the true spirit of Science. It is, therefore, a true service to the cause of Physics to criticize its hypotheses in the manner that Judge Stallo has done. Perhaps no greater service has been rendered during the past year to the department of Molecular Physics than the presentation of his strictures on its Methods.

Turning to the more personal aspect of the progress of scientific discovery, the voyage of the lamented Capt. Hall, in the ship Polaris, deserves more than passing mention. A portion of the crew having drifted 1,500 miles, after incredible hardships were rescued off the shores of Newfoundland by a British steamer. The results of the expedition, when published, will form a valuable addition to science. By reason of the rapid changes in the state of our knowledge regarding aërial currents and ocean currents, the need of careful observation in the polar regions becomes every year more pressing. In this connection, it may be mentioned that, of late, there has been made a series of deep sea soundings, carefully conducted, which has changed the views formerly held as to the possibility of animal and vegetable life at great depths in the ocean.

I am happy to note the fact that the improved facilities for rapid transit in latter years has brought about frequent personal intercourse between the scientific men of different countries. Personal contact serves to stimulate individual endeavor and to encourage self-sacrifice in the pursuit of Science. The late visit of the distinguished physicist, Tyndall, to our shores, is an event of this class, and will long be remembered.

In closing this rapid survey of the scientific situation of to-day, it is fitting that we turn aside to pay our tribute of respect to the memory of the great men whose mortal presence has passed away from us within the year. The illustrious names of Maury, Liebig, and Agassiz, will at once occur to the mind at these words. To Matthew F. Maury, more than to any other individual, we are indebted for what is known of the Physical Geography of the Sea. He is the American star of the constellation to which Ritter and Humboldt belonged. The distinguished John Stuart Mill, born in the same year (1806), and recently deceased, will be remembered in this connection for his labors on Political Economy. Professor Joseph Czermak, of the University of Leipsic, whose researches into Hypnotism in Animals have greatly interested the scientific world, died last September. Earlier in the year, America lost one of her most eminent Botanists in the person of Professor John Torrey, whose reputation has been established for the past fifty years in this country, and in all countries where Botany is studied. Baron Liebig, universally celebrated for his labors in Organic Chemistry—a department which owes almost its very existence to him—died on the 27th of last April. The scientific basis of Agriculture has been furnished mostly by his writings. He was—like the other great men who died during the past year—born near the beginning of the present century, in 1803, and was four years the senior of Agassiz. Both he and Agassiz owed much to the favor of Alexander von Humboldt in early life.

Side by side with the great names of Linnæus, Cuvier, and Humboldt, the name of Agassiz is destined to shine. Educated at the universities of Erlangen, Heidelberg, and Munich—having studied Anatomy and Physiology under Tiedemann, Zoölogy under Leuckert, and Botany under Bischoff—he formed intimate friendships with such great men as Oken the Zoölogist, Martius the Botanist, and Schelling the Philosopher. He interchanged views with Oken on classification and studied embryonic development of Animals with Döllinger. He enjoyed the respect and esteem of Humboldt and Cuvier, the latter being so much delighted with his knowledge of fishes that he offered to give up to him all the materials he had collected for a work of his own on the subject. In 1833 it was the liberality of Humboldt that enabled him to publish his great work on Fossil Fishes. To him belongs the credit of being a pioneer in the discovery of the movement of Glaciers. But the chief portion of the biography of Agassiz belongs to the United States. In the autumn of 1846 he arrived in Boston, and the following year a Professorship was offered him in the newly-founded scientific school at Harvard. His numerous lectures and writings, his wide correspondence and unremitting observations in the field of Zoölogy, have made him the best known of scientific men. His great work—undertaken in 1857—"Contributions to the Natural History of the United States," remains a fragment; but there are hundreds of his disciples scattered all over the land who have availed themselves, step by step, of all his latest results, so that his views will be more prolific of books hereafter than ever before. His journey to Brazil in 1865, and explorations of the lower Amazon, resulted in the discovery of upwards of 1,800 new species of Fishes. With him has passed away the most potent personal influence in Science since Alexander von Humboldt. Good cause, then, have scientific bodies like our own to turn aside from their work and pay their tribute of respect to the memory of their greatest collaborator.

But Science remains with us though life flits away. The noblest word that can be said in commemoration of the services of these illustrious dead is this: They labored for the cause of Truth; and Science, the temple of Truth, will bear eternal witness to their endeavor.

The annual election of officers of the Academy for the ensuing year resulted in the choice of the following gentlemen:

President—William T. Harris.
1st Vice-President—George Engelmann.
2d Vice-President—Albert Todd.
Corresponding Secretary—Nathaniel Holmes.
Recording Secretary—Charles V. Riley.
Treasurer—Enno Sander.
Librarian—J. J. Bailey.
Curators—W. B. Potter, H. H. Morgan, and J. Luce.
Committee on Publication—Geo. Engelmann, N. Holmes, C. V. Riley, and W. T. Harris.

January 19, 1874.

W. T. Harris, President, in the chair.

Twenty members present.

The committee appointed to negotiate for the purchase of some cases belonging to J. L. Tracy, of the Fair Museum, reported that it was not advisable to purchase said cases, as the Directors of the St. Louis Public Schools had agreed to supply the Academy with cases so long as the cases were kept in the Polytechnic building.

The report was approved and the committee discharged.

A communication was received from Prof. C. F. Hartt, of Cornell University, inquiring as to how the palæontological works of the late Dr. Shumard could be obtained. The Corresponding Secretary was instructed to communicate the desired information.

The Corresponding Secretary laid the exchanges on the table. He called the attention of members to the Researches of Dr. W.

B. Carpenter on the Surveying Ship *Shearwater* (Proc. R. S. of Lond., No. 138):

Deep soundings for temperature and currents were made in the Atlantic Ocean and the Mediterranean Sea. It was ascertained that there was a deep current of cold water in the Atlantic downward from the Arctic Ocean to the Equator, and a superficial current of warmer water from the Equator to the Arctic Seas—a vertical circulation, which Dr. Carpenter explained on the principle of gravity. There was a ridge across the straits of Gibraltar, and there was as an upper current flowing inward from the Atlantic and an under current flowing outward from the Mediterranean. In the depths of the Mediterranean, there were but few signs of animal life. This was to be attributed to the effect of the fine silt from the Nile and other rivers, held in solution in the waters. The glacial cold in Britain in the Quarternary period might be explained on the hypothesis of Arctic land shutting off the circulation of currents into the Arctic Sea, whereby the Gulf Stream would be stopped and the Arctic cold would reach further southward. The existing deposits at the bottom of the Atlantic were identical with those of the Cretaceous period, containing the same *Globogerinæ* as the British chalk formation; and it was suggested that the Cretaceous period still continued at the bottom of the Atlantic.

Mr. Riley presented for publication a paper entitled "Descriptions of Two New Mites," being descriptions of *Tyroglyphus phylloxeræ* Planchon & Riley, which he found preying on the Grape Phylloxera underground, and of *Hoplophora arctata*, n. sp., which is found in conjunction with it. Referred to Committee on Publication.

Mr. J. R. Gage called attention to the necessity of investigating the mounds in the vicinity of St. Louis, and moved that a committee be appointed to undertake the investigation at their own expense, the Academy to pay only for the labor of opening the mounds.

Mr. J. R. Gage was appointed on the committee, with power to choose his own assistants, and, on motion of Dr. Forbes, the President was authorized to draw on the Treasurer for $50 for the purpose stated.

Mr. Todd offered the following resolution, which was adopted:

Resolved, That a Committee of three be appointed to draw up a suitable memorial to be addressed to the General Assembly of the State of Missouri, praying that the present laws authorizing the operations of the geological survey of the State and of the State Entomologist may not be repealed, nor said operations suspended, believing that the small saving of money to be realized by such suspension would be no compensation for the much greater loss which the commercial and agricultural industries of the State would suffer thereby; the same to be signed, when drawn, by the President and Corresponding Secretary, under the seal of the Academy, and forwarded to the President of the Senate and the Speaker of the House.

N. Holmes, S. Reber, and Richard Hayes were appointed on the committee.

Capt. Silas Bent and Chas. Doty were elected associate members, and J. E. Teft a corresponding member.

February 2, 1874.

W. T. Harris, President in the chair.

Thirteen members present.

Publications received, laid upon the table.

Mr. Albert Todd presented a specimen of silver ore, of very rich quality, from the mines of Georgetown, Col.; also a curious piece of a Rock formation found in the same locality, and known there by the name of "Devil's Beeswax," because of the grooves upon its surface resembling the cuts made in beeswax by drawing a thread over it.

Capt. C. F. Bendire exibited a curious lizard—the *Holodema horridum*—which he had collected in Arizona. It is reputed poisonous, but Prof. Baird of Washington doubts the fact of its being so, though it has a groove in the back part of the tooth like that of some poisonous serpents.

Dr. J. S. Copes presented, in behalf of the New Orleans Academy of Science, specimens of a very fine rock salt taken at a depth of 80 feet from the salt formations on Petite Anse island in Vermilion Bay, La. It is a very pure salt, but cannot profitably be brought to the New Orleans market in competition with that which is brought over as *ballast* from Liverpool. He also presented specimens of sulphur taken from the mines of Calcasieu Parish, La., said to be the largest deposit in the world.

The meeting closed with a metaphysical discussion, participated in by Messrs. Holmes, Todd, Harris, Copes, Briggs, and Riley, on the imponderables.

February 16, 1874.

W. T. HARRIS, President, in the chair.

Nine members present. Prof. J. W. Clark, of Torquay, England, assisting.

The Corresponding Secretary presented a communication from the Society of Acclimatization of Paris, asking for certain numbers of our Transactions, and was authorized to supply them.

The exchanges were laid upon the table, together with a map of the sources of the Snake River, from the Department of the Interior, prepared by the U. S. Geological Survey, being the first authentic topographical map of that region; also the monthly weather reports and charts for November, 1873.

Messrs. Samuel Hays, R. A. Campbell, Robert S. McDonald, and Hon. Chas. P. Johnson, were elected Associate Members.

March 2, 1874.

W. T. HARRIS, President, in the chair.

The Recording Secretary being absent, R. Hayes was appointed to act *pro tempore.*

Publications received, laid upon the table, and among them a copy of Professor Broadhead's Geological Report, for which the thanks of the Academy were voted.

Judge Holmes spoke of the contents of some of the publications received, and particularly of an article in regard to measurements of the human brain which tended to show the effects of education on the increase of the brain and especially of the frontal lobes. A discussion followed on the distribution of the early races of man, and the evidences of geology and philology on the same subject. Judge Holmes thought that the evidence of philology did not extend sufficiently far back to be of much value in the question of the origin of man. Mr. Harris thought that, though the evidences from philology do not extend so far back as those from geology, they do go back at least 13,000 years. He did not believe that geology shows whether migration was from India westward to Europe, or from Europe toward India. He was of the opinion that philology shows the migration to have been from Europe toward India. Judge Holmes thought that the origin of man could be traced to an East Indian centre, somewhere near the island of Borneo, and that the distribution took place from that centre. Dr. Maughs stated that the differences in the races were as great in the remote past as they are at the present day, and that there is no evidence that the negro ever came from India.

Dr. Engelmann spoke about the meteorological conditions of the past winter.

He remarked that the commonly expressed opinion, that it was a very mild winter, one of the mildest we ever experienced here, only proved how short our memory was, and how soon we forgot what was not of immediate interest and experience. The past winter was indeed a mild one if we compare it with the one immediately preceding it, for that was together with the equally cold winter of 1855–56 the coldest in a series of 40 years, as far back as his observations reach — 26°.3. But, compared with the average of our winters, the last one was only half a degree above the average, and we have had in the above specified period eleven winters which were milder than the past; the very mildest was that of 1844–45, with 40°.4; the average is 33°.6, and last winter showed 34°.1. The subjoined table will more fully explain these conditions:

			Mean	Lowest mean.		Highest mean.	
December, 1873	35°.9	.. for Dec.	33°.4	23°.3	1872	41°.4	1862
January, 1874	33°.9	.. " Jan.	32°.0 ...	19°.3	1857	40°.5	1845, 1858
February, "	34°.5	.. " Feb.	35°.3	20°.8	1838	44°.1	1845
Winter.........	34°.8	.. " Win.	33°.6	26°.4	1855-56, 1872-73	40°.4	'44-45

February, usually the warmest of the three winter months, was colder than either December or January eight times in thirty-eight years: of these eight winters, four were very mild and four very cold.

Within the last forty years we have had December milder than in the past winter nine times; January was fifteen times and February was twenty-three times milder than last month.

I ought to have stated that we ought not to be blamed too much if we considered the past winter an unusually mild one, for not only, compared with the immediately preceding one, was it very mild, but it was milder than the eleven preceding ones; we have to go back to that of 1862–63, with 38°.2, to find one so mild or milder. This period of eleven years might possibly be brought in connection with the well-known period of the sun-spots, and the phenomena now usually connected with them.—I may however be permitted to state that such general cosmic causes would exert their influences over the whole globe, while we find the temperatures of continents or even parts of continents greatly at variance; the past winter was a mild one in Central and Western Europe, while in Southern Europe it was very cold, and to our very cold preceding winter corresponded an unusually warm one throughout Europe; so that we have to look for more local, or at least terrestrial, causes for these conditions.

A peculiarity of this winter was its dampness and cloudiness, and evidently, in connection with this, the smaller range of thermometrical extremes, as the following table exhibits:

	Minimum.	Maximum.	Range	Minimum in 40 years.		Maximum in 40 years.	
December, 1873	14.0	54.0	40.0	—19.7	1872	74.5	1861
January, 1874	— 2.0	66.5	68.5	—23.0	1864, 1873	72.0	1864
February, "	11.3	61.6	50.3	—15.0	1856	81.0	1840
Winter 1873-74	— 2.0	66.5	68.5	—23.0	1864, 1873	81.0	1840

The quantity of rain and melted snow was by 1½ inches greater than the average, and much greater than that of the two preceding winters, when in 1872-73 it was 5¾ inches and in 1871-72 only 3⅓ inches.

	Inches.		Inches.
Rain in December, 1873......	4.43	Average for December......	3.09
" January, 1874......	2.47	" January........	2.17
" February, "	2.23	" February	2.55
" Winter 1873-74......	9.13	" Winter.........	7.81

The rather low temperature of February has retarded vegetation in a degree not very pleasant to us, but no doubt very useful to the country, where a too forward spring vegetation often is the precursor of defective grain and especially fruit crops.

Mr. J. R. Gage was added to the list of Curators.

March 16, 1874.

ALBERT TODD, Vice President, in the chair.

Sixteen members present.

Publications received, laid upon the table.

Mr. Todd presented on the part of Mr. B. F. Young some fragments of a skull and three pieces of ornament made of shells from the Big Mound.

He remarked that the subject of mounds had interested the Society a good deal, and it would be remembered that at a late meeting an appropriation was made for the purpose of beginning an exploration of some of the mounds in this vicinity. Considerable regret had been expressed that there was such neglect in reference to the Big Mound when it was opened. A large number of remains were found there. According to the best evidence the mound consisted, first, of a natural elevation, then on the top of that an artificial elevation. Mr. Young was present at the opening of the mound, and stated that near the surface were some skeletons in good condition and evidently of recent burial. In the centre of the mound, about 25 feet below its apex, there was an excavation or trench, running north and south, in which there were a good many skeletons. One of these had a fine natural appearance, but it fell apart as soon as it was handled. One of the specimens now presented was a fragment of it.

Mr. Terry stated that he had a number of specimens of bones and ornaments similar to those presented; also a piece of cloth apparently woven with some kind of wood, a conch-shell, and several small shells used for beads, all from the mound. He promised to present them to the Academy.

Judge Holmes said the piece of blanket and the shells would be very acceptable to the Academy.

These small shells belonged to the genus *Marginella*, and came from the sea-coast. The same species of shells were found in the Grave Creek Mound, near Wheeling, Va., and in many other Western mounds. In 1870, he took some of these shells from the Big Mound at St. Louis to the Museum of Comparative Zoölogy of Cambridge, where they were identified by Prof. Shaler as a species of *Marginella*, and they were presented to the Museum of Ethnology at that place. They were perforated with small holes for use as beads.

Judge Holmes spoke of Mr. Foster's work on archæology as containing the best account of these mounds. He states one fact with emphasis, and that is that all the skeletons found fall to pieces unless immediately immersed in a solution of glue. This fact argues the great antiquity of the mounds. Mr. Foster also establishes pretty clearly that there were two different types of skulls in these mounds, the older skulls being more dolycocephalic than the later. The mound-builders certainly belonged to a very remote antiquity. Writers have tried to approximate the lapse of time by the growth of forest-trees, but it is altogether superficial and no criterion. Some figure out the age at from 600 to 1,000 years, but the probability is that it is nearer 10,000. Another fact seems to be established by these researches, and that is, that the Peruvians, ancient Mexicans, and the inhabitants of this country, were of the same race. The inhabitants of this country certainly had some civilization, as the fortifications, specimens of pottery, etc., go to show. The question then comes, "By what means was this civilization broken up?" From all the evidence, the strong probability is that the people inhabiting the more northerly regions retained their savage customs, and crowding down upon the more peaceful inhabitants of this valley, the latter were finally driven out and pushed southward. Yet we have every evidence that they were the same race of people. This involves the manner in which population began here. We are certain that the country became peopled at a date so remote, and the residence here has been so long, that the traits of the original settlers have had time to undergo much modification. The evidence goes to show that there have been several migrations from the other continents in very remote times, instead ot one. It is well known that there have been, at various periods, driftings of boats on ocean currents from China and Southern Asia to the coasts of America. It is an established fact that traces of resemblance have been discovered between the Chinese and some tribes of Indians: a tribe was discovered in Central America who had a language similar to the Chinese. With regard to the age of the mounds, the stone structures in Central America were undoubtedly older, and the colossal stone buildings high up on the Andes were probably still older. The stones used in this building were of immense size, and necessarily required some kind of leverage and rollers, as used by the ancient Egyptians, in raising them; and this fact showed that there must have been some knowledge of mechanics among the builders.

Dr. Engelmann thought that all discussion about the age of the mounds was speculative. The condition of the bones would be governed altogether by circumstances. An alternation from moisture to dryness would bring on an early decay, while uninterrupted and favorable conditions might secure preservation hundreds and thousands of years longer than when subject to change or to other conditions.

Judge Holmes said that Foster had reviewed all the facts with great care and ability, and he thought the mounds of much higher antiquity than that generally accorded them.

A communication was read from Mr. R. A. Campbell to the effect that he is preparing a Gazetteer of Missouri, and requesting historical contributions thereto.

Dr. Engelmann submitted a communication from the Agassiz Memorial Comittee, at the same time stating that at a meeting in Boston a committee had been appointed to raise the funds necessary to complete the museum the great scientist began during his life, and which, when completed, would be a monument more appropriate than any other. He was appointed a committee of one to collect subscriptions from members and forward the amount in the name of the committee.

Mr. Albert Todd was appointed a committee of one to take charge of and rent out the lot donated to the Academy and the Historical Society by Mr. Lucas.

G. C. Broadhead, State Geologist, read a paper "On the Occurrence of Bitumen in Missouri," also one on the "Well at the Insane Asylum." They were referred to the Publication Committee.

Frank A. Fitzpatrick, Thomas DeWitt, and Dr. G. J. Engelmann were elected Associate Members. Jno. P. Jones of Keytesville, Mo., was elected a Corresponding Member.

April 6, 1874.

W. T. Harris, President, in the chair.

Fourteen members present.

Publications received, laid upon the table.

A paper "On the Climatic Changes of Illinois and their Causes," by Mr. Amos Sawyer, was read and referred to the Publication Committee after having elicited some discussion.

Judge Holmes called attention to an article in the "American Journal of Science and Arts," by Prof. O. H. Marsh, which very strongly supported the hypothesis of evolution by decrease of toes in the fossil *Ungulata*.

Prof. Marsh, in discussing the genesis of the Horse, suggested that the line of descent was through *Orohippus*, of the Eocene; *Miohippus*, and *Anchitherium*, of the Miocene; *Anchippus*, *Hipparion*, *Protohippus*, and *Pliohippus*, of the Pliocene; and *Equus*, of the Quaternary and recent. *Orohippus* has all four digits on the fore-foot; in *Miohippus* the fourth has disappeared; in *Hipparion* there are three, but the outer ones are too short to be of any use; while in *Equus* they are represented only by rudimentary splint bones. He thought that while it is plain that the change from the cretaceous 5-toed vertebrates involved some kind of continuation, the problem was to get at a conception of the mode and manner of that continuation. Continuous descent as from father to son—from individual to individual—was an erroneous conception. Descent is only from the pair, and there is an interweaving of pairs until all are related. The individual perishes, and nothing continues to live or to change but the type, or the ideal species. This view presents us with the true conception of the doctrine of evolution; and so conceived that doctrine would cease to be so objectionable. Such a conception is in harmony with the idea of new creation and also of evolution.

Mr. Riley thought the process of evolution was not a matter of conception but of fact; that modification through climatic changes, natural selection, and the other natural influences now recognized by evolutionists, were suffic ent to account for the origin of species; and that to conceive of the modification through any other means than descent was begging the question, and only another way of expressing the old idea of special creation.

Mr. Todd presented two newspaper accounts of the late terrific storm at Alton, Ills., for preservation in the records.

Mr. E. Harvey was elected an Associate Member.

April 20, 1874.

ALBERT TODD, Vice President, in the chair.

Publications received, laid upon the table.

The following communication from Mr. Amos Sawyer, of Hillsboro, Ills., was read and ordered to be inserted in the proceedings:

THE METHOD ADOPTED BY SQUIRRELS FOR SECURING THEIR WINTER'S FOOD.

It should be our constant endeavor to correct errors wherever found, even in so small a matter as the one to which I shall now direct your attention.

I had been puzzled to know why it was that during cold winters the squirrels became poor, and not unfrequently starved to death, notwithstanding that nuts of all kinds had been very abundant the previous fall. I therefore concluded to watch the succeeding fall and see just how they secured their winter's supply of food; and it was while hunting in the woods that I made the discovery that the squirrels (I refer to the Gray and Fox) do not lay up their winter's store of nuts in hollow trees, as all our natural histories teach; but take a nut in their mouth, and, descending to within a few feet of the ground, jump from the tree, and where they touch the earth bury the nut; and never more than one in a place. The wisdom of this measure is plain to be seen; for if they stored all their nuts in a hole in a tree, the wood-mice, which abound in the timber, would be sure to find and devour their supply, or some other squirrel appropriate them; whereas the other way they can lose but few during the winter.

After cutting all the nuts from a tree, they turn their attention to those that have fallen, but *always* climb a short distance up the trunk of a tree and make their jump before planting: the object may be to better observe if they are watched by an enemy, or, remembering how far they bound, find it easier to get their food in the winter by repeating the jump: at all events, where you find one nut, by going round the same tree in a circle you will discover more, placed with almost geometrical precision the same distance from it. I have never seen them recover their food, only store it, so do not know what process they adopt.

The only objection to their plan is that during severe weather in winter they are unable to open their little caches, and if it continues for any length of time they become poor in consequence.

Although this may at first seem of little importance, yet by calling attention to the fact it will enable some author to correct the old and false idea, when convinced that my statements are correct. These mistakes arise chiefly from the difficulty of making *personal observations* in order to confirm the conclusions of others.

Too much stress cannot be laid upon the importance of observing, and reporting the result of such observation either in confirmation or denial of the accepted theory as regards the habits of animals, for by this means only can we hope to arrive at correct conclusions.

Mr. Riley, while he agreed with the writer that too much stress could not be laid on the importance of testing accepted views by personal observation, yet thought it was even more important not to make sweeping generalizations from isolated observations, when the last conflict with long accepted opinions. He had himself seen the abundant remnants of what were taken for squirrel winter stores, in holes in felled trees, and could not believe that naturalists like Audubon and Bachman were all astray in this matter.

Mr. Geo. B. McLellan said he had had much experience in hunting squirrels, especially the Gray Squirrel; and, however true Mr. Sawyer's story may be in his own locality, it cannot apply to the extreme north; for, 1. The depth of snow in winter would prevent access to food thus stored; 2. In New Hampshire, in cutting down trees in which gray squirrels have taken refuge, deposits of nuts have been found in the same holes with the game. It cannot be true of the south; for, 1. The extreme moisture of the winter months in the Gulf States would cause decay; 2. This mode of storage would afford no security against the depredations of wild hogs and other animals that abound in the southern swamps. The probable conclusion is that the habits of the same species of animals differ in different localities and varying conditions of season and climate.

Mr. Hayes said that when a little boy in New Hampshire he had many a time cut down trees and found pints of nuts stowed away, and these had always been considered squirrel stores. Beech nuts were generally shelled.

Dr. Galney inclined to the views of Mr. Sawyer.

Dr. McPheeters presented a piece of rock from St. Augustine, Fla., where it is used as a building material. The specimen drew forth some interesting remarks on the peculiar rock-formation and on the shell-mounds.

Mr. McLellan thought that the existence of natural deposits of comminuted and more or less compacted shells on the St. Johns, and the coast, is the result of the geological growth of the peninsula, which is gradually rising from the sea on a basis of coral; and that in regard to the large artificial shell-mounds on the Indian and St Johns Rivers in Florida, tradition and recent research unite in the conclusion that they have been heaped up by successive generations of Indians who have resorted to the sea-coast periodically for supplies of shell-fish as food.

Dr. Geo. J. Engelmann exhibited a specimen of Venus's Flower Basket (*Euplectella speciosa*), belonging to the sponge family, and made some remarks as to its nature and habits.

Dr. Geo. Engelmann presented an appendix to his paper on Yucca, stating that the genus is purely American, extending from Virginia to Guatemala, but not occurring in South America.

Mr. Riley stated that the Yucca is not only an interesting plant botanically, but that entomologically it is curious as nourishing, first, that most anomalous of moths *Pronuba yuccasella*; second, a rather anomalous butterfly, having so much the aspect of a moth that it effectually links the Rhopalocera with the Heterocera. The larva of this butterfly bores the stems and roots of the different species of the genus, and through the kindness of Dr. J. H. Mellenchamp of Bluffton, S. C., he had lately succeeded in rearing this butterfly. It was long since described as *Eudamus yuccæ* by Boisd. et Lec. from Georgian specimens; afterwards catalogued as *Castnia yuccæ* by Dr. F. Walker of the British Museum, and finally made the type of a new genus, *Megathymus*, by one of our own entomologists, Mr. S. H. Scudder.

Dr. Galney presented some paper pulp made from corn-pith.

Judge Holmes called attention to a valuable work on the Great Ice Age, by Mr. James Geikie, who brings out and establishes a glacial period of great cold, followed by an interglacial period in which the ice-sheets were melted and retired into the valleys—followed then by submergence—then another glacial period—then a warm period down to the present time.

Mr. O. H. Fethers and Dr. L. A. Richardson were elected Associate Members.

May 4, 1874.

W. T. Harris, President, in the chair.

Twelve members present.

Dr. Briggs exhibited a living specimen of *Arctomys Ludovicianus*, which derives its popular name of Prairie Dog from its bark resembling that of the dog. He reminded the Academy that this animal is classed with the Muridæ, although it appears to be the connecting link to the Sciuridæ, its dentition resembling that of the Squirrel, namely, two incisors and two premolars above and below, with four molars on each side above and below. It resembles the European Marmot, and like that animal can be tamed. With regard to the concurrent statement from numerous sources that the Prairie Dog lives amicably with the Burrowing Owl and the Rattlesnake which invade its quarters, Dr. Briggs did not consider it so improbable that it should be rejected upon that ground; holding, that, as it is known that the antipathy to serpents is not equal in the different genera of other animals, it is quite possible that there are some genera that have a tolerance for them.

Mr. Riley gave some account of the colorational adaptation of the animals of the Western plains with the general tint of their surroundings, and thought there was nothing strange in finding rattlesnakes and owls in the burrows of the prairie dogs on these treeless plains where no other hiding-places can be found. The stories of their amicable association, however, should (he thought) be taken *cum grano salis.*

Dr. Johnson, from all he could learn about the subject, had concluded that the three animals mentioned did live amicably together.

Dr. Briggs mentioned that in places where rattlesnakes abound, hogs were used to drive them off, and the popular impression was that the fang of the snake does not reach the circulation, but loses its force in the fat.

Mr. McLellan had known the flesh of a hog to swell from the bite of a Water Mocassin. Deer kill snakes by jumping, with all four feet closed together, upon them.

Dr. Galney stated that the tame hog will not attack a rattlesnake, but that the wild hog will.

Mr. Riley presented, on behalf of Prof. Luce, the fragments of a large fossil tusk of a Mastodon, found in the Indian Territory.

Dr. Wislizenus told of a strange electrical phenomenon that had recently come under his observation. A tree situated on a ridge of ground was struck by lightning, and the trunk from the branches to the ground, a distance of thirty feet, was cut in a spiral column, about six inches wide and three inches deep. The winding of the column was very regular. He did not think it killed the tree.

Mr. McLellan remarked that although lightning indulges in many freaks hard to explain, yet extensive observations in sections that are subject to frequent and violent thunderstorms have led to the conclusion that, when trees are struck, the electric fluid almost invariably follows the grain of the wood. This appears from the following facts, viz.:

1. The track of lightning down the trunk of a tree growing on upland shows a greater twist of the grain than in the case in trees of the same same species growing in swamps. Sometimes the spiral completes the circuit of the trunk in a space of twenty or thirty feet, and the same timber when afterwards split into rails shows the same twist in the grain.

2. Long and slender splinters are frequently thrown off with the bark showing unbroken continuity of the wood-cells.

Mr. Todd stated that he had recently found an additional item to confirm him in the belief that forest trees have a strong influence in producing rain-fall. It was to the effect that the Italian government is preparing to have all the bare mountains in the country planted with trees, in order to protect the country in their vicinity from sterility.

Mr. Riley reiterated his belief that while the planting of trees, and other means at man's command, might affect the rain-fall in restricted localities, that of the entire country must remain the same, as forests acted as distributors and not as sources of rain.

Dr. Wislizenus concurred with Mr. Riley. We cannot increase the volume of rain-fall, but we can do much to equalize the distribution of it, as Marsh in his "Man in Nature" has very well shown.

Mr. S. S. Bassler was elected as an Associate Member, and Mr. Amos Sawyer, Hillsboro, Ills., a Corresponding Member.

June 1, 1874.

ALBERT TODD, Vice President, in the chair.

Twelve members present.

The Corresponding Secretary laid the exchanges on the table, and drew attention more especially to the following:

M. Paul Broca (Bull. de la Soc. d'Anthropologie de Paris, T. viii., No. 4, p. 572) gives an interesting account of certain artificially flattened skulls of the ancient Cymri or Cimmerians (the *macrocephales* of Herodotus) found in sepulchres of the Bronze Age, near Tifflis, in the Caucasus, by M. de Smirnow, a Russian archæologist. These Cymric Celts were the rear guard of the older branch of the same Aryan migration, the Gaelic Celts, who passed into Europe across the Caucasus and to the northward of the Black Sea, having occupied the Crimea and Southern Russia from time immemorial prior to the Iron Age, which was itself much older than the Iliad of Homer. This practice of flattening and elongating the skull, by means of bandages bound tight across the frontal regions, has been traced along the line of march of this ancient people, from the Caucasus and the Crimea to Denmark and to Toulouse in the south of France. Those of Toulouse used but one bandage, while the more ancient custom was to employ two. Comparing the researches of Amadée Thierry with the account of Herodotus, it was rendered highly probable that the Scythian nomads, pressing upon them from the east, cut the nation in two, forcing one portion of them into Asia Minor and the other ino Russia north of the Black Sea. There was evidence also that, about seven centuries before the Christian era, a wave of this people was turned back eastwards across the Caucasus into Central Asia, whence they originally came. In these sepulchres at Tifflis bronze implements were numerous, but there were none of iron. Hippocrates mentions that in his time these people had abandoned the practice of flattening the skull, and that then their heads were developed in the normal shape.

M Faidherbe (ibid. pp. 605-12) states the results of his researches on the populations of Northern Africa, as follows:

Lybian Indigenes, Whites from the North in very ancient times, } Berbers	75	per cent.
Phenicians	1	"
Romans, auxiliaries, and Greeks	1	"
Vandals (in the East)	½	"
Arabs (nearly pure)	15	"
Negroes (of all shades, pure and mixed)	5	"
Israelites (analogous to the Arabs)	2	"
Turks and renegade Europeans	½	"
	100	"

M. Topinard also read a paper showing extensive and minute researches upon the origin of the different races in Northern Africa.

Other members expressed the opinion that this Celtic migration into Europe extended much farther back in time, and was more ancient than the observations of Dr. Broca would seem to imply.

Drs. T. L. Brunson and J. Payrer, on the Poisons of the Venomous Snakes of Hindustan—the Colubrine (*Cobra*) and Viperine (*Crotalus*), *Naja*, *Daboia*, &c., in the Proc. Royal Soc. of London (No. 149, p. 68)—state, as the result of numerous and varied experiments, that the poison acts directly upon the nervous system and great nervous centres, and has the effect to stop respiration rather than the action of the heart. Death ensues from the want of aëration of the blood; the nerves seem to be paralyzed; absorption and excretiön do not help much towards removing the poison; and *ammonia* and all other reputed antidotes proved useless when the poison was administered in sufficient quantity to produce death. No remedy was known to them.

Dr. Copes, alluding to the poison of snakes, remarked that he had never known a case of death from snake-bite, or of a well authenticated case, and desired to remove the fearful apprehensions people entertain, and which frequently have much to do with the results of snake poisoning.

Judge Holmes recollected having read of a number of cases of fatal snake poisoning, and cited the case of the death of a soldier from the bite of a Tarantula in Texas.

Mr. F. J. Stanton of Denver, Col., was elected a Corresponding Member.

June 15, 1874.

ALBERT TODD, Vice President, in the chair.

Sixteen members present.

The Corresponding Secretary read letters from Capt. Augey, of the Signal Office, requesting a copy of the Transactions, which was sent. Also, letters from the Royal Society of London, the Zoölogical Society of London, and the Society of Geography and Statistics of Frankfort-on-the-Main, acknowledging the receipt of copies of the Transactions.

Exchanges received, laid upon the table.

Dr. Engelmann, from the Committee on Agassiz Memorial, reported that he had not succeeded in raising any funds.

Dr. Engelmann presented to the museum of the Society a specimen of Big Muddy coal, given him by Prof. Heiss. On the face of it were characters which, he stated, a number of persons declared to be chirographic char. cters bearing an analogy to the Hebrew writing of Upper Egypt.

He explained, however, that the coal belonged to a carboniferous formation of an age long before that of warm-blooded animals, and long before that of man. The characters were not writing, but were the impressions of the leaves of a hollow-stemmed plant, belonging to Sigillaria, which flourished at that time. Coal thus marked is rarely found in Illinois, but is quite common in Iowa and Pennsylvania.

He then referred in terms of praise to the late Report of the Signal Service Bureau, and gave the following interesting facts which he had condensed from it. Regarding the rise in our rivers, he stated that during the two years of observation the Mississippi and Missouri showed the smallest amount of variance in volume, and were the most regular in their variations of all our western rivers. The high periods of the Mississippi were from March to July, and the highest point reached as a general thing was 15 feet above low water. It rose higher at St. Louis than farther north, reaching 28 feet above low water. From February to May the Ohio rose 40 feet. The high season in the Cumberland was in February, in the Red River in June. The Lower Mississippi was highest the end of May. The rise between the mouth of the Missouri and the mouth of the Ohio was not so great as it was below the mouth of the Ohio.

It was also interesting to note the difference in climate in different parts of Missouri. The observations of the signal stations at Leavenworth, Keokuk, Cairo, and St. Louis, represent nearly every quarter of the State. The summer temperature in all four was identical last year. The winter temperature differs considerably. In the winter of 1872-73 it was eleven degrees warmer at Cairo than at Keokuk, and five degrees warmer at St. Louis than at Leavenworth, although the latter two have the same latitude. This difference in temperature may possibly be accounted for by the fact that the St. Louis observations were slightly influenced by the proximity of buildings, but this would not make a difference of five degrees. Keokuk is three degrees of latitude north of Cairo and Leavenworth is four degrees of longitude west of St. Louis. As we go west on the great plains, the extremes are more severe until a point midway between St. Louis and the Rocky Mountains is reached, where the rule changes. At the mountains the variations are not nearly so wide, and at San Francisco the difference between the temperature of summer and winter is only a few degrees.

Dr. Briggs presented a collection of fresh-water shells, which he had obtained at a point where a small adjoining lake empties into Lake Monona, Wisc.

Mr. Riley presented a copy of his Sixth Annual Report on the Insects of Missouri, for which a vote of thanks was tendered on motion of Judge Holmes, who spoke in praise of the Report.

Dr. Engelmann stated that he had prepared two papers to be read before the Society. One was on

"The Cedars of America," or, rather, what we choose to call Cedars, they being really Junipers. The species of this class of trees are so numerous, and authorities have so poorly distinguished them, that he had, by close microscopical study, and an extensive knowledge of the trees, tried to give the geographical limits and the distinctive features of each kind.

His other paper was on

"The Oaks of the United States." The very many different species of Oak which abound in different parts of the United States, the largest number being found in the Carolinas, have been, like the Cedars, so confused by botanists, that he had given the matter much study for the purpose of bringing order out of confusion.

Both papers were referred to the Committee on Publication.

Mr. Riley also presented two papers for publication, one "Descriptions and Natural History of two Insects which brave the Dangers of *Sarracenia variolaris*": the other, "Notes on the Yucca Borer, *Megathymus yuccæ*." They were both referred to the Committee on Publication.

October 5, 1874.

W. T. Harris, President, in the chair.

Eighteen members present.

A large amount of correspondence and a large number of exchanges were laid before the Academy by the Corresponding Secretary, and on motion he was instructed to send a series of the Transactions, excepting vol. i, to Mr. B. W. Irving of Tecumseh, Nebr., in consideration of a donation of birds' eggs collected at Tecumseh, Nebr.

Dr. Stevens, who had just visited the Onondagua limestones of New York, exhibited a number of fossils including two fine specimens of trilobites, which he had collected there.

Mr. Gage, from the committee appointed to investigate certain mounds, reported having done so, and that he will lay the results, with specimens, before the Academy at a future meeting.

Dr. Geo. Engelmann then gave an interesting account of observations, geological and botanical, made during the summer in the Rocky Mountain region of Colorado.

He referred to the gradual and continued rise from St. Louis to the foot of the mountains, scarcely noticeable as one travels over the plains except by the uniform eastward flow of the rivers; to the fact that coal of good quality, belonging to a later formation than the carboniferous, and probably to the cretaceous or tertiary, was found in the foot-hills of the mountains, and to the prominence on the plains of the buffalo-grass. He dwelt on the well-known peculiarities of this grass, and stated that it ceases to grow within 80 or 90 miles of the mountains, where the soil is more arenaceous.

In describing the flora of the mountains and the replacement of deciduous trees by conifers, he mentioned the discovery of a balsam fir (***Abies concolor***) which had not been reported from that region before, but which he had described, a number of years ago, from Santa Fé. He found ten species of Firs, Spruces, and Pine, and three species of Junipers; none of them occurring in the east except *Juniperus communis*. *J. occidentalis* had its N.E. limit in Southern Colorado. The only Oak (*Q. undulata*) is a small shrub with acorns which taste like chestnuts, and so variable in its leaf that it had formed the basis of several fictitious species.

In ascending the mountains the growth does not cease gradually, but with comparative suddenness. Good healthy trees, 50 feet high, will be succeeded by a stretch of a quarter of a mile of stunted ones, always bent eastward by wind and snow, with the bark stripped on the west side.

He referred to the number of fir-cones found severed from the trees while green, and supposed that the severing was done by squirrels to prevent the breaking up of the cones and scattering of the seeds, which takes place in the firs when the cones are ripe—the object being to save labor and to secure their winter food without too much trouble.—Also, that it was a mistake to suppose that there was anything in the nature of a desert between here and the mountains. The land was everywhere rich and covered with Buffalo-grass.

Mr. Riley remarked that while such a statement as this last would hold true of the country along the Kansas Pacific, there were vast tracts of land, farther north, with no other vegetation than a few cacti, which might not inaptly be called desert land.

Mr. Todd referred to the contradictory reports made by correspondents and officers of the Custar expedition to the Black Hills, and how the glowing accounts of the profusion of flowers and the perpetual spring and summer of that country were apt to mislead, as it is one of the characteristics of the far west that the flowers are abundant and beautiful in summer even where the weather is so severe as to preclude human habitation during a great part of the year.

After a few further remarks by Dr. Geo. Engelmann on the importance of regularity in meteorological observations, the meeting adjourned.

October 19, 1874.

Dr. Geo. Engelmann, Vice President, in the chair.

Publications received, laid upon the table.

The Corresponding Secretary presented a gold medal received from the Royal Frederick University of Norway, and struck in commemoration of the 1,000th anniversary of the first kingdom.

Dr. L. A. Richardson spoke of several mounds which he opened last July and August in the vicinity of King's Lake, on the Mississippi, a few miles above the Missouri. They were burial mounds, and the graves were all laid north and south, and were covered with stone slabs. They were on the high crests of the bluff.

Dr. Engelmann referred to observations by Dr. Wislizenus of a similar nature in similar situations, some distance down the river. The graves were rather close together, not covered with a mound, and the remains surrounded by slabs of limestone.

Mr. Riley gave some new biological facts regarding the Grape Phylloxera, showing how the studies of the present year had well given us its complete natural history.

He had obtained the sexual individuals of three distinct species, namely, of *Ph. vastatrix* Planchon, *Ph. Rileyi* Lichtn., and a large species beaten from *Quercus obtusiloba* and which was apparently *Ph. caryæcaulis* Fitch, which makes galls on Hickory. The life-history of *Ph. vastatrix* may be thus epitomized: It hibernates, mostly as a young larva, torpidly attached to the roots. With the renewal of vine-growth in the spring, this larva molts and rapidly increases in size and commences laying eggs. These eggs hatch and produce, in due time, apterous, egg-laying, parthenogenetic mothers like the first one. Five or six generations of these virgin mothers follow each other, when, about the middle of July, some of the individuals begin to assume wings. These are all females, and, like the wingless mothers, bring forth parthenogenetic eggs. They rise in the air and spread to new vineyards, where they lay their eggs—usually 2 or 3 in number and not exceeding 8—and then perish. These eggs are of two sizes, and in the course of a fortnight the larger ones give birth to females, the smaller to males, which are born for no other purpose than the reproduction of their kind, and are without means of flight or of taking food or excreting. The sexes pair and the female is delivered of one large egg, which doubtless gives birth to the ordinary larva, which crawls on to the roots and recommences the virginal underground multiplication. He had some reason to believe that there were two of these developmental cycles each year, i.e., that the winged and sexual forms were twice produced annually: yet there is no intermission in the appearance of the winged females from the middle of July till frost, but the increase reaches its acme the latter part of August.

He found it very difficult to obtain the sexual individuals, as, though the winged insects delivered themselves of their eggs with the greatest ease, attaching them in clusters to the sides of tubes or jars in which they were contained, or pushing them into the tomentose portions of the vine, or into crevices in the earth; yet the eggs generally failed to hatch, and the embryo perished most often when just at the point of hatching and when sufficiently developed to show its character. He had, however. succeeded in hatching two males, and had been much more fortunate with the American oak species.

He had recently received a letter from M. J. Lichtenstein of Montpellier, France, in which that enthusiastic entomologist made the astounding announcement of having discovered that *Phylloxera vastatrix*, in the winged form, congregates and swarms on the leaves of the Chermes oak (*Quercus coccifera*), which it uses as a nidus for its eggs. Mr. Riley stated that with all his faith in M. Lichtenstein's knowledge of Phylloxera, he was forced to the conclusion that some other species had been confounded with *vastatrix*, and microscopic examination of specimens of the sexed individuals kindly sent by Lichtenstein only confirmed him in the opinion. It was, therefore, with no little interest that he noticed, from the abstracts given in *Nature* of the doings of the Paris Academy of Science, that Balbiani considered the species found on *Q. coccifera* as distinct from *vastatrix*, and proposed to call it *Lichtensteinii*.

Dr Engelmann exhibited a section of the trunk of *Juniperus Californica*, var. *Utahensis*, which was not quite 4 inches in diameter and yet showed an unmistakable age of 127 years, each ring being on an average about $\frac{1}{3}$ of a line wide. The largest growth in 10 years had been about 4 lines, the smallest in 10 years about $1\frac{1}{2}$ lines. It was one of the most remarkable instances of slow growth that had come to his notice.

November 2, 1874.

W. T. Harris, President, in the chair.

Fifteen members present.

Several communications were read by the Corresponding Secretary, who was instructed to send the Transactions, from vol. iii. No. 1, to the Rantoul Literary Society, Rantoul, Ills.

The following communication, from Mr. Amos Sawyer, was read and ordered incorporated in the minutes:

"ON THE ORIGIN OF RAVINES IN THE PRAIRIE."

In this paper I propose to record my observations upon this subject, as I do not remember to have seen it mentioned in any of your transactions.

To the present generation it may be of little interest, as they know—or, if curious, can be informed by those who have witnessed the change—how *most* of the ravines in the prairie originated; but a century hence, should the question be asked, it would probably prove to be a problem not so easily or satisfactorily solved, unless there should be accessible some well authenticated record of their origin. I therefore call your attention to this subject.

The prairie situated one mile east of Hillsboro could, thirty years age, during the wet season, truly be said to be an immense lake, interspersed with islands; for the tough sod, together with the rank growth of grass, reeds, and flags, offered a considerable barrier to the rapid flow of the water during the spring and summer floods, as it had to filter through the roots of the grass, or percolate the drifts of broken and decaying vegetation which always lined the shores of the prairie-lakes, to again encounter the rough surface of the tough native sod in its struggle to reach the fluid's goal. Its progress was necessarily so slow that it did not attain sufficient velocity to cause any washing of the soil; however, it forced the water to spread over a large scope of country, requiring at that early day weeks to discharge the same volume that will now pass off in forty-eight hours.

The change was wrought in this way: after the first of June, until quite late in the fall, the prairies used to swarm with "green-head" flies, and so vigorous in their attacks were they that all domestic animals were driven to the woods after eight o'clock in the morning, nor did they dare to return until just before sunset, when they would emerge from their retreats and march in single file through the long grass to the nearest pond for water, and thence on to their feeding-ground—the different neighbors' cattle having their own path, pond, and feeding-ground. In course of time, this constant passing to and from the pond completely killed the sod, and when the spring rains came, the cow-path being lower, and the water meeting with no obstruction, poured down these new-found channels, and in time cut a ravine, which in most instances has become of sufficient size and importance, where it crosses a public road, to require bridging.

In conclusion, I would say I have watched quite a number of these *cow-path* streams from their inception to the present day; and the size they have attained during this time would astonish any one after becoming acquainted with their history.

The Corresponding Secretary laid a number of exchanges on the table, and called special attention to the following:

Bulletin of the Anthropological Society of France, No. 5, July, 1873, p. 671, M. de Mortillet presented a flint lance-head, found by the Abbé Bourgeois in the Miocene, of unquestionable human authorship, and this discovery put the question of the existence of men in the Miocene capable of making such lance-heads beyond dispute. Madame Clemence Royer, at the same meeting, remarked that there was nothing in the present state of geological or zoölogical knowledge that would preclude the possibility of the existence of such anthropoid human ancestry in the Miocene. This lady had also attempted, in the same Bulletin, to map out the appearance of the world in the Tertiary. This map closely resembled one which Judge Holmes had himself constructed some years ago for the same purpose. But in one respect Mad Royer arrived at a quite different conclusion to his own. She concludes that the white Aryan race had its origin in Europe, while, as he had stated at a previous meeting of the Society, he thought such a conclusion untenable.

Prof. Gage exhibited a number of vases, implements, and other antiquities, formerly belonging to the mound builders in Louisiana and Mississippi. He had obtained these relics by an exploration in those States, and promised to prepare a paper on the same for the Transactions.

Dr. Geo. Engelmann referred to an article on curious plants, in one of the morning papers, and gave an account of the very curious Welwitschia, and exhibited a colored plate of the same.

Mr. B. V. B. Dixon exhibited a curious forked growth, which, as he had been assured on credible authority, had been taken from the inside of the skull of a soldier on a battle-field, the process branching into the brain. Several members gave opinions as to the nature of the growth, and it was finally referred to Mr. Enno Sander for analysis.

Dr. Geo. Engelmann read the following communication, from a private letter by Mr. Henry Gillman. relative to the perforating of Indian skulls found in mounds:

Do you know anything, personally, or in any writings, of the custom, among the former inhabitants of this country, of *perforating the skull after death?* A short time ago, a large number of skulls were taken out of a mound at Thunder Bay, Lake Superior, all with this peculiarity. From its proximity to Isle Royale, this is most interesting. And now I have lately taken from the ancient mound on the Rouge River, near Detroit, two skulls with similar perforations; thus greatly increasing the interest. The hole is in the top of the head, sometimes at the exact juncture of the sutures; it is from about the size of a bullet-hole to three quarters of an inch or more in diameter, being much larger on the outside—sometimes exceeding an inch in diameter, and evidently made with a rude (probably stone) implement. I am unable to find anything on the subject in any work accessible to me at present, and would be much obliged if you would kindly communicate any information which you may be possessed of as to this most peculiar custom.

No additional facts were elicited from the members.

Mr. Jno. C. Ellis presented some bitumen taken from the under surface of a large rock in the shaft of a mine, 86 feet deep, at Joplin, Mo.

Mr. R. Hayes presented a paper enumerating earthquakes of 1872–73. Referred to Committee on Publication.

November 16, 1874.

W. T. Harris, President, in the chair.

Fifteen members present.

Mr. J. R. Gage, from the Committee to Investigate Mounds, reported having opened some recently near Mascoutah, Ills., in which, among other things found, was a complete skeleton, which he had managed to preserve intact, and hoped to present at a future meeting.

Publications received, laid upon the table.

Dr. McPheeters exhibited a curious piece of ancient pottery, supposed to have been buried for 300 years in the grave of one of the Inca kings in Peru, it having been dug up near Valparaiso. The vessel represented the head of some ruminant, and probably the llama; it was probably filled with some native liquid made from the grape, as was the custom of the Incas.

Dr. Richardson spoke of finding lately a number of solid balls of hair in the first stomach of cattle. The explanation given was that the hair was licked and swallowed in sufficient quantities as to become felted together and impassable into the smaller intestines; and that the only way such balls were voided was by vomiting.

Mr. Edwin Harrison had taken as much as seven pounds of specular ore, in different sized lumps, from the stomach of an ox which had worked around iron mines.

In answer to a question from Dr. Galney, Dr. Engelmann stated that several species of Cacti had tuberous roots, and that such roots were characteristic of many plants, especially such as grow on the arid plains of the west.

Speaking of tuberous plants, Mr. Harrison said that he had found the wild potato growing in New Mexico, though our cultivated varieties were supposed to have originated in Chili and Peru. Dr. Engelmann stated that the tuber referred to by Mr. Harrison was a small one, belonging to a species of *Solanum* different from the *Solanum tuberosum*, which gave rise to the cultivated varieties, and was never larger than a marble. Mr. Riley stated, that, on account of the degeneracy noticed of late years in most of our cultivated varieties of potato, some agricultural journals had suggested the propriety of experimenting anew with the wild tuber, with a view of producing more vigorous varieties.

Judge Holmes referred to some experiments cited by Dr. Carpenter with Faradic electricity on different parts of the brain, the notable results of which went to show that the increase of intellect was in proportion to increase of the middle and posterior parts of the cerebrum, and not of the front parts, as was generally supposed.

December 7, 1874.

Dr. J. B. Johnson, in the absence of the President, was called to the chair.

Thirty-six members present.

The Corresponding Secretary submitted communications and exchanges.

Mr. G. C. Broadhead donated a copy of his Geological Survey of Missouri, and a vote of thanks was tendered him for the same.

Dr. Engelmann presented three maps of Colorado, sent to him by Prof. F. V. Hayden as illustrating the work of the Government Geological Survey in that Territory the past year. One curious thing noticeable was the fact that many of the higher peaks are so nearly of the same height, being within a few feet of each other. Gray's Peak is the highest, but only one foot higher than Mt. Rosalie, and five feet higher than Torrey's Peak. He also presented some meteorological observations condensed from the Records of the U. S. Signal Service at Cañon City, in Southern Colorado, and made the following comparisons of means and extremes between Philadelphia, St. Louis, and Cañon City, the latitude of the last two being about the same—Cañon City being, however, about 5,000 feet higher than St. Louis, though much sheltered:

MEAN TEMPERATURE.

	Philadelphia.	St. Louis.	Cañon City.
November, 1873	44°·0	40°·3	49°·9
December, "	34 ·5	35 ·9	43 ·0
January, 1874	31 ·8	33 ·9	40 ·7
February, "	32 ·3	34 ·5	37 ·2
March, "	41 ·0	42 ·4	40 ·5
Winter	33°·5	34°·8	40°·3

EXTREMES.

	St. Louis.			Cañon City.		
	Max.	Min.	Range.	Max	Min.	Range.
November, 1873	72°·0	13°·0	59°·0	73°	28°	45°
December, "	68 ·0	14 ·0	54 ·0	62	20	42
January, 1874	66 ·5	—2 ·0	68 ·5	58	18	40
February, "	61 ·5	11 ·5	50 ·0	60	—4	64
March, "	77 ·0	19 ·0	58 ·0	67	18	49

The whole winter in Cañon City until January is mild, fair, and clear; but February and March are much more wintry and disagreeable.

Dr. Richardson presented several balls of hair taken from the stomachs of oxen, and Dr. Galney presented a smaller ball without any hardened exterior and probably from the stomach of a hog, as it consisted of bristles intermingled with a few feathers.

Professor Adolph Schmidt read a paper "On the Forms and Origin of the Lead and Zinc Deposits of Southwest Missouri." Referred to Committee on Publication.

Judge Holmes remarked that the old theory of the formation of lead and other ores was that they came up from below in a gaseous form. This idea is now abandoned for that of solution in water, and he asked, what is or was the source of the lead?

Prof. Schmidt remarked in reply that time enough has transpired to account for the deposition of our present lead ores by water containing no more than many waters of the present day are known to contain.

Dr. Engelmann announced as a triumph of Science the late discovery of a splendid coal vein from 6 to 7 feet thick, at a depth of 560 feet, at Centralia, Ills., as explained in the following communication to the "Engineering and Mining Journal" for November 7, 1874:

IMPORTANT DISCOVERY OF COAL AT CENTRALIA, ILLS.

To the Editor. Lasalle, Ills., October 29, 1874.

Sir:—Although deprived, by unavoidable circumstances, of the pleasure of meeting with you and the Institute, I am to-day placed in a position to communicate to you a fact which is of considerable practical interest. A bed, 6 to 7 feet thick, of good quality of coal (evidently the Belleville-Duquoin vein) has been struck to-day in a shaft sunk at Centralia, on the Illinois Central Railroad, at a depth of 560 feet, 30 miles east and 22 miles north of the nearest coal mines working on the same vein, which is the only vein in this part of the State of more than purely local and very small importance. There is no reason now to doubt that the Illinois and Indiana fields connect continuously from east and west, and not merely at the rim of the basin. From careful detailed surveys of several of the adjoining counties, as Assistant Geologist of Illinois, I had predicted, ten years ago, that if this vein of coal extended thus far, it might be expected at a depth of between 560 and 640 feet. Mr. Worthen, the State Geologist, could not see the strength of my argument, and stated in his report that this vein of coal would be found not much over 300 feet deep. On the strength of his argument the citizens of Centralia sank a shaft, but, not finding the coal at that depth, remembered my prediction, and came to me for advice. Their funds having all been "sunk" in the shaft, they raised an additional amount upon my suggestion, with the above result. Although I have not received particulars, I am satisfied that this stratum is the equivalent of the Belleville and Duquoin seam of bituminous coal, the vein which furnishes most of the coal used in St. Louis. Mr. Worthen considers these two veins as distinct, but I have never been able to see it.

H. Engelmann.

Theodore Allen, C. E., was elected an Associate Member.

December 21, 1874.

W. T. Harris, President, in the chair.

Fifteen members present.

The Corresponding Secretary submitted communications and exchanges, and called especial attention to a work by T. Sterry Hunt, entitled "Chemical and Geological Essays." One idea contained in the work struck him forcibly, viz., that the law of water congealing into ice, whereby it becomes lighter, does not hold with regard to many minerals, which in cooling and condensing from the molten state become heavier. Hence the nucleus of the earth, as of all globes, is probably solid, though it is now believed that there is a molten space between the nucleus and the crust. Another idea of importance is that the rocks down through the oldest stratifications to the Lawrentian, or the whole of the cooled crust of the earth, is not necessarily formed by the cooling and solidification of the crust, but by later condensations and deposits from the atmosphere and ocean.

Complete sets of the Transactions (as far as they could be furnished) were ordered sent to the Buffalo Society of Natural History and the Royal Geographical Society of London.

January 4, 1875.

W. T. Harris, President, in the chair.

Eighteen members present.

Among the communications read was one from the San Diego (Cal.) Society of Natural History, a newly organized society, requesting to be placed on our exchange list. On motion, the Society was placed upon the exchange list, and the Transactions from vol. iii. No. 1 ordered sent.

The Corresponding Secretary then submitted his annual report, as follows:

REPORT OF THE CORRESPONDING SECRETARY FOR 1874.

To the President of the Academy of Science.

As Corresponding Secretary, I submit my report of operations for the year 1874. The correspondence and exchanges of the Academy have been continued as heretofore, and with rather increased activity. The effect of sending forward another number of our Transactions, in 1873, has been quite perceptible in the increase of returns received by way of exchange. Another number will doubtless be distributed in the coming spring. Some few of the Societies, which ceased to send us their publications during the intermission of our Transactions, have not yet renewed their sending; but most of them have done so. The greater number of the Foreign, and nearly all of the Home, Societies have continued to send us their publications uninterruptedly. Four Foreign Societies and three Home have been added to our list during the year 1874.

The number of Foreign Societies and authors to whom we are now sending our Transactions in exchange is 201; and returns are received from the greater part of them.

The number of Home Societies and authors and public Libraries to which our Transactions are regularly sent (and Canada is included in this list) is 86; and we receive from nearly all of them such exchanges as they have to return.

Our foreign exchanges are conducted through the agency of the Smithsonian Institution as heretofore, without other expense to us than the cost of freight and postage between Washington and St. Louis. This service of that excellent Institution, thus rendered gratuitously to all the scientific Societies in the United States, must be regarded as of immense value to the whole country.

Four names have been added to the list of Corresponding Members during the year.

I submit herewith my account of receipts and expenditures, showing a

total of receipts	$78 64
" expenditures	75 76
and a balance in hand of	$ 2 88

Of the receipts, there has been received

From the sale of Transactions	$13 89
" last year's account	16 00
" the Treasurer for expenses	10 00
" " " " the Bust of Agassiz	37 85
" freight charges refunded	90
	$78 64

The expenditures are almost entirely for freight and postage.

Yours respectfully, NATHANIEL HOLMES,
Corresponding Secretary.

The Treasurer's Annual Report was next submitted to an auditing committee consisting of N. Holmes and S. Pollack, and was found correct. It showed that the sum of $350.16 remained in the hands of the Treasurer at the commencement of the year 1874; $614.00 were collected during the year from various sources, and of the total amount of $964.16 the sum of $508.00 was expended for different purposes, but especially towards printing the Transactions of the Academy, which consumed $342.75; the cash balance amounts to $456.16.

Mr. J. R. Gage presented some interesting specimens taken from a coal mine in Moniteau Co., and read a communication thereon, which was referred to the Committee on Publication.

Dr. Richardson presented a specimen of coagulated blood albumen.

Dr. Engelmann made the following report on the meteorology of the year:

The mean temperature of the past year, at my place, in the outskirts of the city, where the influence of densely built up squares is not felt, was 56°.0; while the mean temperature of the city itself, according to my forty years' observation, is only 55°.4. Last year was one of the unusually warm years with us: 1858, and again 1860 and 1861, as well as 1870 and 1871, were warmer, and 1854 with 58°.0 mean temperature was the warmest observed by me.

My tables show that January was very mild, February and March a little below the average, and April decidedly cold, marking 9° below the average, so that spring was cool and late. But all the other months of the year, with the exception of November, were unusually warm; May indicated about 3, June even 4, July and August each 2 degrees above the average.

The rain-fall of the year, of 33 inches, though less by 9 inches than the average, and 7 inches less than in the previous year, seems to have been so beneficially distributed as to bring the crops to perfect development. But the rain-fall of the years 1870, '71 and '72 was too limited, less than we had observed it for many years, and on the whole insufficient for the farmer and gardener.

The President then called Mr. Todd to the chair and read his annual address, as follows:

PRESIDENT HARRIS'S ADDRESS.

Gentlemen of the Academy of Science:

Upon retiring from the chair, which I have filled the past year through your kind sufferance, I comply with the usual custom, and offer a few reflections upon the recent achievements and present status of science. From year to year we have beheld a steady increase in the number of investigators of Nature, and in proportion as their labors have become systematic and organized their influence upon civilization has become more marked and more generally recognized. We may look upon science now as the great power of the age, having not only its indirect influence upon the arts of man and upon the theoretical views of the learned, but having likewise a direct effect upon the masses of common people, who read its glad tidings in myriad books carefully adapted to convey to the popular mind the processes and results of scientific investigation. The earth and the atmosphere; the waters of the sea and the rivers; the distant stars; the invisible infusorial world, and the subtle molecular changes in bodies; the wonders of organic life exhibited in plant and animal;—all these, in their minute subdivisions, are unfolded to the people, high and low.

THE NATURAL HISTORY OF MAN,

too, is written with the aid of all other sciences. In many respects, the moral and religious life of man is receiving direct modification from his familiarity with scientific methods and results. His physical life is so radically changed in its conditions by the same cause as to occasion no longer any surprise at the enumeration of special instances. Freed from the goading importunity of physical wants, man is more and more devoting his life to a theoretical activity, increasing thereby the breadth and accuracy of his survey of the world in which he lives, and concentrating more attention upon the organization of society, in whose processes ebb and flow the tides of his spiritual life. Out of the immense mass of data which the scientific activity of the past year has placed at my disposal, I can at best only mention here and there a striking detail, and hold it up as a sample of the stores of which I can attempt to give no inventory.

ASTRONOMY.

The visit of the distinguished astronomer Proctor to our city, the past year, is still vividly remembered by us all as a practical demonstration of the superior interest which attaches to all masterly expositions of Nature. Later in the year, the appearance in our skies of the comet of Coggia furnished illustration of the exposition which he made of the nature of these singular bodies. The careful investigations of Huggins and Secchi regarding its spectra have added much not before known. It must be remembered that Coggia's comet is the first large one visible since the utilization of the spectroscope. The old theory regarding comets has been exploded. They are not composed of nitrogen, as at first supposed, but of carbon vapor and—as Dr. Vogel and Dr. Zenke think—watery vapor. Meanwhile, their connection with meteoric showers has received additional confirmation. It is not probable that the nucleus or the tail of a comet is composed of meteors, but it seems that meteors follow the nucleus without luminosity, except when impinging upon our atmosphere. The probability of immense showers of comet or meteoric dust upon the earth, by reason of our annual passage through three or four streams of these bodies, has led to the investigation of the soil of widely separated tracts, in order to discover if possible traces of matter of a composition similar to that of meteoric stones hitherto analyzed. The investigation has proved sucessful, and Prof. Nordenskiold of Stockholm relates in Poggendorf's *Annalen* that he has found these traces of metallic iron and carbon, as well as of nickel and cobalt, in the snow of certain great snow-storms supposed to be connected with meteoric disturbances.

While the spectroscope is yielding great returns to science in the way of determining for us the chemical analysis of the most distant bodies in the universe, the telescope is again rapidly improving. Immense refracting instruments are now being made with a perfection hitherto deemed impossible. That of the Naval Observatory at Washington—twenty-six inches in clear aperture—is likely to be rivalled by another one constructed by the same maker—Mr. Alvan Clarke—for the Washington and Lee College of Virginia; and we hear of a monster endowment of $750,000 for the purpose of building an observatory on the Sierras in California, and furnishing it with a telescope of a size far beyond anything hitherto attempted. As the great refractor at Washington cost only $44,000, it may be well understood that the California instrument may, at the price of $100,000 or $200,000, surpass anything yet attempted in this line. Add to this fact the marvelous purity of the atmosphere in the Sierras, and we may anticipate something of a new revelation of the starry depths. The long looked for transit of Venus has come and gone. Our absolute distance from the Sun is probably ere this well fixed, but no report has yet reached us of these calculations. The American stations for the observation of the transit were eight in number, and located at Kladiwostock, Pekin, Nagasaki, Hobart Town, Bluff Harbor, Chatham Island, Kerguelen Island, and Possession Island—three stations being in the northern hemisphere and five in the southern. The chances of foul weather at all the points of either hemisphere were very small, and the event has justified anticipations. The parallax as determined by Encke was $8\frac{5776}{10000}$ seconds, while from other observations made on Mars the parallax has been placed at $8\frac{848}{1000}$ (American Naut. Al.) or $8\frac{91}{100}$ (Brit. Naut. Al.) Thus our present results vary $\frac{34}{100}$ths of a second. The probable error of the coming result will not equal $\frac{1}{100}$ths of a second. Besides, whatever experience teaches in this experiment as desirable in the observation of transits will be made available at the next transit, which fortunately occurs in 1882, only seven years hence. While the recent transit was visible in the longitude of Asia only, the next one can be most favorably observed in America.

While mentioning these matters of astronomic interest, we should not omit to mention the labors of Dr. Gould at the new observatory, located at Córdoba, in the Argentine Republic. The mapping of the stars in the southern hemisphere has been vigorously prosecuted by him, and is the basis for future great discoveries which we may look for.

The investigations of Lockyer and Secchi into the composition of the Sun are still progressing, and new and more reliable results are continually reached. Some most remarkable phenomena are reported, which seem to indicate a temporary change of diameter in the Sun accompanying the appearance of spots and protuberances. The minimum diameter of the Sun seems to coincide with the maximum manifestation of spots and protuberances.

In this connection should be named certain fluctuations of the American lakes observed by Dawson, the geologist of British North America, to be synchronous with the development of sun-spots. This comparison extends from 1790 to 1870. In Lockyer's work on Solar Physics is exhibited the parallelism of the periods of solar energy as denoted by the outburst of solar spots, with the maximum periods of rain-fall and cyclones. In this we have the clew to the variation of water-level of the lakes, which is exhibited in a diagram and shown to fluctuate almost exactly in correspondence to the maxima and the minima of the sun-spots.

THE EARTH'S MOTION.

Of equal interest are the researches of Professor Newcomb into the variation in the rapidity of the Earth's revolution. Certain apparent inequalities of the Moon's motions led him to suspect that the siderial day is not of uniform length. His conclusion is that the Earth rotated more slowly than the average rate for ten or twenty years previous to 1860, and that about 1860 this motion was accelerated, so there has been a gain of at least a second per year till about 1872. This startling theory has since been proved by an independent investigation, conducted on the satellites of Jupiter; and, in addition, the researches of Mr. Glasenapp, the Russian astronomer at Pulkova, sustain Prof. Newcomb's hypothesis.

METEOROLOGY.

Astronomy has, of late, become closely connected with meteorology. The meteoric showers in the high regions of the atmosphere must have a close relation to storms. Still more intimately is the electric and magnetic condition of the air connected with the great solar process which produces spots and protuberances. Hence the labors of the various astronomical observatories are supplemented by the Signal Service Bureau, and both conspire to force from Nature the secret of the climate and the key to the control of the weather. A prediction for several months in advance is equivalent to a direct control of the weather, for it is possible for man to adapt himself to any contingencies which he can sufficiently anticipate. The international congress which met recently at Vienna to discuss meteorological affairs, and settle upon a system of international signals by which each national bureau is to hear daily by telegraph what the weather "probabilities" are, was a first great step. Holland, Spain, Portugal, the Netherlands, Norway, Sweden, and China, there entered into agreement with England, Russia, Turkey, and the United States, for a uniform system of observations, to be made throughout the northern hemisphere at 12 m. London time, or 7:35 a.m. Washington time. By this system a storm may be traced from its first vortical whirl to its last stages, and after a few years it will be possible to foretell the weather for a whole season in advance, by combining solar observations with known cyclical movements on the earth.

Professor Loomis, last July, read before the National Academy of Sciences a paper on the movements of storms, in which he gave careful estimates of the velocity of storm-centres for 314 days, as deduced from the data of the maps of the Weather Bureau. The average velocity he finds to be 26.6 miles per hour; the average direction of the storm-paths for two years was 8° north of east. It seems, moreover, that the area of rain-fall extends further on the eastern than it does on the western side of a storm-centre.

ENTOMOLOGY.

It is perhaps not a very abrupt transition to pass from meteorological storms to the devastating locust storms which have proved so disastrous to our western neighbors the past year, and this more especially if it is found, as suggested by distinguished authorities, that these swarms of locusts are connected with the occurrence of droughts in the mountainous, desert countries lying to the west. Dr. Gould's description of the immense swarms of locusts that devastated Córdoba, in the Argentine Republic, would seem to suggest the desert of Atacama as the source in that instance. He speaks of a cloud of locusts, extending like a thick, black trail of smoke over 160 degs. of horizon, and for an altitude of 5 degs.—a swarm at least twenty miles in length and six miles in breadth. In 1835 China was ravaged by locust swarms, which obscured the sun and moon like clouds. In 1797 these insects covered the ground on the sea-coast in South Africa, forming a drift near the sea four feet in depth and fifty miles long. Charles XII. of Sweden, when conducting his army through a defile after the disastrous defeat at Pultowa, suddenly found himself obliged to halt by a hail-storm of locusts which came down upon them with a roar that surpassed that of the breakers on the sea-shore. Meteorology, perhaps, will yet be found to furnish the key to the mystery of the times and seasons of these plagues, which, like the famous one in Egypt, seem to be all connected with some desert country situated near by. Inasmuch as the future colonization of North America is to be more and more directed to the regions lying contiguous to the great mountain chains of America and its accompanying deserts, we shall find this subject a very practical one.

This topic, although suggested by meteorological questions, in fact belongs to entomology. And here, therefore, it is appropriate to allude to the valuable discoveries, made in the interests of science and of economic agriculture equally, relating to the habits of insects. Every one of us, I trust, feels proud that to a member of this Academy has been awarded the French medal of honor for his services in developing the natural history of the *Phylloxera* or Grape root-louse, which has proved so damaging to French vineyards. The Report of the State Entomologist is a credit alike to the gentleman who writes it, and to the State which creates and supports such an office.

Missouri, so vast in its natural resources, whether in the direction of agriculture, mining, or manufactures, can ill-afford to spare her special scientists who are charged with the task of pointing out her resources, and in caring for the protection of the same.

THE GEOLOGICAL SURVEY

of the State is, perhaps, the most important scientific enterprise of the kind in the United States. Certainly the welfare of the country does not depend on the mining of the precious metals, while it is most immediately connected with that of the iron and lead mining. Our Academy has been under constant obligation to the gentlemen of the State Survey, and the presence with us of Prof. Broadhead, Prof. Gage, and Dr. Adolf Schmidt, has frequently assisted our deliberations the past year. The recently completed volume of the Report of the Geological Survey, including the field work for 1873-4, does credit to Prof. Broadhead and his assistants.

EXPLORATION.

In the recent explorations of the Black Hills of Dakota, the scientific attention of the country has been aroused, and expectation is now on the alert for unusual results. The wealth of its flora and the supposed unparalleled mineral resources will soon attract pioneers there in great numbers. It seems, moreover, that the complete insularity of Greenland has been proved by the voyage of the *Polaris*.

OXYGEN.

On the first of last August an interesting celebration occurred at Northumberland, Pennsylvania. It was the centennial anniversary of the discovery of the chemical element oxygen. Priestley, the honored discoverer, had passed his last days at this secluded town in Pennsylvania. The hundred years since the important discovery has been so rich in great achievements that could not have transpired without a knowledge of chemistry, that we may well understand what constituted the staple of the eloquent discourses delivered on the occasion by Professors Cross, Horsford, Sterry Hunt, Silliman, Dr. Smith, and others.

In the midst of the great

VICTORIES OF SCIENCE,

which have all conspired to produce the welfare of man and enable him to stand over Nature and command its services in the interests of human freedom, it is important to state the results of investigations into the comparative longevity of the race. Dr. Jarvis, in his carefully collected data, shows that man's life has been expanded, his strength increased, and his days on earth prolonged, by better adaptation of means, circumstances, and habits, through science. The length of a generation—in other words, the average length of life—has increased from thirty years under the Roman Empire, or twenty-one years in the sixteenth century, to fifty years at the present time.

On every hand we see the lines of discovery in Nature converging upon the welfare of man. It is the accepted principle in science that everything that is in Nature should be investigated. Nothing exists isolated, but every fragment is related to every other fragment of the universe. Social science is slowly building its immense structure as one by one these physical relations are traced through to their correlation with the human soul. The world—the macrocosm and the human body belonging to it—is the counterpart and visible symbol of the microcosm or human soul.

SCIENCE IS FREE

and fears no results: the truth alone is its object: and wherever the truth leads, it is for the man of science to follow unhesitatingly. But all circumspection and all coolness of temper are here requisite. No methods derived from lower and rudimentary spheres are to be applied without modification to the higher and more developed ones. In Nature is the realm of efficient causes; with spirit begins the sway of final causes. The words of DuBois Reymond, who draws the line between the results of observation of external movements and functions, and legitimate inferences touching the dependency of conscious being upon material conditions, are to be remembered. We never can conclude certainly from an external activity or movement to an internal feeling or thought; the two are discrete, distinct genera of phenomena. But it is legitimate, he adds, to trace out the rich field of correlations. On this investigation depends our social science and our conquest over Nature.

The pious George Herbert knew the general tendency of this correlation, and stated man's hierarchy over Nature.

"Nothing has got so far,
But he hath caught and kept it, as his prey.
His eyes dismount the highest star:
He is in little all the sphere.
Herbs gladly cure our flesh, because that they
Find their acquaintance there.

"For us the winds do blow,
The earth doth rest, heaven move, and fountains flow.
Nothing we see but means our good,
As our delight, or as our treasure:
The whole is either our cupboard of food,
Or cabinet of pleasure."

A vote of thanks was tendered to the President for his address.

Mr. Riley, referring to the mention made in the address as to the possible connection between drought and the locust plague, remarked that he did not believe there was any real connection between the two phenomena, and gave his reasons at length.

Dr. Briggs gave an account of Prof. O. C. Marsh's recent palæontological explorations in the Black Hill country.

The annual meeting, and, consequently, the election of officers, was adjourned till the 18th, on account of the lateness of the hour.

W. H. H. Russel and Joseph M. P. Nolan were elected Associate Members.

January 18, 1875.

Albert Todd, Vice President, in the chair.

Twenty-five members present.

The annual election of officers, for the ensuing year, took place. with the following result:

President—W. T. Harris.
1st Vice President—Albert Todd.
2nd Vice President—George Engelmann.
Corresponding Secretary—Nathaniel Holmes.
Recording Secretary—Charles V. Riley.
Treasurer—Enno Sander.
Librarian—J. J. Bailey.
Curators—W. B. Potter, Adolph Schmidt, and F. C. A. Richardson.
Committee on Publication—Geo. Engelmann, N. Holmes, and C. V. Riley.
Committee on Library—Chas. E. Briggs, S. Pollack, and G. J. Engelmann.
Committee on Cabinet—Edwin Harrison, G. C. Broadhead, and R. Chauvenet.

Mr. Bailey made an explanation as to the confused state of the Library, and promised to keep it in order hereafter if the Academy would have the books catalogued and put in order up to date.

On motion, the whole matter of cataloguing and arranging the books was referred to the Committee on Library.

Dr. G. Engelmann read the following meteorological report:

The unusual and especially the steady and long continued cold weather of this winter elicits everywhere the inquiry whether it ever was so cold, or cold so long, here in St. Louis. Consulting my meteorological records of the last 40 years, I must say that we have experienced colder weather here in former years, but not such long continued cold. Three weeks ago to-day the thermometer reached to or above the freezing point for the last time; during these last 21 days it has ranged between —18° and +32°, the freezing point; and when it will rise above that important limit is now quite uncertain.

Comparing former years, we find colder weather in the well remembered winter of 1863-4; but the temperature remained below the freezing point only 13 days, from December 30 to January 11.

Several cold spells occurred in the severe winter of 1855-6; but the mercury stood below the freezing point never longer than 9 days in succession.

The coldest January within the period named was that of 1857; for 28 days, from Dec. 29 to Jan. 25, the thermometer rose to between 32 and 33° only 3 times, and to 38° once.

The lowest temperature of that January was —12°.5, and the highest 45°.5; the mean was only 19°.3, while the mean of January in 40 years proves to be 31°.8.

The mean temperature of the first 18 days of this present January is only 13°.5, and how much the last 13 days of the month will raise it is to be seen; it will be no doubt one of the coldest, if not the coldest, January on record.

Several members expressed the opinion that the late severe cold had some connection with the excessive drought of last summer.

Mr. Riley called attention to the fact, that, notwithstanding the glowing accounts given last summer of the climate of the Black Hill country, the thermometer had there recently fallen to 40° below zero; and the soldiers sent out to drive away the gold-hunters, found none such, and were glad to get away, in most cases, with frozen limbs.

February 1, 1875.

W. T. Harris, President, in the chair.

Twenty-four members present.

The Corresponding Secretary laid the exchanges on the table, and made some remarks as to their contents.

Judge Holmes next called the attention of members to an interesting article by Herr Plath (Sitzungsb. der K. Akad. der Wissenschaften zu München, 1873, Heft vi.) on the agricultural economy of the Chinese and Japanese.

The subject is treated with great learning and minuteness of detail of the more important facts. It is a matter of singular interest that we have in China a fine country stretching from the sub-tropical to the cold temperate zone and climate, and from the low sea levels and valleys to the loftiest ranges of mountains, and inhabited by 400 millions of people, whose agricultural history and experience reaches back through 4,000 years and more, and whose libraries contain more than 160,000 volumes relating to agriculture alone. Nearly the whole available territory even to the tops of the highest hills, which, in many places, are terraced and irrigated, is divided up into small parcels, which we would rather call gardens than farms, and is thoroughly cultivated, and largely by hand labor. A proprietor owns his land no longer than it is worked. Leasings are common. There are few cattle and sheep, and beef and mutton scarcely constitute an article of food, though swine-flesh and poultry are quite common, but still sparingly in use for food. Single oxen and horses are used somewhat, especially in the northern parts, as draft animals; but there are not cattle, horses and sheep enough in all China, nor in Japan, to furnish flesh for food or manure for the land. Human excrement is the chief resource for manure, and it is collected and saved with extraordinary care and with many ingenious contrivances, and, mixed with other materials, is poured, in a liquid state, out of buckets and ladles, about the roots of the plants. Tea, rice, wheat, barley, buckwheat, millet, corn, cotton, potatoes, mulberry trees, yams, batatas, onions, cucumbers, melons, beans, cabbage, carrots, and a variety of other garden vegetables, are cultivated, principally in rows and in beds, with interval spaces between, in which the seed of one crop is sown while another crop is ripening for the harvest; and as soon as one crop is harvested the same ground is immediately prepared and manured again for another crop, the same season; so that there is almost a continual alternation and succession of crops, on the same land, the year round. Extensive arrangements are made for inundating the rice fields, and for irrigating the lands over the whole country and up to the highest terraces on the hills. The rudest sort of plows, however, with mattocks and hoes, are used, and water-wheels are employed for raising water out of the rivers for purposes of irrigation. The harvests are cut with knives and sickles, and gathered in by hand. Women and children as well as men work in the fields. It is evident that nothing but the continual and careful manuring of the soil could have kept up its fertility, under constant cropping, for so many thousand years. The value set upon manure by these people would be hardly credible to the European or American farmer. The simplest methods are employed for threshing grain. Sometimes animals tread out the grain on threshing-grounds, and sometimes flails are used. There are different crops for the winter and summer seasons. Agriculture employs the greatest part of the population. The state of things in Japan is very similar, but with some differences. In general, there is great industry, cheerfulness, and plenty; and when scarcity or famine occurs, the necessities of the destitute are provided for by a kind of public depot supplied by fixed contributions. The public taxes are a large item in the whole economy. — The peculiar interest of this excellent article consists in the minuteness and accuracy of particulars, of which no abstract can be given.

A lengthy discussion followed the abstract of Prof. Loomis's paper, the point of which was the re-affirmation of the well-known fact that a high barometer is indicative of a low temperature, and *vice versa*.

Dr. Engelmann made the following meteorological report:

The extraordinary low temperature for last January, 21°.3, was in the last forty years surpassed only by January, 1856, 20°.1; January, 1857, 19.°3; and February, 1838, 20°.8. These four were by far the coldest months during the period of his observations. The lowest temperature in these years ranged between 5° and 18° below zero, the highest between 45° and 51° above. Generally the warmest days of January attain a temperature of 60°, and sometimes even 70°.

The river has been frozen over firmly since January 4th, and continues bridged over to this day bearing the heaviest wagons.

The month of February after the cold January of 1856 was also very cold (26°.5), but that of 1857 was unusually mild (41°.8) and our mean temperature for January is 31°.8 and for February 35°.3.

The standing committee on Library reported having examined into the condition of the library. After stating that Mr. J. J. Bailey agrees to supervise the shelving, classification, and the catalogue, which will be made on the most approved card system, and that he also agrees that the future regular additions to the library of the Academy of Science shall be catalogued without cost as they come in, the committee presented the following resolutions, which were passed unanimously:

Resolved, That Mr. Harvey Raymond be engaged from date, January 25, 1875, to catalogue the library of the Academy of Science, at two dollars ($2.00) per day, under the supervision of the Librarian of the Public School Library and of the Academy of Science.

Resolved, That the Treasurer of the Academy of Science be directed to supply the Librarian with a list of those members who have paid their dues within two years, and to correct said list at the commencement of each year.

Resolved That the Librarian be authorized to lend books to members whose names shall be on said list, or who shall furnish other evidence that they have paid their dues to the Academy within two years.

Mr. Todd suggested that books be opened in the Academy and the Historical Society for stock subscriptions for a new building to cost $40,000. It was necessary to commence the building before the lapse of five years, and two years and a half had already passed. It was evident that the money could not be raised by direct subscription. — On motion, Mr. Todd was requested to bring the matter before the Society in definite shape at the next meeting, and also to endeavor to get a tenant for the lot until a building is commenced upon it.

Dr. Geo. J Engelmann exhibited photographic figures of Swiss lake relics that were offered for sale by a gentleman from La Crosse, Wis., with whom he (Dr. E.) had been instructed to correspond. The Society concluded not to purchase, and instructed Dr. Engelmann to so inform the correspondent.

Mr. Riley presented the following communication from Mr. Otto Lugger of St. Louis, in reference to the storing of acorns and the cutting of pine cones by squirrels:

Near Grand Haven, while resting from an extended tramp through the woods, I observed several squirrels at work, cutting off the cones of pines. They were always in pairs, one on the ground and one on the extreme end of a branch. These branches very often were not strong enough to bear the weight of the animal: it would then slowly crawl toward the cone until the branch commenced to bend, then it would stretch itself to the utmost to reach the prize: quick as lightning it performed the operation, and hastily retreated to presently repeat the same process. The second squirrel was almost invariably on the ground. In regard to the storage of food, I have observed repeatedly the following facts:—Near Chicago and Detroit I have often found, in early spring, as soon as the snow had disappeared from the sunny places on the edge of the forest, and while searching for beetles and chiefly pupæ of moths, great numbers of acorns, loosely covered with earth and moss, close to the trunks of oak, and chiefly under the roots These acorns had certainly been put there by some species of squirrel, since without any exception the germ of the acorn had been bitten out by sharp and long incisors, such as these animals possess. The number of acorns thus deposited varies from about half a dozen to upward of sixty.

Dr. C. L. Cassin, 1215 Washington av., G. W. Riggs, and Prof. F. E. Nipher of Washington University, were elected Associate Members.

February 15, 1875.

Albert Todd, Vice President, in the chair.

Eighteen members present.

Mr. Todd, to whom was referred the subject of the best means toward the erection of a new building to be occupied by the Academy of Science and the Missouri Historical Society, on the lot deeded to the societies by James H. Lucas, reported favorably on the subject of beginning the work as soon as possible. He proposed a scheme for taking subscriptions to capital stock. This plan was gotten up on the supposition that a proper building could be erected for $40,000. If the Academy should get subscriptions to the amount of $15,000, and the Historical Society would do the same, this would give $30,000; and this fact, together with the fact that the lot was valued at $10,000, would give a basis for borrowing more than $10,000, or even $20,000, in order to complete the building and furnish it with all necessary appurtenances. He proposed the following resolutions, which were adopted:

Whereas, by a deed dated June 3, 1872, and recorded on page 263 of the recorder of deeds for the county of St. Louis, James H. Lucas conveyed to the Academy of Science of St. Louis and the Missouri Historical Society a lot of ground as a contribution towards the erection of a building for the occupation and uses of said parties, provided the same were begun within five years from the date of said deed:

Resolved, 1. That, for the purpose of obtaining money for the erection of such a building, the Academy of Science of St. Louis will issue its stock to the amount of fifteen thousand dollars.

2. That said stock shall be in shares of twenty-five dollars each, and be paid for in instalments as required from time to time by this Society for paying demands made for the erecting of said building.

3. That in case said lot of ground, after being improved by such a building, shall ever be sold, the proceeds of such sale shall be disposed of as follows, to-wit:—The costs and expenses of such sale shall be first paid therefrom; next shall be paid therefrom whatever indebtedness may exist which is a lien upon the property; next there shall be reserved therefrom, if enough therefor (and if not enough therefor, then what remains), a sum equal to the value of said lot of ground, to be held and used for the same purposes for which the lot was conveyed by said deed. What then remains of said proceeds shall be divided among the owners of said stock *pro rata*.

4. For the subscription of this stock a book shall be kept open by the Secretary at every meeting of the Academy of Science of St. Louis at its place of meeting, and subscriptions shall also be solicited by advertisement in the city newspapers and by other means as may be from time to time directed.

Books and exchanges were laid upon the table by the Corresponding Secretary, who called especial attention to Leo Lesquereux's work on the Fossil Flora of the Western Territories, contained in Hayden's Geological Survey of the Territories.

Mr. Daniel Hough, of Indianapolis, was elected a Corresponding Member.

March 1, 1875.

W. T. Harris, President, in the chair.

Fourteen members present.

Mr. Riley, from the Committee on Publication, stated that signature 16 of the Transactions was just off the press, that the

Proceedings up to the last annual meeting were being rapidly printed, and that No. 2 of vol. iii. would soon be distributed.

Mr. Todd made the following report, which was accepted:

The undersigned, appointed to get a tenant for the occupation of the parcel of ground donated to it and the Missouri Historical Society, would respectfully report: That he placed the same in the hands of Messrs. S. D. Porter & Co. for letting, and that they have let the same to Messrs. James L. Ohlhausen & Co., for one year, from March 15, 1875, at the rent of $55 per annum, payable semi-annually in advance, with the privilege of another year at a rent equal to taxes and expenses, provided the Academy should not require its possession for erecting a building, and in this case the same to be surrendered upon demand at any time after the end of the first year. Porter & Co. are to be paid a commission of five per cent. upon the collection.

He also presented a subscription book and explained its purpose:

It was designed to receive subscriptions to stock to the amount of $15,000. Each subscriber was to agree with the Academy of Science to take a certain number of shares, to be issued by the Society, against his or her signature, and to pay for the same $25 a share, from time to time. as might be demanded for the erection of the new building, provided that the sum can be subscribed for before any payment on the same be demanded. The book was ruled for the names of the subscribers, number and amount of shares taken.

The book was accepted, and Mr. Todd's name heads the list for twenty shares of stock.

Rear-Admiral C. H. Davis sent a copy of the astronomical and meteorological observations taken during the year 1872. A vote of thanks was returned for the same.

Captain Robert B. Wade, of St. Louis. sent a sample of lace taken from the so-called "Lace Tree" of the West Indies. The sample was referred to Dr. G. Engelmann, and a vote of thanks was passed to Capt. Wade.

Mr. Riley called attention to the following published correspondence of Mayor Brown on the subject of the Colorado Potato-beetle, in answer to inquiries made by a Belgian, M. A. C. Hardy de Boislieu:

Some of the European Governments, fully appreciating the fact that it is easier to prevent than to cure an evil, and alive to the importance of economic entomology, have become somewhat alarmed now that this insect is known to have reached the Atlantic sea-board at a number of different points, lest it should be carried to Europe. Cognizant of the well-known fact that many of the worst weeds and insect pests of agriculture are importations from other countries, and with the history of the Grape Phylloxera—its American origin and recent devastations in Europe—fresh in mind, they feel the necessity of endeavoring to prevent a possible national calamity in the introduction of our dreaded potato pest.

To show that this alarm is not entirely unfounded, Mr. Riley read the following passage from his 6th Report:

That there will be danger of the insect finding its way to Europe, when once it reaches the Atlantic sea-board, no one can doubt; for the impregnated females will live for weeks, and even months, without food, especially in the spring and autumn, when they also take most readily to wing. Such females, alighting on outward-bound vessels, may easily be given free passage to European ports, and, as they will be apt to land without passports, it would be well for the authorities to look out for and prevent such unwelcome incursions. I do not think that there is danger of its being carried across the ocean in any other way; for potato plants, on which the eggs or larvæ might be carried, are not articles of commercial exchange, and seed potatoes do not, as a rule, harbor the beetles. Let our European friends profit by our sad experience with this insect, and, taking time by the forelock, endeavor to prevent its introduction into their potato-fields. This end will best be accomplished through the agricultural and horticultural societies, which should make provision for the dissemination of correct information concerning the pest. A small card, giving a colored figure of the beetle, or of all stages of the insect, setting forth the disasters which would follow its introduction, and appealing to the reader to assist in preventing such a calamity, would do good service if posted in the cabins of vessels plying between the two countries, in the warehouses and seed-stores of sea-port towns, and in the meeting-rooms of agricultural societies. Some such simple means of familiarizing the public with a possible enemy should be adopted in a country like Ireland, which will, perhaps, be the first to receive the pest, and would suffer most from it.

Mr. Riley stated that the subject had already been considered by the authorities of Prussia, Austria, Switzerland, and France; and it was in view of the introduction of a bill in the Belgian Chambers, prohibiting the importation of American potatoes, that our Mayor had been importuned for advice, and gave it in a letter, which concludes as follows:

Treating your letter, therefore, seriously, I have to state that there never has been a potato-bug seen flying about St. Louis, or any other city in the United States or Territories; that the potato-bug never has caused any alarm in any city nor in the country—only in certain seasons that seemed to be favorable to the production of them. I am not aware of the potato-bug attacking any other vegetable. I consider the fears of the people of

Belgium entirely groundless, even if the ravages of the potato-bug had been great in any locality the last season (which they have not), and is a matter of no apprehension or comment at the present time in this country.

Mr. Riley remarked that every one of the opinions expressed by our worthy Mayor is diametrically opposed to the facts, and the letter goes to show, what is too evident in so many other directions, that one may be a good politician and yet have no real acquaintance with the condition of the agriculture of the country. Mr. Riley gave an extended history of the Colorado Potato-beetle, and concluded by expressing the opinion that the course being pursued by some of the European authorities, in prohibiting traffic in American potatoes, was not the wisest. The only way that the insect could be carried over in potatoes was by being secreted in earth or haulm; and while there is a bare possibility of its chance transmission in this manner, there is little probability of it; and all danger will be removed if the exporters are directed to see that the tubers are free of earth, and to use no haulm in packing. If it ever gets to Europe at all, he believed it would travel in the manner already indicated.

Mr. Todd offered the following resolutions, which were unanimously adopted:

Resolved, That, in the judgment of the Academy of Science of St. Louis, the highest economical interests of the State demand the continuance of the offices of State Geologist and Entomologist, and it respectfully protests against any change of them, and most emphatically against their abolishment; and prays that the General Assembly of the State of Missouri sustain them with its usual necessary appropriations.

Resolved, That a copy of this resolution be sent by the Secretary to the President of the Senate and the Speaker of the House, certified to under the common seal of the Academy.

Resolved, That there accompany said resolution the signatures of such members of the Academy as can be conveniently obtained.

Antonio del Castillo and Mariano Barcena, of the city of Mexico, were elected Corresponding Members.

March 16, 1875.

Dr. Geo. Engelmann, Vice President, in the chair.

Fourteen members present.

Communications read and exchanges laid upon the table.

Mr. Riley exhibited four interesting fresh-water Crustaceans, presented by Mr. J. Boll, who had collected them around Dallas, Texas. One was a fresh-water Shrimp very near the genus *Palemon*, found in ponds near Dallas, and the more remarkable from the fact that while *Palemon Jamacensis* was known to occur in flowing fresh-water, no species has hitherto been found, so far as he was aware, in standing water; another was an interesting and probably undescribed species of *Branchipus*, also found in ponds; a third was a species belonging to the curious genus *Argulus*, which is remarbable for the large carapace or shield, its rudimentary abdomen, and by the second pair of legs being transformed into two large suckers, by means of which the animal attaches itself to the gills of the gar-fish (*Lepidosteus ferox*), where the species in question is found. *Argulus* is supposed to be parasitic, but Mr. Boll thinks it uses the gar-fish simply as a beast of burden. The fourth was a species of *Estheria*.

Dr. G. Engelmann communicated the results ot his observations of the temperature of last winter and compared it with previous winters during the last forty years:

December, 1874,	35°.3	December, mean of 40 years,	33°.2
January, 1875,	21°.3	January, " "	32°.0
February, "	24°.2	February, " "	35°.3
Winter 1874-75,	26°.9	Winter, " "	33°.5

This table shows that the first winter month, December, was over two degrees milder than the average; but January was 10° 7 and February even 11°.1 colder than the average, so that the low temperature of the past winter is entirely owing to the low temperatures of January and February.

In the last forty years we have experienced only four winters in which the mean temperature fell below 30 degrees, viz.:

1855-56	26°.4	1872-73	26°.3
1871-72	29°.1	1874-75	26°.9

In the first and last of these four winters the low temperature was owing to the excessive cold of January and February (to which a very cold March succeeded); in the third winter December and January were the cold months, and in the second all three months were very cold, but none so excessive as in the other three winters.

It appears that three of the coldest winters of forty years occurred within the last four years, with a milder one (1873, 79°-34°.8) between them. The other cold winter dates back nineteen years; no winter was colder than 30°.5; in the winter of 1837-38 there was an extremely cold February, while December and January ranged above the average. The question then arises whether our winters are getting colder. An answer, as far as it goes, is given in the following table of mean temperatures, in which I have arranged the forty years in four decades, and have given the summer temperatures as well as those of the winters and contrasted them :

Years.	Winter. *Deg.*	Summer. *Deg.*	Difference. *Deg.*
1836–45, - - - -	34.12	76.51	42.39
1846–55, - - - - -	34.21	76.11	41.90
1856–65, - - - -	33.21	77.36	44 15
1866–75, - - - - -	31.46	77.90	46.44

The winters and summers of the first and second decades have kept their own pretty well; or, to speak more correctly, the winters in the second decade seem to have become a little milder and the summers a little cooler than in the first; but in the third decade the winters were cooler and the summers warmer; and in the last ten years the progress in the same direction is still more remarkable.

Is this accident, or is it the expression of a general law? Do our winters get colder and our summers hotter, and has this been going on for a length of time and will it continue so to do?

A simple calculation would show the absurdity of such a proposition; a few hundred years back would bring us to a perfect paradise of a climate, and the same number of years forward would exhibit a state of things in which life could scarcely exist.

No, these changes are mere temporary oscillations, regular perhaps, irregular probably. The oldest witnesses of our climate, the forest trees, prove that five hundred years ago they must have flourished under the same conditions they now exist in; and in Europe and Eastern Asia, where history dates back from three to five thousand years, it appears the same vegetation, the same trees, and the same products of the field and the orchard, flourish now as in the most ancient times. So our trembling friends who see the finger of a terrible destiny in what they notice in the short span of their lifetime, or in a small part thereof, may take comfort.

The question about the change in the humidity of our climate and the fall of rain is an analogous one, and it is at this moment of particular importance to our young sister city, East St. Louis, where many expect an occasional return of high-water and an overflow, and want to prepare for it; while others, relying on the increasing dryness of the country, consider such steps as unnecessary.

Here again "facts," the observations of a limited number of years, seem to indicate an increasing degree or even aridity of the climate, and, corresponding with that, it is supposed that our rivers would never rise as high again as they have done in years past; the "cutting down of the forests" is insisted on as the great cause for such a change.

It is very true, and the history of our time as well as that of thousands of years ago proves it, that man's action in cultivating the soil and clearing the forests has important local effects on the annual quantity of rainfall, which is less dependent on local causes than on the distribution of the rainfall throughout the season, and especially on the benefit the soil (and thus the natural and cultivated vegetation) derives from the precipitated moisture, and the stage of water in the smaller tributaries and larger streams.

If the Mediterranean countries have become more arid, less fruitful, than they were in the time of the Greeks and Romans, they owe it no doubt in great part to the destruction of the forests of their hills and mountains, and with it the denudation of the rocky soil, and not to a diminished annual rainfall. But this rain is probably less evenly distributed, and is certainly less beneficial to the soil, because not absorbed and retained; it runs off over the arid surface, washes the soil more and more, swells the streams rapidly, and disappears rapidly. We see the same effects in countries where the soil is naturally destitute of forests, e.g in our southwestern regions and Mexico. But in the United States territory the artificial destruction of forests is, compared with the vast extent of country, so limited that important general effects on the climate can not have resulted. Whatever changes we may have observed within a few years, are, like the changes of temperature spoken of above, evidently only of a temporary or local character.

The stage of the Mississippi River has not been recorded for more than fifteen years, but we know of floods of the river at this point during ninety years, an account of which I have published in our Transactions of 1868 (vol. 2, p. 423). In that period the river seems to have risen more than 40 feet above low-water mark twice, in 1785 and (61 years later) in 1844; and 37 feet also twice, but at shorter intervals, 1851 and 1858; so that in fourteen years we had three floods, and none as high in the last sixteen years. But who can say that this coming season or next year will bring us a great flood again? There is not the least improbability in it.

It is not the rains here about St. Louis or those in Missouri, nor the melting of the snow in the mountains and northwestern regions, which alone are the causes of the great floods; it is the coincidence of many causes, and especially contemporaneous high rises of the great rivers which unite just north of us, which cause the highest floods, and there is no reason why they might not occur again in any spring or summer.

Judge Holmes announced to the Academy the death of a member, Mr. C. C. Whittelsey, in a fitting speech, and offered the following resolution:

Resolved, That the Academy of Science has heard with regret of the death of Charles C. Whittelsey, Esq., who had been for many years an active and useful member to the Academy, and that we desire to give expression in this form of our high appreciation of his merits and services, and of his excellent character and scholarly attainments.

M. L. Gray spoke to the resolution, paying high compliment to the gentlemanly and scholarly attainments of the deceased, and closed by earnestly seconding the resolution.

Dr. Engelmann announced the decease of Dr. Theo. C. Hilgard, a few days since, in New York, also a former member of the Academy. Judge Holmes and Mr. Riley referred to their acquaintance with the deceased in fitting terms.

The following resolution, reported by the Corresponding Secretary, was adopted:

Resolved, That this Academy has learned with profound regret of the recent decease of our late associate Theo. C. Hilgard, M.D., in the city of New York. We recognize the high qualities of the deceased and especially his ardent devotion to microscopical researches, and particularly in botanical and zoölogical subjects, in which he made very valuable contributions to our Transactions and to other scientific publications; and we shall ever cherish a grateful recollection of his services to science.

Both resolutions were adopted, when the Academy adjourned.

April 6, 1875.

W. T. Harris, President, in the chair.

Twenty members present. Charles J. Norwood, of Columbia, Mo., assisted.

In the absence of the Recording Secretary, Mr. B. V. B. Dixon was appointed *pro tem.*

No. 2 of vol. iii. of the Transactions was laid upon the table and 1,000 copies delivered to the Librarian.

Specimens of wood cut by beavers in Jasper Co., Mo., were presented by Prof. G. C. Broadhead, who stated that the mill-dam on Spring River is kept in good repair by the beavers. Hackberry wood is mostly used, but also other kinds. The beavers are protected by the mill owners, and thrive and multiply.

Dr. Engelmann's paper on the Trees of Colorado, read at Washington University, was presented by Mr. Todd for preservation in the archives.

Dr. Engelmann presented a specimen of the *Oxytropis Lamberti*, a member of the pea family, the herb and fruit of which family are generally wholesome and nutritious. This species presents the peculiarity of being injurious, with a few others, such as the Laburnum and the Calabar-bean of Africa.

Dr. Engelmann reported with regard to his recent study of vines:

American grape-vines are commonly said to be polygamous; he finds flowers with both pistils and stamens, some of these with incomplete stamens, but none devoid of the same. He deduces from this the theory that the flowers are incompletely fertile, i.e. that fertilization of a flower by its own pollen is not so good as fertilization by that of another flower. He would therefore recommend the cultivation of a few sterile or pollen-bearing vines of the proper species in each vineyard, thus following the plan of nature, which furnishes a large number of staminate plants. We find a similar state of things in regard to certain varieties of strawberries.

The cultivated grape-vines in Europe have been propagated from slips for so long a time that sterile plants are almost unknown; but sterile plants can be raised from the seed in European as well as American species—a fact unknown to naturalists until recently.

It was thought that the Taylor grape, one of the finest of our varieties, now not very productive, could be much improved in this regard by the process proposed.

Mr. Todd mentioned the introduction of Arundel glass in spectacles, the advantage of which he claimed to be that the tinge of violet absorbed the heat-rays injurious to the eye. Dr. Engelmann doubted the fact that the heat from ordinary light was sufficient to injure the eye or cause suffering.

Prof. Broadhead presented specimens of quartz traversed by capillary crystals of titanium oxide; also crystals of zincblende notable for their large size; also the fossil *Actinocrinites proboscidiales.*

April 19, 1875.

ALBERT TODD, Vice President, in the chair.

Ten members present.

Mr. Riley being absent, Dr. S. Pollak was chosen Recording Secretary *pro tem.*

The Corresponding Secretary read several communications. One of these, a paper on Intermittent Fever, by Mr. Amos Sawyer, of Hillsboro, Ills., was referred to Dr. Stevens.

Dr. C. F. Tennant sent several teeth for the consideration of the Society, and desired whatever information the members might possess on the subject. It was surmised by several that they were the teeth of some carnivorous animal. Dr. Stevens thought the sender should give some statement of the circumstances under which they were found, as it was impossible for the most scientific to judge of the species of the animal, or to decide whether the teeth were those of one animal or more than one. The Secretary was accordingly requested to address a note to Dr. Tennant desiring further information.

A daguerreotype of a flash of lightning, taken June 18, 1847, was received from the artist, Mr. T. M. Easterly, to whom the thanks of the Society were returned.

Dr. Galney was appointed to fill the place of Dr. Schmidt in the Board of Curators, recently made vacant by resignation.

May 3, 1875.

W. T. Harris, President, in the chair.

On account of Mr. Riley's absence, Wm. McLellan was chosen Secretary *pro tem.*

Thirteen members present.

The Library Committee reported progress.

Communications were then read by the Corresponding Secretary, and several publications were laid upon the table, among which were the Proceedings of the "Sociedad Mexicana de Historia Natural," Mexico.

A letter was read from Señor Antonio del Castillo, of Mexico, acknowledging his election as a Corresponding Member of the Academy.

On motion of the Corr. Sec., the "Rantoul Literary Society," of Rantoul, Ills., from which a copy of Proceedings had been received, was placed on the list of exchanges.

Dr. Stevens read a communication on Intermittent Fever, from Mr. Amos Sawyer, of Hillsboro, Ills. In this paper the "spore" theory was advocated, and it was claimed that a moist soil and solar heat in the presence of carbonic acid were the principal generating agencies.

These views were characterized by Dr. Engelmann and Dr. Briggs as speculative and non-scientific, and it was voted to deposit the paper in the archives.

May 17, 1875.

W. T. Harris, President, in the chair.

Fifteen members present.

Minutes of previous meetings read and approved.

The Corresponding Secretary read several letters and communications. He stated that he had received the following works: From the Secretary of the Interior—Hayden's 7th Ann. Rep. of the Geological Survey of the Territories; Coues' Birds of the Northwest; Lesquereux's Cretaceous Fauna; Leidy's Extinct Vertebrate Fauna; Thomas's Synopsis of Acrididæ; Porter and Coulter's Flora of Colorado. From the Royal Academy of Sciences, Berlin—a copy of their Proceedings. A Memoir on the Antiquity of Caverns and Cavern Life of the Ohio Valley, by Prof. Shaler, Boston; Herbert Spencer's "Illustrated Sociology," from Mr. Ward Combs, of Fieldon, Ills.; Proceedings of the Academy of Sciences, Königsberg. Also a work by Gustav Wen, "Ueber die Wasserabnahme in den Quellen, Flüssen und Strömen bei gleichzeitiger Steiger ungder Hochwässer in den Culturländern," accompanied by a circular asking for facts relative to the same subject in this part of the world.

Nos. 1 and 2 of vol. iii. of the Transactions were ordered to be sent to Mr. W. W. Caulkins in return for his work on Fresh-water Shells.

Dr. Richardson read a brief paper on the appearance of four rainbows.

Dr. Stevens presented to the Academy a number of crinoids, trilobites, and orthocerata, obtained from the Grafton stone quarries in Illinois. He reported that specimens were quite numerous in that rock.

Mr. Riley referred to the ravages of the young locusts in the western counties of the State as truly alarming. He said, however, that he did not apprehend that they would do any serious damage outside of the districts in which they had hatched; that the bulk of them would get wings by or before the middle of June to enable them to fly away, which they would do. He predicted that they would this season return to the northwest; that very few eggs would be deposited in Missouri this year, and that, consequently, there would be no injury from the pests in 1876. He thought the only way to obtain relief now, in the sections in which they were hatching, was for the farmers to destroy them by use of the roller, by driving them into ditches, drowning or burning them there, and by thoroughly cultivating the soil. He was of the opinion that much more could be accomplished by concerted action among the farmers than would be supposed from the simplicity of the remedies proposed. He thought it would be a good plan for the State to offer rewards for the killing of the pests and for the destruction of their eggs. This had been practised in European countries with good results.

No. 2 of vol. iii. of the Transactions was laid before the members.

Mr. Chas. J. Norwood, Columbia, Mo., was elected a Corresponding Member.

May 31, 1875.

Dr. G. Engelmann, Vice President, in the chair.

The regular business was dispensed with, the meeting being specially called, with an invitation to the citizens generally, to listen to a lecture by Mr. Riley on the Rocky Mountain Locust, the ravages of which were absorbing public interest and attention. The lecturer by the aid of diagrams gave an exhaustive account of this locust plague—showing how best to manage it, and prevent a recurrence of the evil which the State is now suffering under—and insisted that the suffering and destitution in our western counties would soon end, and that the insects in the course of the next two weeks would leave the State. There would be time to raise many important crops, and he fully expected that, within three months, the people in the ravaged districts would be blessed with a plenty that would be all the more appreciated by contrast with the present desolation.

October 4, 1875.

In the absence of the President, Dr. Forbes was called to the chair.

Hon. S. M. Breckinridge was proposed as an Associate Member by N. Holmes and R. Hayes.

The attendance was so small that after informally discussing various subjects an adjournment was moved and carried.

October 18, 1875.

W. T. Harris, President, in the chair.

Eighteen members present.

The Committee on Building being asked to report, Mr. Todd said that a former meeting a scheme had been reported for the collection of money and the erection of a building for the Academy of Science and the Historical Society. It was proposed to raise $20,000 by subscriptions for shares, and $20,000 was to be borrowed on the property. The subscription book was in the hands of the Recording Secretary—who remarked that it was laid upon the table at each meeting for the signatures of members, and at the same time suggested that something should be done to appeal more effectually to the citizens outside the Academy.

Dr. Briggs, from the Committee on Library and Catalogue, reported that it had been found necessary to suspend the work of cataloguing pamphlets, as it was impossible to proceed until the bound volumes could be overhauled. This could not be done until the School Board should supply the cases necessary for the reception of the pamphlets. It was hoped this would be done within a month. A request for information regarding the number of volumes in the library had been received from the Commissioner at Washington. There were now only eleven copies remaining of the first number of vol. i. of the Transactions.

On motion, the committee was empowered to take such means as seemed proper to preserve the pamphlets.

The Corresponding Secretary called attention to a large number of pamphlets, books and papers on the table. Among them were the Quarterly Journal of Conchology, published in Leeds, England; the Geological Survey of Missouri, from Mr. Broadhead; A Volume of Explorations in Colorado, by J. W. Powell; Bulletin of the Anthropological Society; Observations made at the Magnetic and Meteorological Observatory at Batavia.

Judge Holmes also called attention to an article in the *Canadian Naturalist* on the Indian Race in America, by Prof. Daniel

Wilson, which gave data of facts to prove that the American Indians, whenever located on their reserves in proximity to the white people, very soon became a race of half-breeds. The pure Indian blood disappeared, and in time no individual of the pure race remained. The race became extinct in one sense, but continued in another.

Mr. Riley presented, on behalf of Capt. Eads, a curious spinous fish from the Gulf of Mexico, and popularly known as the Toad Fish. He remarked that it was evidently a species of *Diodon*, a genus of Branchiostegous fishes, belonging to the family Gymnodontes. These fishes have the peculiar power of puffing themselves up like balls; when the spines, directed on all sides and kept in constant agitation, render them quite formidable. The puffing power no doubt protects the animal from enemies, though it is said that the boys around New Orleans make footballs of it. The species presented resembles figures of *D. orbicularis*, which, however, inhabits the seas of Jamaica and the Cape of Good Hope; and it differs from *D. Plumieri*, which is a native of American seas, in being covered dorsally with bluish, anastomosing lines, instead of elongated bluish and white spots. Not only the wound made by the spines is said to be dangerous, but the flesh is poisonous.

Mr. Riley read a paper entitled "Remarks on Canker-worms, and Description of a new Genus of Phalænidæ"; also one entitled "Notes on the Natural History of the Grape Phylloxera (*Phylloxera vastatrix* Planchon). He illustrated both papers with figures and specimens, and they were referred to the Committee on Publication.

Prof. Nipher, of Washington University, read a paper "On a new form of Lecture Galvanometer," which was referred to the Committee on Publication.

Hon. Samuel M. Breckenridge, of St. Louis, was elected an Associate Member.

November 1, 1875.

W. T. Harris, President, in the chair.

Twelve members present.

Dr. Briggs, from the Committee on Library, made a further brief report, recommending the proper labelling of our books.

He also submitted the following communication from the Librarian relating to the present condition of the library:

Dr. C. E. Briggs, Ch. Com. on Library, Acad. of Science.

Dear Sir:—I am instructed by Dr. Auler, President of the Board of Managers of the St. Louis Public School Library, to inform you that at a meeting of the Book Committee held Thursday, 28th inst., it was ordered that the duplicate books belonging to the library, and not in circulation, be removed from the book-cases and stored away, and that the shelf-room thus gained, together with that which will result from bundling and storing away the Transactions of the Academy (as you suggested), be devoted to the books and pamphlets of the Academy. The work of getting the pamphlets into book-cases will be begun at once, and the cataloguing of the entire library of the Academy will be pushed on as rapidly as possible.

The count made for the U. S. Commissioner of Education shows the contents of the library to be as follows:

407	bound volumes	Transactions of Societies
904	" "	miscellaneous works
962	unbound "	Transactions of Societies
162	" "	miscellaneous works
		(The last two items represent *complete* vols.)
214	" "	Transactions (incomplete)
95	" "	miscellaneous "
54	" "	pamphlets, Transactions
133	" "	pamphlets, miscellaneous
		(Computed at 10 pamphlets per vol.)
2931	vols. total contents of library.	

As regards the unbound volumes and pamphlets, the haste with which the count had to be made rendered absolute accuracy impossible. I believe, however, that the corrected count, to be made while cataloguing, will not differ materially from the above.

In addition to the foregoing, the Academy library collection contains the following numbers of its own Transactions:

12	copies	Vol. 1,	No. 1,	Transactions
104	"	" 1,	" 2,	"
110	"	" 1,	" 3,	"
304	"	" 1,	" 4,	"
256	"	" 2,	" 1,	"
384	"	" 2,	" 2,	"
488	"	" 2,	" 3,	"
543	"	" 3,	" 1,	"
469	"	" 3,	" 2,	"
750	"	Charter, Constitution, &c.		

I beg to suggest that a large proportion of the above unbound volumes could be bound in "Emerson's Patent Binders" at a cost (labor included) not to exceed from 13 cents to 45 cents per volume, according to size. We are using these binders very largely in the Public School Library, and intend binding with them all our loose pamphlets. Samples of them may be seen in the library.

I have the honor to be
Your very obedient servant,
JNO. J. BAILEY, *Librarian Ac. of Sci.*

St. Louis, Oct. 30, 1875.

On motion, the committee was instructed to procure labels to place on the books of the Academy.

Exchanges were laid on the table by the Corresponding Secretary, who called especial attention to the Geological Survey of Ohio, and gave an interesting *resumé* of Professor Newberry's views on glacial phenomena, as well as those of Mr. Croll in his late work on "Climate and Time."

The salient points were that the large lakes of North America had their basins excavated by the glaciers; that glacial action appears in Ohio as low down as the 40th degree of latitude, and that the alternations of glacial and interglacial periods were due to the eccentricity of the earth's orbit in conjunction with the winter solstice occurring in aphelion, and thus causing a longer period of intense cold and accumulations of glacial ice, and, at the same time, producing a change in the level of the sea in consequence of the greater accumulation of ice and snow at times in the polar regions, having the effect to change the direction of the Gulf Stream and ocean currents, and to transfer large masses of water from one hemisphere to the other in the form of glacial ice, with a consequent change in the centre of gravity of the earth.

Dr. Engelmann presented, on behalf of Dr. Boisliniere, male aments of the bread-fruit tree (*Artocarpus*) candied in the manner used as sweetmeats; also a humming-bird nest from Guadaloupe.

Mr. Riley presented, from the author, Mr. Samuel H. Scudder, of Cambridge, Mass., a work on Fossil Butterflies, the first memoir of the American Association for the advancement of Science.

A skull, supposed to be of great antiquity, found in a mound at Fenton, Mo., was exhibited to the Academy by Messrs. F. E. Roesler and F. J. Soldan.

Mr. Gage gave an interesting account of an ancient stone-wall in Mississippi, near Natchez, presumed, from such examinations as have been made, to inclose a territory embracing about 400 square miles. He remarked:

In the summer of 1870 my attention was called to the existence of an ancient wall cropping out at different points in Claiborne County, 18 miles east of Port Gibson, in the State of Mississippi. Blocks of the stone have been taken by the farmers for building purposes for many years, and it has formed a general quarry for furnishing large blocks of stone for laying foundations for houses. But the farmers have never, it seems, been aware of the antiquarian importance of this wall. Prof. Gage employed laborers and uncovered a portion of the wall 20 feet in width and 175 feet in length, but, on removing the soil here and there, he traced it 600 feet. The workmen uncovered the wall to a depth of six feet. but lower than this the excavations were not continued.

Large forest trees of pine and oak, several hundred years old, are growing on top of the wall. The blocks are limestone and belong to the tertiary formation. They were hewn out of this formation, and are 3 feet in length, 20 inches in width, and 22 inches in thickness. One of these blocks has been shipped for St. Louis, and is expected to be on exhibition in the geological department before the close of the Fair, and then it will be sent to Philadelphia for the Centennial.

The wall from which the block is taken forms two sides of a rectangle, one portion running east and west and the other north and south. The excavations were made near the angle. Three miles due south from this point another portion of the wall reappears on the banks of Bayou Pierce, owing to the washing out of the creek, making it a large exposure, and it is therefore judged that this is a continuation of the ancient wall. The wall was built on the side of a ridge overlooking a swamp which, in ancient times, was evidently the bed of a lake, and the inference is that the wall was erected by the ancient occupants as a barrier against an enemy. From other evidences of the extent of this wall, as described by the people in other sections, it is evident that it included a large area of land, covering probably 400 square miles and extending to the Mississippi River.

He states that within a few miles there are ancient mounds scattered all over the valley. Specimens of pottery, vases, stone axes, arrow-heads, skulls, bones, and sea-shells, have been found in any quantity. The locality where this remarkable wall exists is in the neighborhood of the Natchez Indians, who were found in a state of considerable civilization when first visited by the French, and these remains, it is conjectured, may have some connection with the occupation by the war-like ancestors of this interesting and famous tribe.

Mr. Riley suggested, as a matter worthy perhaps of going on record, the fact that the events of the past summer had fully borne out his conclusions, given at the meeting for May 17, and the called meeting for May 31, regarding the probable doings of the Rocky Mountain locusts.

November 15, 1875.

Dr. G. Engelmann, Vice President, in the chair.

Fifteen members present.

Exchanges received laid upon the table by the Corresponding Secretary, who also stated that he had called the attention of Mr. Amos Sawyer to a notice in the "*Nature*" (313) of his article in No. 2 of vol. iii. of our Transactions quoting his statement, that in the State of Illinois "there were at least three million horses, cattle and mules, and five million hogs and sheep, and that they will consume more than *seventy million* gallons of water every twenty-four hours—quite a lake in itself"; with the remark that "surely, this must be a misprint, or American animals are very thirsty beings." He had received from Mr. Sawyer the following reply:

Hillsboro, Ills., Nov. 13, 1875.

Judge N. Holmes, St. Louis, Mo.

Dear Sir: — Yours of the 9th at hand and contents noted. In reply would say, *it is not a misprint;* and therefore I presume that "American animals *are* very thirsty beings." Had our "British cousin," however, stopped to consider the difference between his little Island where the atmosphere is always humid, and which at times becomes so charged with moisture that the animals are *really living in a cloud*, and that of our State, with her broad prairies situated nearly in the centre of our Great Republic, where the temperature of midsummer almost equals that of the torrid zone, and the atmosphere is so devoid of moisture that for some years previous to the present season the "fall of dew" was scarcely perceptible, and the wind at times approximating a simoon,—he must readily have perceived that animals would require a greater amount of water here than in England; and the statement would not have appeared so extravagant. I should have answered more promptly, but wished to obtain the views on this point of four men who have been handling stock all their lives, and whose opinions, therefore, would be valuable. Three of them agreed with me except in the amount consumed by cattle, considering *that too low;* the other thought the estimate for hogs too high. In conclusion, then, I will say, I have owned a stock-farm for 16 years; and during this time have owned thousands of cattle, hogs and sheep, and my conclusions are the result of an experiment made with the view of ascertaining the amount of water consumed in a given length of time by different animals. This estimate was for six months, commencing with May, the time during which stock are out on pasture. For winter it must be reduced one-half. Now for the mode by which I arrived at the result: It was by placing a number of each kind of animals by themselves and measuring the amount of water consumed by each; for instance, I took 12 cattle of different ages—1°, 2°, and 3°. I found a large 3-year old steer, with a big belly, would consume *15 gallons 3 times a day:* but the average amount for 2-year olds, and upwards, was 10 gallons 3 times a day; yearlings, 7 gallons. The amount would vary according to the degree of heat, and condition of the atmosphere. I own a horse now that will drink from 25 to 30 gallons of water every day during warm weather. As with man, so with our domestic animals, one will drink more in a given length of time than another.

In arriving at the total amount consumed, I estimated thus for 24 hours:

1,000,000,000	horses,	12	galls. each,	- -	12,000,000,000
2,000,000,000	cattle,	25	" "	- -	50,000,000,000
2,000,000,000	sheep,	1	" "	- -	2,000,000,000
3,000,000,000	hogs,	2	" "	- -	6,000,000,000
			Total,	- -	70,000,000,000

This, I think, will be found to be as nearly correct as it is possible to make it.

One word with reference to the horse. Carpenter says: "Of the *water* taken into alimentary canal or contained within the body, nearly two-thirds passes off with the fæces; and of that which is absorbed, little more than one-seventh passes into the urine, the remainder being exhaled from the lungs and skin." Now I found after repeated measurement that the quantity of urine passed by a horse in 24 hours would average one gallon and a half; taking *even this* as a basis for estimating the probable amount of water consumed during the day, and it will be found that my calculation for the horse does not *exceed* the true amount.

Thanking you for your courtesy in calling my attention to this subject, and with my best wishes for your prosperity and happiness, I remain

Very truly yours, &c.,

AMOS SAWYER.

Dr. Theodore Fay presented a hydrograph of the Missisippi River, at the foot of Market street, showing the rise and fall of the river from 1844 to 1875. The highest point attained by the river the present season was on the 8th of August, when the water was five feet below the city directrix. The highest water was in 1844, the lowest in 1863. The map is on vellum, and four by five feet in size. A vote of thanks was tendered to the donor.

Prof. F. E. Nipher made some striking experiments with colored glass, the substance of which was published in the "Notes" in *Nature* for Oct. 7, 1875. It is well-known that if the eye be forced to look steadily at a certain color—as, for instance, red—the sensation of red is gradually enfeebled. If now the eye be fixed on a sheet of white paper, the red which goes to make up the white is enfeebled, and the remaining colors impress the eye with the sensation of green. What is true of red and green is of course true of any other complementary color.—A much more striking effect is produced if some white and brilliantly illuminated object is observed with colored glasses. Look with the right eye through red glass and with the left through green glass. The sensations of red and green gradually become more feeble. To the eye thus fatigued by green, white would appear tinged with red, and a red color would appear strengthened. To the eye fatigued by red, white would appear tinged with green, and a green color would appear strengthened. If now both eyes are transferred to the red glass, these effects can be brought out in a very striking manner by opening and closing each eye alternately. The converse effects are of course observed by placing both eyes before the green glass. The best object for observations of this kind is a brilliantly illuminated (white) cumulous cloud.

Mr. Riley remarked that among the changes that took place in those portions of the State so thoroughly devastated by locusts last spring, none were more interesting than the wide-spread appearance of a grass unnoticed in ordinary seasons. This grass is the *Vilfa vaginæflora*, an annual which, as he was informed by Dr. Engelmann, is common from the Atlantic to the Rocky Mountains. The locusts eat down the blue grass so closely that in most instances it dies out, and this annual grass takes its place and grows up rapidly just at the time when most needed by stock, so that it is considered a God-send by the farmers, who generally believe that it was brought by the locusts. The seed was scattered over the land the fall before, and the conditions were all favorable for its starting. In ordinary seasons, on the contrary, it is smothered and choked down by other plants. It was a beautiful illustration of what Darwin has called "the struggle for existence." He added other facts of a similar nature and showed how a certain large worm (*Deilephila lineata*, figured and treated of in the 3rd Mo. Ent. Rep., pp. 140–42) which feeds on purslane was from similar causes also unusually numerous.

Dr. G. Engelmann remarked that these instances of the abnormal multiplication of a species in exceptional years were very interesting, and that the unusually wet season and other favorable conditions helped to give the grass mentioned so wide-spread a growth.

Judge Holmes objected to the term "struggle for existence," as if a plant could struggle. If it be intended literally, either it is asserted that a plant thinks and wills, or it is asserted that an animal possessing will struggles only in the same way. He could not help feeling a little indignation at Mr. Darwin's illogical use of such expressions as "natural selection," or "a law acting," as if those things could do anything. A law does not act: it is merely operative by sheer obstruction and resistance. It is not an active power.

Mr. Riley defended the use of the first two expressions: he thought they were happy, and ought not to be viewed in so hypercritical a sense. Words are mere symbols to convey ideas, and come to have various meanings according as they are used by high authority. The terms criticized have been generally accepted as expressions of the meaning Darwin gave to them. This does not imply present conscious action, and "struggle for existence" should no more be taken in its literal sense than "shipping a carload," or dozens of other expressions which have come to have a special meaning by common acceptance and accord.

Dr. Engelmann presented a chip from the big California tree, *Sequoia gigantea*, now on exhibition in this city, the wood of which (without the bark) is represented as having a diameter of 25 feet. The specimen, from the external part, or latest growth of the tree, showed 55 annual rings in a thickness of 55 millimeters; 10 rings had a thickness of 6 mm., in other pieces only of 4 or 5 mm; the sapwood of this tree has a thickness of about 100 mm., and consists of 120 to 150 annual layers. As a general rule, then, the external portions of wood proper and of sap in this specimen have annual rings of ½–1½ mm. in thickness, indicating an increase in thickness of the whole tree during this latest period of its existence of 1–3 mm. annually, or 4–12 inches every hundred years. But in its younger years the tree grew much faster, as proved by a specimen of wood said to come from the innermost part of the tree, which exhibits 30 rings in a thickness of 86 mm., or 1 ring nearly 3 mm. thick, indicating an increase of 2 feet in 100 years. Whether at any time the tree grew more rapidly can not be ascertained from any of the specimens; it is, therefore, not safe to base any calculations on these incomplete data. They only permit us to say that at one time one foot of increase was accomplished in 50 years, at a later period in 100, and even in 300 years. It is well known that Dr. A. Gray, with much more complete material at his disposal, accorded to this species an age of about 2,000 years, more or less.

December 6, 1875.

Dr. S. Pollack in the chair.

Nine members present.

Mr. Riley, from Committee on Publication, laid sig. 18 of the Transactions upon the table.

The Corresponding Secretary laid a number of exchanges on the table, and read a communication from the Secretary of the Soc. of Nat. Hist. of San Diego, Cal., making inquiries relating to the effects of forests on rainfall, which letter was referred to Dr. G. Engelmann for answer.

JUMPING SEEDS AND GALLS.

Mr. Riley exhibited certain seeds which possessed a hidden power of jumping and moving about on the table. He stated that he had recently received them from Mr. G. W. Barnes, of San Diego, Cal., and that they were generally known by the name of "Mexican Jumping Seeds." They are probably derived from a tricoccous euphorbiaceous plant. Each of the seeds measures about one-third of an inch, and have two flat sides, meeting at an obtuse angle, and a third broader, convex side, with a medial carina. If cut open, each is found to contain a single fat, whitish worm, which has eaten all the contents of the seed and lined the shell with a delicate carpet of silk. The worm very closely resembles the common Apple Worm (*Carpocapsa pomonella*), and, indeed, is very closely related, the insect being known to science as *Carpocapsa saltitans*. It was first recorded by Westwood in the Proceedings of the Ashmolean Society of Oxford, in 1857 (t. 3, pp. 137–8), and repeatedly referred to under the name of *Carpocapsa Dehaisiana* in the Annales of the French Entomological Society for 1859. The egg of the moth is doubtless laid on the young pod which contains the three angular seeds, and the worm gnaws into the succulent seed, which, in after growth, closes up the minute hole of entrance, just as in the case of the common Pea Weevil (*Bruchus pisi*). Toward the month of February the larva eats a circular hole through the hard shell of its habitation, and then closes it again with a little plug of silk so admirably adjusted that the future moth, which will have no jaws to cut with, may escape from its prison. A slight cocoon is then spun within the seed, with a passage way leading to the circular door; and the hitherto restless larva assumes the quiescent pupa state. Shortly afterwards the pupa works to the door, pushes it open, and the little moth escapes. When ripe, the shell is very light, and, as the worm occupies but about one-sixth the enclosed space, the slightest motion will cause the seed to rock from one of the flat sides to the other. But the seed is often made to jerk and jump, and, though this has been denied by many authors, Mr. Riley had had abundant proof of the fact, and had seen the seed jerked several lines forward at a bound, and raised a line or more from the surface on which it rested. If the seed be cut, the worm will soon cover up the hole with a transparent membrane of silk; and if two of the opposite angles be cut, the movements of the worm can then be seen, if the seed be held against the light. It then becomes evident that the jerking motion is conveyed by the worm holding fast to the silken lining by its anal and four hind abdominal prolegs, which have very strong hooks, and then drawing back the head and forebody and tapping the wall of its cell with the head, sometimes thrown from side to side, but more often brought directly down as in the motion of a wood-pecker's head when tapping for insects. In drawing back the forebody, the thoracic part swells, and the horny thoracic legs are withdrawn, so as to assist the jaws in receiving the shock of the tap, which is very vigorous and often given at the rate of two a second and for twenty or more times without interruption. It is remarkable that this, of all the numerous seed-inhabiting Lepidopterous larvæ, should possess so curious a habit. The seed will move for several months, because, as with most Tortricidous larvæ, this one remains a long time in the larva state after coming to its growth and before pupating.

Mr. Barnes gives the following account of the plant, received through Capt. Polhamus, of Yuma, A. T. It seems to be called both *Yerba de flecha* and *Colliguaja* by the Mexicans:

"*Arrow-weed* (*Yerba de flecha*).—This is the name the shrub bears that produces the triangular seeds that during six or eight months have a continual jumping movement. The shrub is small, from four to six feet in height, branchy, and in the months of June and July yields the seeds, a pod containing from three to five seeds. These seeds have each a little worm inside. The leaf of the plant is very similar to that of the 'Garambullo,' the only difference being in the size, this being a little larger. It is half an inch in length and a quarter of an inch in width, a little more or less. The bark of the shrub is ash-colored, and the leaf is perfectly green during all the seasons. By merely stirring coffee, or any drink, with a small branch of it, it acts as an active cathartic. Taken in large doses it is an active poison, speedily causing death unless counteracted by an antidote."

Mr. Riley stated that the seed of *Tamariscus* was known to be moved by a Coleopterous larva (*Nanodes tamarisci*) that fed within it; and he concluded by describing and exhibiting a still more wonderful jumping property in a seed-like body which may be observed in our own woods. It is a little spherical seed-like gall produced in large numbers on the underside of the Post and other oaks of the White Oak group. This gall drops in large quantities to the ground and the insect within can make it bound twenty times its own length, the ground under an infested tree being sometimes fairly alive with the mysterious moving bodies. The noise made often resembles the pattering of rain. The motion is imparted by the insect in the pupa and not in the larva state. He presented the following description of the gall, which may be known by the name of *Quercus saltatorius*, the black fly which issues from it having been described as *Cynips saltatorius* by Mr. H. Edwards of San Francisco:

Gall of Cynips saltatorius.—Formed in summer on the underside of the leaves of *Quercus obtusiloba*. *Q. macrocarpa*, and *Q. alba*, often to the number of 1,000 on a single leaf: each gall inserted in a deep cavity which causes, on the upper surface, a bulging of a straw-yellow color, irregularly sub-conical, with the top flattened, or concave, and with a minute central nipple, sometimes obsolete: the galls becoming detached and falling to the ground in autumn, leaving a pale, fulvous, circular disc at the bottom of the cavity. The gall has an average diameter of 1 mm., and the color and general appearance of a miniature acorn—the base being paler than the sides and conically produced to the central point of attachment. The apical portion is slightly constricted into a deep purple-brown rim, and the top within this rim is flat, with a small central nipple.

Received at different times from M. W. Harrington, of Ann Arbor, Mich.; from Irvin Armstrong, of Vevay, Ind.; from N. B. Baldwin, of Elgin, Ills., and from Wm. R. Howard, of Forsyth, Mo.: also sufficiently common in St. Louis County.

December 20, 1875.

W. T. Harris, President, in the chair.

Twelve members present—J. M. Mansfield, Professor of Natural Philosophy, Mt. Pleasant, Iowa, assisting.

The Corresponding Secretary laid a large number of exchanges on the table, among them the transactions of Academies in Naples, Milan, Bologna, Florence, and Rome.

In reply to a letter from Thos. Bicknell, editor of the *New England Journal*, asking for a report of the proceedings of the Academy for publication in the *Journal*, Mr. Riley suggested the propriety of making arrangements with one of the daily papers to publish a full and authentic account of our proceedings. There was an increasing demand for scientific information in the country, and such an arrangement would prove advantageous both to the paper and to the Academy.—On motion of Judge Holmes, Mr. Riley was appointed a Committee of one to see to the matter.

A couple of molar teeth, apparently of *Mastodon angustidens*, were exhibited by Mr. Todd. He said they had been found in Pike County of this State, and brought to the city by Mr. Jameson, of Louisiana, Mo. They had been taken from a creek that entered the Mississippi River at the upper end of Clarksville, and were very well preserved, having the enamel still on them. A portion of the mastodon's jaw was attached to one of them.—Judge Holmes remarked that such remains were most frequently found in the Loess or Bluff formation of the Mississippi Valley, often in quite superficial deposits, and in the beds of ancient lakes or swamps in the eastern parts of the United States. Dr. Koch had given in our Transactions, some years ago, reasons for believing that the Mastodon had been contemporaneous with man in Missouri; and though Prof. Dana had shown that Dr. Koch was not a scientific and reliable observer, he did not venture to deny that the fact might be so.

A paper by Prof. G. C. Broadhead, on "The Rocky Mountain Locust and the Season of 1875," was read, and referred to the Committee on Publication.

Mr. Riley made some remarks on the use of Paris green as an insecticide, and cited some recent experiments by Dr. R. C. Kedzie, of the Michigan Agricultural College, which fully bore out his (Riley's) own previous conclusions and advice, and from which he drew the following:

1. Paris green that has been four months in the soil no longer remains as such, but passes into some less soluble state, and is unaffected by the ordinary solvents of the soil.

2. When applied in small quantities, such as alone are necessary in destroying injurious insects, it does not affect the health of the plant.

3. The power of the soil to hold arsenious acid and arsenites in insoluble form will prevent water from becoming poisoned, unless the green be used in excess of any requirement as an insect destroyer.

He referred to other "potato-bug" poisons, especially one made at the Lodi (N. J.) Chemical Works, which analysis shows to be half salt, half arsenic (arsenate of copper). It cost one dollar a pound, was no cheaper than Paris green, and was more dangerous on account of its color, which rendered it liable to be confounded with common salt.

January 3, 1876.

ALBERT TODD, Vice President, in the chair.

Nineteen members present.

Mr. Riley, in accordance with instructions at the previous meeting, reported that he had taken measures to have an authoritative report of the Proceedings published in *The Western*. Mr. L. B. V. Dixon, with the assistance of the Secretary, will prepare such a report and the matter will be at once set in type, so that galley proofs may be had on application to the former gentleman.

Dr. Briggs, from the Committee on Library, made a statement of what had been done during the year, and read the following letter from the Librarian:

Public School Library, St. Louis, Jan. 3, 1876.

Dr. C. E. Briggs, Ch. Com. on Library of the Academy of Science.

Dear Sir:—On conferring with Geo. Brooke, I find that more work has been done than I thought. All the unbound books and pamphlets have been compared with the Catalogue and located in permanent places on the shelves of the book-cases. It only remains to compare the bound volumes with the Catalogue: numbering and labeling them at the same time; and to re-write such of the cards as have needed correcting during the process of comparing. I am satisfied that the employment of Geo. Brooke for one month more, at the same rate of payment as last month, will finish up everything, so that for the future I can keep the Catalogue always up to date, without further expense to the Academy. I should add that the Transactions of the Academy have been tied up in bundles of 20 each, carefully covered with strong wrapping-paper, each package numbered, and the whole placed where they are safe and easily accessible.

With great respect, your obed't servant,

J. J. BAILEY, *Librarian.*

The Corresponding Secretary submitted his annual report, as follows:

To the President of the Academy of Science.

I have to report that the operations of the Corresponding Secretary have continued in the usual manner, and with good success, for the last year. One number of our Transactions has been issued and distributed abroad, and another number is nearly through the press. We have received from Foreign Societies numerous publications of great value, in exchange, which have been duly placed in the library. Six new Foreign Societies have been added to our list of exchanges within the year. Four Corresponding Members have been elected during the year. Of the new exchanges, one is in Mexico, one in England, one in Italy, and three in the East Indies.

The Smithsonian Institution has, as heretofore, been the medium of transmission of our foreign exchanges, without other expense to us than the cost of transportation between Washington and St. Louis.

The receipts of the Corresponding Secretary for the year have been $57,68, and his expenditures $53.26, leaving a balance on hand of $4.42, of which a particulur account is herewith submitted.

Of the amount, $12 were received from the sale of Transactions and $30 from the Treasurer. The expenditures were chiefly for freight and postage.

All of which is respectfully submitted.

NATHANIEL HOLMES, *Corr. Sec.*

The Treasurer submitted his annual Report, which showed that there was a balance at the commencement of last year of $456.16; there was collected on dues $467 — making a total of $923.16. The sum of $530 has been expended, of which nearly $400 was for the publication of the Transactions. He thought it was a favorable condition of the treasury, that the publication could be thus made without calling for subscriptions on the part of individual members. There is a balance of more than $400 on hand and about the same amount standing out. The amount of cash in bank was $392.96.

There are 109 Active and Associate Members. During the last year the Academy has elected six Associate Members. Three members have left the city, three have handed in their resignations, and three have not paid their dues and may be dropped from the roll.

The annual election of officers took place, with the following result:

President—Charles V. Riley.
1st Vice President—Albert Todd.
2nd Vice President—Silas Bent.
Corresponding Secretary—Nathaniel Holmes.
Recording Secretary—F. E. Nipher.
Treasurer—Enno Sander.
Librarian—J. J. Bailey.
Board of Curators—G. J. Engelmann, J. R. Gage, and G. B. McLellan.

The President elect was then introduced by Vice President Todd, and, on taking the chair, thanked the members for the honor conferred on him. He hoped that, as we enter on a new era in this, the Centennial year of the nation, the Academy might also enter on a new era of prosperity and usefulness. He would do all he could to further its interests, and he asked the assistance of the members in so doing, and craved their indulgence for his short-comings.

NEW USE FOR THE AMERICAN AGAVE.

Mr. Riley referred to the interesting paper on the Agaves which had just been published in our Transactions by Dr. Engelmann. In it Dr. E. gives an account of the economic importance of these plants in their native countries for food and drink, for fibre, and, he might have added, building material. Mr. Riley called attention to another use less generally known, to which the stalk is being put. No valuable or permanent entomological collection can be formed except in close-fitting boxes lined with some material in which the finest pins may be securely stuck. Boiler-felt, bog-peat, the pith of various plants, as elder, broom and Indian corn, etc., have been used for this purpose; but nothing hitherto had surpassed sheet-cork. He exhibited slices of the stalk of *Agave Americana*, $12 \times 4 \times \frac{1}{2}$ inches, which answer this purpose admirably, the wood being remarkably light and porous, and pins being pushed into it with great ease, and yet being held firmly. It is much cheaper than cork. The celebrated traveler Mr. A. R. Wallace preserved all his valuable entomological collectings in the East Indies, in boxes made of pieces of this substance pinned together with thorns, and it is now coming into very general use.

THE METEOROLOGY OF 1875.

The following paper by Dr. George Engelmann, absent, was read by his son, Dr. G. J. Engelmann:

It is always interesting to review the meteorological history of a year just past, but it is doubly so when the year has been of such an uncommon character as the last was.

The general characteristic of the year 1875 was the continued low temperature, and a greater degree of rainfall in the summer, than we have had for a number of years. Not that the temperature of summer was so low as to interfere with a proper development of the agricultural products of our region, or the humidity to any excessive extent injurious to them; but, compared with other seasons, the temperature was low, and the rainfall at a certain (to the agricultural interests, important) season, considerable, if not excessive.

Not only was the mean temperature of the year the lowest one of the forty years during which I have made such observations here in St. Louis, but the temperature of every single month in the year was lower than the average for the month.

Not that every single month of the past year was colder than the same month ever was before; that was the case only in August. No month of August in forty years was as cool as that of the past year. February was colder only once, in 1838; January twice, and, singularly enough, in two successive years, 1856 and 1857; April three times; March and September five times, and so forth.

The only exception—and a remarkable one it is—was made by the last month of the year. The temperature of December was not only higher than the average of this month, but it was absolutely the highest observed by me in that long series of years.

The following table will more distinctly exhibit these facts:

Months.	Mean Temperature. 1875	Mean Temperature. Average of 40 Years.	Difference.	Lowest Mean Temperature.	Lower Mean Temperatures were observed in the following Years—the lowest being designated by an asterisk.
January	21·3	31·6	—10·3	19·3	1856, 1857*.
Feb. ...	24·2	35·0	—10·8	20·8	1838*.
March..	38·3	43·7	— 5·4	33·4	1843, 1856, 1867*, 1869, 1872.
April...	51·0	56·1	— 5·1	44·4	1837, 1857*, 1868*.
May ...	64·4	66·2	— 1·8	60·5	1837, '38*, '47, '50, '53, '57, '58, '61, '66, '67*.
June ...	72·7	74·8	— 2·1	70·3	1837, '39*, '46*, '47, '48, '52, '55*, '57, '63*, '69.
July	78·0	79·2	— 1·2	73·7	1839, '40, '42, '48*, '49*, '53, '61, '63, '65, '73.
August.	72·7	76·7	— 4·0	72·7	
Sept. ...	66·0	69·1	— 3·1	63·2	1839, '40, '48, '66*, '68*.
Oct.....	53·9	55·7	— 1·8	47·1	1836*, '38, '43, '44, '49, '63*, '64, '69*, '73.
Nov. ...	40·0	43·0	— 3·0	34·7	1838*, '39, '42, '48, '52, '57, '58, '69, '71, '72*.
Dec. ...	41·9	33·5	+ 8·4	23·3	1872* (highest temperature before, 41·4, in 1862).
Wh. year	52·0	55·4	— 3·4	52·0	
Winter .	26·9	33·4	— 6·5	26·3	1856, 1873*.
Spring .	51·2	55·3	— 4·1	48·6	1843, 1857*, 1867.
Summer	74·5	76·9	— 2·4	73·7	1839*, 1842, 1848, 1852, 1863.
Autumn	53·3	55·9	— 2·6	51·3	1836*, '38, '48, '63, '69*, '73.

This table shows that the mean temperature of January and February was more than 10 degrees, and of March and April over 5 degrees below the average, of August 4, of September and November over 3, and of the months of May, June, July and October between 1 and 2 degrees below. Winter was colder by 6½ degrees; spring came next, with 4 degrees, and summer and autumn were not more than 2½ degrees below the average.

The quantity of rain during the past year was about the average of 37 years, a little over 41 inches; but it was even more unequally distributed than usual. In January, in April, and from August to the end of the year, we had much less than the average quantity of rain; in February, March, and May, we got our regular share; while in June and July the quantity was enormous: in these two months 20 inches, or very nearly one-half the quantity of the whole year, almost as much as in the other ten months of the year together!

The effect on agriculture was such as was to be expected; those crops —especially wheat and hay—which, maturing just at that time, required drier weather, suffered more or less, especially on low and level lands; while the later crops, and, above all, corn, received a start which brought abundance into every farmer's household.

The effect of this extraordinary season on the general health was that always experienced from the same causes. The complaints brought on by excessive summer heat were not as prevalent nor as severe as in other years; but malarious diseases, produced by excessive humidity, followed by dry weather, were the great scourge of this whole region during the latter part of summer and in the fall. The absence, however, of the second morbific element, the heat, prevented them from becoming so pernicious as we have sometimes seen them here.

Messrs. G. N. Hitchcock and J. C. Parker, both of San Diego, Cal., were elected Corresponding Members.

January 17, 1876.

C. V. Riley, President, in the chair.

Mr. Riley, as chairman of the Publication Committee, reported the publication of another signature of the Transactions, and that the Proceedings were in type up to the last meeting.

The Corresponding Secretary read some correspondence, and called attention to a paper of Prof. Rütimeyer, of Basle (a notice of which appears in *Nature*, December 16, 1875), on the discovery, at Wetzikon, of traces of man in the inter-glacial coal-beds of Switzerland. Rütimeyer has given a description of the remains, with drawings, which seem to show clearly the existence of man in one of the warm intervals of the glacial epoch. The remains consisted of four pointed rods of wood, bearing evident marks of cutting, while at one part of the rods are marks as if of a string wound round and round them.

Dr. Richardson exhibited a skull and some specimens of pottery obtained from a mound "near the stock-yards" at East St. Louis. The mound was about ten feet high, and forty feet in diameter at its base. At a depth of six or seven feet, eighteen skulls were found. The bodies had been laid in a circle, with the heads outwards. Many of the skulls were fractured on the temporal bone. He had also found eighteen graves in the bluffs on the Belleville or "rock" road. These bones were found under slabs of stone, with some article of pottery near the head.

Mr. Geo. W. Allen exhibited some pottery and skulls found in mounds in Southeast Missouri. The mounds were near a swamp, and enclosed in an earth-work about a quarter of a mile square. Three mounds were opened. In only one were human remains found. Here were found the skulls, arms and legs of many skeletons. No vertebræ nor ribs were found. The bodies had been placed in a circle with the heads inward. The skulls were nearly all flattened on the left side, and pressed out on the right side, but lay with the face upward. Many articles of pottery were found with the skulls. Mr. Allen also stated that many of these adult skulls possess rudimentary teeth. Within the enclosure were also found many pits, laid out in regular order, apparently the sites of human habitations. Fragments of clay burnt like brick, which perhaps were remains of hearths which had served these rude habitations, were also found.

Mr. A. J. Conant exhibited some skulls and implements of bone and stone, found by him in caves, in Pulaski Co., Mo., on the Gasconade river.

These three gentlemen were invited to prepare papers upon the subjects presented by them.

Mr. Gage then offered the following resolution:

Be it Resolved, by the Academy of Science, that the Committee appointed at a previous meeting for the Investigation of Indian Mounds, be hereby authorized to make arrangements for examining mounds situated in New Madrid county, and are empowered to draw on the treasury for the balance of the appropriation, amounting to $35.00 now remaining in the treasury, which was made at said meeting for such investigations: *And be it further resolved*, that an additional sum of $25.00 be made for such investigations.

The President appointed the chairmen of the respective committees, and these nominated their assistants with the following results:

Committee on Cabinet—A. J. Conant, Edwin Harrison, Geo. W. Allen.

Committee on Library—Geo. J. Engelmann, L. F. Soldan, Dr. S. Pollak.

Committee on Publication—Geo. Engelmann, N. Holmes, F. E. Nipher, and Pres't Riley.

Prof. Gage, from the Board of Curators, represented the cabinet to be in a very unsatisfactory condition.

February 7, 1876.

C. V. Riley, President, in the chair.

Six members present.

The Corresponding Secretary made his usual report, calling attention to the last monograph of the late Jeffries Wyman "On the Shell Mounds of the St. John's River in Florida."

A communication in regard to a proposed mound excavation in East St. Louis, was referred to the committee on mound exploration.

The Academy voted to endorse the action of the Boston Civil Engineers' Club, asking Congress to set a day when the metric system shall go into effect.

Dr. Geo. Engelmann read a paper "On the Meteorology of the Month of January," as follows:

The unusual meteorological conditions of December last, of which I gave an account a month ago, have continued through January. The last month of last year was the warmest December we have had in forty years. The past January was one of the five warmest Januaries in the same period. The mean temperature was 39.4°, while the usual mean for that month is 31.5°. January, 1848, had the same temperature, and was followed by a February and a March warmer than usual. January, 1842, was warmer, and the following four months were warmer than the average. January, 1845, and 1858, had a mean temperature of 40.5°. In 1845 the three succeeding months had a temperature above the average, but the mild January of 1858 was preceded by an equally warm December, and followed by a bitter cold February with a mean temperature of 27.2°—over 13° lower. Thus, in the four years mentioned, three times a warm January was followed by a warm February and March, and once the reverse was true.

But what of the unusual quantity of rain which fell last month? It is commonly thought that mild winters, in which of course southerly winds prevail, are also wet winters; but what are the facts? Three of the above mentioned mild Januaries ('42, '45 and '48) had, the first less than 1 inch, the others less than 2 inches of rain, all three less than the average 2.13 inches, and only the January of that year ('58) which was followed by a very cold February, and the January just past, have had more than the average amount of rain, the former 3.42 and the latter 4.44 inches: and

January is on the average the driest month of the year. I have observed only one January (that of '55) when the quantity of rain was larger than this year, viz., 4.66 inches; in four other years ('49, '62, '63 and '66) it rose to over 4 inches; those of '49 and '62 were much colder than the average: those of '55 and '66 were slightly and that of '63 considerably above the mean temperature. In '63 a February and March of nearly average temperature followed. In the other four cases, February was from three to five degrees below the average, and in some of those March also.

The Corresponding Secretary remarked that he had received from the Hon. T. J. C. Fagg, of Louisiana, Pike Co., Mo., for exhibition to the Academy, a remarkable fragment of limestone from the rocks near that place, enclosing what appears to be a fossil of some kind. The fossil has the appearance of a piece of bone or wood 9 inches long, from 1$\frac{1}{4}$ to 1$\frac{1}{2}$ inches wide, $\frac{1}{2}$ to $\frac{1}{4}$ of an inch thick in the middle part, gradually thinning to rounded edges, is slightly convex on one side and concave on the other, and tapers gradually towards the smaller end. Both surfaces show a longitudinally striated structure. One end is hollow to the depth of half an inch. The fossil exactly fits the cast of it in the block of limestone. According to Prof. Swallow, the rocks belong to the Oolitic Onondagua limestone (overlaid by three feet of impure arenaceous limestone) of the Devonian period.

The fossil was referred to Dr. Engelmann for examination under the microscope.

Mr. Holmes further remarked that Mr. Senoner, of Vienna, in a recent letter to him, observed that many did not believe that fly-catching plants derive any material nourishment from the bodies of the dead insects, and that Mr. Riley seemed to be of the same opinion. He refers also to some late researches of Mr. Batolin, of St. Petersburgh, published in the *Gartenflora* of September, 1875, as contradicting that idea.

Mr. Riley disclaimed the idea here imputed to him, remarking that Mr. Darwin, in his work on "Insectivorous Plants," demonstrates that *Drosera* and *Dionæa*, and some other plants, do actually digest the nitrogenous matters, absorb and appropriate them. It was not yet demonstrated that the *Sarracenias* possess the requisite glands for directly appropriating animal food, and Mr. Riley had simply remarked of *S. variolaris*, that, apparently, the only benefit it receives from the captured insects is from the liquid manure resulting from their putrescent bodies, and passing perhaps to the root, as Mr. W. H. Ravenel surmises, through the tubular cells in the leaf-stalk.

F. E. Nipher called attention to the discovery of Dr. Kerr, of London, who has rendered plate-glass birefrangent by submitting it to electrical tension. Mr. Nipher remarked that he himself had made many attempts, during the past year, to produce this effect, but had never succeeded. He is engaged in a research on the effect of magnets and electric currents on tesseral or monometric crystals while in the act of crystalizing from a solution, by which they appear to receive permanently the property of double refraction. He will in due time present a paper on the subject.

Dr. H. Kinnear was elected an Associate Member.

February 21, 1876.

Hon. ALBERT TODD, Vice-President, in the chair.

Eight members present.

The Corresponding Secretary made his usual report.

A letter from Wm. H. Wahl, of the *Polytechnic Review* of Philadelphia, requesting reports of our proceedings for publication in his journal, was referred to the Recording Secretary.

Dr. Geo. Engelmann exhibited several photographs of California plants, taken by J. C. Parker of San Diego. One of them represented *Agave Shawii*, recently described by him in our Transactions, in full bloom in January.

He also stated that the fossil from Louisiana in this State, submitted to his examination four weeks ago, was coniferous wood, imbedded in chert.

The Library Committee was instructed to confer with the Library Committee of the Public School Board, with a view to secure coöperation in the binding of books.

Geo. C. Pratt, George Dennison and Edmund F. Allen were elected Associate Members, and Dr. G. W. Barnes of San Diego, Cal., and Prof. Gustavus Hinrichs of Iowa City, Iowa, were elected Corresponding Members.

March 6, 1876.

CHAS. V. RILEY, President, in the chair.

Ten members present.

The Corresponding Secretary laid upon the table several volumes of the Royal Irish Academy.

G. C. Broadhead read a paper on the meteor of December 9, 1875, which was seen at 9 o'clock P. M. over Southern Iowa and Northern Missouri. The duration of visibility was variously estimated at from three to sixty seconds. The majority of observers fix the time between three and ten seconds. At Kansas City, St. Joseph, Savannah, Oregon, Mound City, Graham, and Maryville, an explosion was also heard, which was violent enough in many places to rattle windows.

Mr. Broadhead also remarked that P. Sterry Hunt has decided that the porphyritic rocks of S.E. Missouri are Huronian. This opinion is based upon an examination of the mineralogical and lithological characters of the rock.

Dr. Geo. Engelmann made the following report upon the temperature of the past winter:

After reporting at the time about the unusually warm weather during every month of this winter, I can now, at the end of three months, December, January and February, which constitute meteorologically the winter season, state that the past winter was, together with that of 1844-45 (thirty-one years ago), the warmest in forty years, namely, a little over 40 degrees in mean temperature.

The coldest winters were those of 1855-56 and 1872-73, both about 14 degrees colder than the last, while the average winter temperature in St. Louis is nearly 33½ degrees.

Judge Holmes made the following remarks on

AMERICAN ANTIQUITIES.

For a long time he had been impressed with the general similarity of the stone sculptures and pyramidal buildings of Palenque, Copan and Uxmal, in Central America, with like remains in the island of Java and other parts of Southeastern Asia—a general resemblance in respect of the stage of art and grade of civilization, rather than in the particular details or style. A like general resemblance with the earlier Egyptian monuments is also apparent, but much less striking in respect of the stage of progress, while in point of style and form in detail the difference is so great that no inference of a common derivation could be thought of.

More recently, the reading of Mr. Herbert Bancroft's volume on American Antiquities (vol. iv.) had at once recalled to mind what he had read many years ago upon the subject, strongly suggestive of this resemblance, and especially Sir Stamford Raffles' "History of Java," with illustrations of the Javan monuments.

Dr. Samuel Ferguson, in the Proceedings of the Royal Irish Academy (No. 7, p. 137, 1872), has made a like observation, referring to Gailhabout's work on Ancient Architecture, and giving a wood-cut of a Javan pyramidal temple from Sir Stamford Raffles' History. Dr. Ferguson gives also from the same work some fanciful drawings of the human head and face resembling somewhat the type of face exhibited in the Central American sculptures; and he thinks that these circumstances are "worthy of grave consideration in any system of ethnology dealing with Central American origins." He observes, also, that the trunk of the elephant is an ornamental feature in Hindu architecture, and that the head and trunk of the elephant ("distorted and conventionalized" according to the American taste) may be traced in these sculptures of Central America.

This may very well be doubted. Mr. Bancroft mentions that some writers had expressed that opinion; but the particular examples of it that are given in his work do not seem at all to justify such an inference. The resemblance, in these instances, is certainly so remote, and merely fanciful, that it would require a very vivid imagination to discover in them any proof that the artists had ever seen or heard of an elephant.

Nevertheless, the general resemblance in the character and grade of these monuments may point to a remote connection with Southeastern Asia, not perhaps by way of direct importation of the same style of architecture from Java or Hindustan (however possible that might be in any period), but rather by way of race origin reaching back into that period of geological time when a much greater extent of continent and island existed in the Indian and Southern oceans than has been the case within the remotest historical period, and when populations kindred in origin to those of Asia may have reached America, and, in course of time, attained to a corresponding stage of progress in art, ideas, and civilization.

Mr. Herbert Bancroft's discussion of the evidences tends to the conclusion that all the Central American monuments may be brought within the second century of the Christian era, while admitting that there are no certain data by which the age can be fixed, and that they may very possibly belong to a much higher antiquity. He infers that some of the ancient cities were still inhabited when the Spaniards first arrived, but his facts hardly warrant such a conclusion. He admits, however, that Palenque had been previously abandoned. It is not easy to believe that the stage of art and progress indicated by these older remains of Central America existed, and was flourishing, contemporaneously with that found existing in Mexico and Peru at the date of the Spanish conquest. There is no certain proof of the fact. And while the ascertained facts would seem to show a much more ancient date for these ruined, forest-covered cities, still their age may very well be quite modern in comparison with the vast period of time during which this continent has certainly been the seat of human habitation.

Mr. Nipher remarked that Mr. Stephens found the wooden lintels of doors at Uxmal, which seems to be conclusive evidence against a very great antiquity.

Mr. Conant exhibited the upper part of a skull from the New Madrid mound, which was remarkable as having an exceeding low retreating forehead. The skull gave no evidence of abnormal distortion. It was found buried with the usual pieces of pottery which accompany the bones of the mound builder.

Dr. G. J. Engelmann presented a bill of $52.75 for expense incurred in arranging and cataloguing the library, which was allowed. He also read a letter from Mr. Bailey, stating that the catalogue of the books in the library was now complete, and that it would hereafter be kept up to date.

Dr. Engelmann also reported that the Public School Board could take no action at present in regard to the binding of books.

Dr. John J. R. Patrick, of Belleville, Ills., was elected a Corresponding Member.

March 20, 1876.

Chas. V. Riley, President, in the chair.

Twelve members present.

Prof. Potter reported that Dr. G. J. Engelmann and himself had visited the New Madrid mound region during the past week. They opened four mounds, secured ten or twelve skulls and about one hundred specimens of pottery. They also made a survey of the locality, and will soon submit a more extended report.

The Corresponding Secretary read several letters, one of which made known the death of M. Chas. Desmoulins, of Bordeaux, a Corresponding Member of the Academy. He also presented a communication from Mr. Amos Sawyer, of Hillsboro, Ills., on American Antiquities, which was referred to a committee consisting of Messrs. Conant, Potter, and Geo. J. Engelmann.

G. C. Broadhead read a paper "On the Porphyritic Rocks of Southeast Missouri," elucidating the evidence that these rocks are Huronian. This paper was referred to the Publication Committee.

A. J. Conant read a paper "On the Mounds of New Madrid." The burial mound examined by him was found within an enclosure of about fifty acres, which is surrounded by earthen walls. Probably a thousand (very much decayed) skeletons have been already found. Three pieces of pottery occur usually with each skeleton. Some vessels were more than a foot in diameter, with walls so thin that they could not have been safely moved when filled with water. It was observed that some skeletons were in a much better state of preservation than others. In some cases the outline of the skull was only shown by a thin white line in the sand. In other cases the usual pieces of pottery were found, but all traces of the skeleton had disappeared. Mr. Conant thought this an evidence that the mounds had long been a place of burial.

Dr. Geo. Engelmann remarked that the preservation of bones depends upon humidity and the character of the soil. Many bones, vastly older than any of the bones of these mound builders, are found in a state of good preservation, where the external conditions are favorable, especially when immersed in saline mud.

Mr. Conant's paper was referred to the Publication Committee.

Dr. G. Engelmann made a communication "On North American Oaks." The genus *Quercus* is more extensively developed in America than in any other part of the world. In the Carolinas and in the southwest oaks grow as small shrubs. The leaves of different oaks show great variations, some resembling the leaves of the willow, others that of the holly, etc.; and even the leaves of the same species vary excessively, as he had shown, e.g., in the polymorphous Rocky Mountain oak, *Quercus undulata;* but the fruit is very much the same in all. The typical and probably the primitive oaks of the Tertiary had probably lobed leaves. An oak found in California (*Quercus densiflora*) has a flower and leaves like a chestnut, but bears acorns like an oak: the cup of the acorn, however, is spiny like the burr of the chestnut. Dr. Engelmann remarked that this oak may be a hybrid produced between the chestnut and oak in bygone times when these genera were less differentiated, and it is well-known that even now hybrid oaks are not sterile, like most hybrids, but will propagate when removed from the "struggle for existence" against more hardy rivals.

Mr. Riley said that the interesting facts cited seemed to point to a common origin in the past for the oak and chestnut.

Dr. Engelmann remarked that the oak and chestnut of the Tertiary appear to be as distinct as they are to-day.

April 3, 1876.

CHAS. V. RILEY, President, in the chair.

Thirteen members present.

Prof. Potter, chairman of the Committee on Mound Exploration, made a partial report, as follows:

The committee have examined and made a survey of five groups of mounds. Two hundred specimens of pottery have been obtained, of which one hundred and twenty-six are quite perfect, the remaining specimens being in a fair condition, and may be wholly or in part restored. The collection also embraces the skulls of twenty individuals, of which number one is complete, seven nearly so, the remaining twelve being in fragments of sufficient size to be of value. They have also obtained the leg and arm bones, and in some cases the vertebræ and other small bones, representing twelve individuals.

The committee have expended for labor, transportation, etc., the sum of $88, an amount which exceeds the appropriation granted by the Academy by the sum of $28.05.

On motion of Judge Holmes, the thanks of the Academy were tendered the committee, and an appropriation of $28.05 was voted to cover the deficiency.

On motion of Dr. Briggs, a further appropriation of $50 was placed at the disposal of the committee for the purpose of continuing the examination of mounds.

The Corresponding Secretary made his usual report.

A letter from Dr. John J. R. Patrick, of Belleville, Ills., was read, acknowledging his election as Corresponding Member.

Several numbers of Transactions of the Royal Irish Academy were placed before the Academy, with vol. i. of the Geological Record, by Wm. Whitaker, being a catalogue of geological publications for the year 1874.

Dr. A. Galney presented the Academy with a portion of the skeleton of a monkey, an arm and leg being lacking.

Mr. Theo. P. Gillespie, a gentleman recently arrived from Peru, was introduced to the members by Dr. Briggs, and exhibited a collection of pottery taken from the burial grounds of an ancient tribe of Peruvians. The graves from which the specimens were taken were in drift sand near the sea beach. The graves are supposed to belong to a tribe that was conquered by the Incas fifty or sixty years before the advent of Pizarro in Peru. Many bones were found, being preserved by the perfect dryness of the sand in which they were buried. The greater portion of these relics were found along the line of the Chimbote and Huaraz railroad, latitude 7° S., and, with few exceptions, they represent what are supposed to have been drinking vessels. In several of the specimens the handle, which is hollow, arches over the top of the vessel, the two branches of the tube uniting in a single vertical tube of several inches in length. The ornamentation, both in form and color, was in many cases very striking and expressive. A small mould of strongly baked clay—the negative of a human face—containing within it the figure which it was designed to reproduce, was also shown. The collection contains twenty-seven specimens. Three specimens of copper were also exhibited, viz., a finger-ring, a long needle with an eye, and a chisel with a smooth edge and battered head.

The thanks of the Academy were tendered Mr. Gillespie for his kindness in the exhibition of this interesting collection.

Dr. Geo. Engelmann made the following report on the Meteorology of March, 1876:

The past March was not only an unusually cool month, but it made itself so much the more disagreeably and injuriously felt, inasmuch as it succeeded to a very mild winter and an unusually early and favorable spring development.

The mean temperature of the past winter was 40.2°, and that of every winter month at least over 39°; February, the coolest, 39.3°; and here comes March with 38.3°, destroying the brightest prospects for full and early fruit crops. In the last 41 years the mean temperature of March was over 5 degs. higher than this year; six times it was lower than in the past month, but it never in that period of time was lower than that of each of the preceding winter months. As I have stated on a former occasion, the only winter equal to the past in mildness was that of 1844–45, but the succeeding March was warmer (though not much) than any of the winter months, 6 degs. warmer than our past March, and of course the early development of vegetation did not suffer destruction as it did in the last few weeks.

The quantity of rain (including snow, which by the way was unusually heavy) was also more than 3 inches above the average, viz., about $6\frac{3}{4}$ inches. If we examine the records, we find that in 7 out of the previous 40 years the quantity equalled or exceeded that of last March; and eleven years ago (1865) it reached the enormous amount of 8.61 inches. All the seasons which followed such a wet March, exhibited a large, and some of them an excessive, quantity of rain.

April 17, 1876.

CHAS. V. RILEY, President, in the chair.

Twelve members present.

Several communications were read by the Corresponding Secretary.

At the request of the President of Roanoke College, Salem, Va., a full set of the Transactions, except No. 1 of Vol. I., were sent to that institution.

G. J. Engelmann exhibited a fragment of the jaw of a mound-builder, from the collection of Dr. Richardson, showing what was thought to be a third set of teeth. Dr. Forbes was of the opinion that these teeth were those of the second set, in an abnormal position.

Mr. Todd made some remarks on the cave habitations of the Colorado canyon. He thought the caves at the top of the canyon sides might have been made when the river was cutting through the rocks immediately below the caves.

Judge Holmes took grounds against this idea, pointing out that none of the caves are now inaccessible, and that it was therefore unwarranted to assume such an antiquity for these cave-dwellers in order to account for the existence of the caves.

This view was shared by other members.

May 1, 1876.

CHAS. V. RILEY, President, in the chair.

——— members present.

Judge Holmes read letters from scientific societies in Rio Janeiro, and Haarlem, Holland, requesting copies of the Transactions of the Academy. These societies were accordingly placed upon the exchange list.

Mr. Wm. Lucas donated to the Academy the works of Sir W. Jones, 10 vols. 4to, and Say's American Entomology, 3 vols., original edition.

Mr. Nipher made the following communication "On the Distribution of Errors in Numbers Written from Memory":

In writing logarithms which were read off to me, it was observed that it appeared to be much more difficult to remember the figures in the middle of the number than those at the extremes. In order to test this point, numbers containing six digits were read to a person unaccustomed to work with numerical tables. Each figure was separately named, the interval between the names being the same, and all being spoken in a monotone. After each number had been wholly given, the experimenter immediately wrote them in proper order. The results here given are obtained from 100 numbers. The whole number of errors was 125, occurring in 59 numbers. For each 100 errors, the distribution throughout the number is shown in the column *e* in the table below.

Chances.		Per 100 Draws.				
r.	*w*.	*Theory*.	*Exp*.	*e*.	*d*.	*d'*.
5	0	1.0	0	0.8	1.0	0.2
4	1	7.7	9	8.8	1.3	1.1
3	2	23.0	21	26.4	2.0	3.4
2	3	34.6	39	33.6	4.4	1.0
1	4	25.9	27	27.2	1.1	1.3
0	5	7.8	5	3.2	2.8	4.6

Thus, out of 100 errors, 0.8 were in the digit first written, 8.8 in the second, etc. The probability of error is greatest in the fourth digit.

The probability in this case is the same as in the drawing of five balls from an urn, containing a very large number of white and red balls in the ratio of 3 to 2. In drawing five balls, six chances may occur, as shown in the table above.

According to the theory of probability, for each 100 draws, we should draw all red, 1.0 time; one white and four red, 7.7 times, etc., as shown in the third column. An actual experiment of 100 draws, gave the values shown in column four. The differences between the theoretical and observed values, is given in the column *d*. It will now be seen that column *e* also agrees even more satisfactorily with the theoretical values, the differences being given in the last column.

By allowing a definite interval of time to elapse between the giving and writing of the number, Mr. Nipher proposes to obtain numerical estimates of the power of memory.

Mr. Riley treated of the oviposition of *Leucania unipuncta*, or the Army-worm moth.

In his 8th Annual Report, the last forms of which were going through the press, he had remarked that "at first view it seems singular that the eggs of an insect that appears in such countless myriads from Maine to Georgia, and from Virginia to Kansas, should have remained undiscovered either by farmers or entomologists. One of the obstacles that have stood in the way is, that, as soon as the worms have increased so prodigiously as to attract attention, their natural enemies become so multiplied that a very small per cent. of the worms entering the ground issue again as moths. A second reason is that during the season when the insect is not numerous, and attracts no attention, no one thinks of searching for the eggs. A third reason is that the moths that are reared indoors do not oviposit in confinement. I venture to suggest a fourth possible reason that has hitherto occurred to nobody: it is that the eggs are for the most part secreted where they are not easily seen."

Structure is a trustworthy guide to habit, and Mr. Riley had been led to this last conclusion by study of the structure of the ovipositor of the moth in question. The time, place and manner of oviposition in this species is quite important from the economic point of view, as the insect may readily be destroyed in the egg state by fire, if the conclusions drawn are correct.

Mr. Riley had recently been able to verify the correctness of his conclusions by direct observation, having witnessed the mode of oviposition on blue grass. The eggs are, as he surmised, secreted, being either glued in rows of from 5 to 20 in the groove which is formed by the folding of the terminal grass-blade, or in between the sheath and the stalk. In exceptional cases they may be pushed into crevices in the ground. The eggs are white, slightly iridiscent, spherical, and only $\frac{2}{100}$ of an inch in diameter. They are fastened to each other and to the leaf, and covered along the exposed portion, by a white, glistening, viscid substance. As they mature the color becomes more sordid or yellowish, and by the seventh day after deposition the brown head of the embryon shows distinctly through the shell. The larva hatches from the eighth to th etenth day, measures 1.7 mm. in length, is dull, translucent white in color, with a large brown-black head, and is a looper, the two front pair of abdominal prolegs being atrophied. On account of its extremely small size and of the color resembling the pale bases of the grass-stalks near the ground, it is almost impossible to find them even where there are dozens to the square foot.

PARASITES ON BEES.

Mr. Riley also read a communication from G. W. Barnes of San Diego, California, in relation to parasites found upon bees in that State.

The parasite was described as the color of a flaxseed, and easily distinguishable by the naked eye. It appears usually under the wing of the bee, and adheres with considerable tenacity. It occasionally crawls all over the bee and is quite agile in its movements. The bees affected with the vermin become agitated and move rapidly over the comb, frequently dying of injuries. The parasites were first noticed there last year, and have again appeared this season, giving considerable trouble in large apiaries. Specimens of the insects afflicted accompanied the letter, and Mr. Riley pronounced them to be the first larvæ of the Oil-beetle (*Meloë*), and probably of our common species ***M. angusticollis***. It was well known that these larvæ attached themselves to bees and were thus carried into the hive, where they usually left the grown bee and attacked the bee-larvæ and bee-bread. They there soon change their form entirely, undergoing what is termed hypermetamorphosis. He had not before heard that these insects injured the fully developed bees. The information was valuable if reliable.

John W. Turner was elected an Associate Member, and the names of J. A. Dacus, Geo. W. Letterman and Dr. G. Hambach were proposed.

May 15, 1876.

CHAS. V. RILEY, President, in the chair.

Twelve members present.

Dr. Engelmann exhibited a specimen of sponge from Maine, donated to the Academy by Dr. Richardson.

He also presented the Academy with a specimen of lignite coal of anthracitic character from Peru, the gift of Mr. Theodore P. Gillespie.

Mr. Riley read extracts from an article by L. J. Dupré "On the Work of the Mound-builders in the Irrigation of the Lower Mississippi." The author took the ground that the lower valley had once been under an extensive system of irrigation.

Judge Holmes thought this might well be doubted, as in so well watered a country such a system of irrigation seems unnecessary. Dr. Engelmann further pointed out that high-water occurs at a time when it would be an injury rather than a benefit to the growing crops.

Judge Holmes remarked as follows upon

MAN AND THE ELEPHANT IN NEBRASKA.

In Dr. Hayden's Annual Report of the U. S. Geological Survey for the year 1874 (recently published) appears the report of Dr. Samuel Aughey on the Loess deposits of Nebraska. It is stated that the Loess covers three-fourths of that State, ranging in thickness from 40 to 150 feet, and extending westward from the Missouri River to a limit beyond Kearney and the Republican Fork.

The more important fact which he desired to notice was, that Dr. Aughey, after some years of careful searching, had succeeded in finding imbedded in this deposit two distinctly shaped and well-worked arrow-heads, which are figured in his report (p. 255). One of them, a small arrow-head, was found at a depth of 15 feet at a place three miles east of Sioux City; the other, nearly four times larger, might very well have been a spear-head, and it was found at a place two and a half miles southeast of Omaha, and at a depth of 20 feet; and "thirteen inches above the point where it was found, and within three inches of being on a line with it, in undisturbed Loess, there was a lumbar vertebra of an elephant (*Elephas americanus*)." The material is not named, nor are measurements given. Flint chips are mentioned as found "in the bluffs" in Dakota County, but as not certainly of human origin.

The discovery is important as going to show the contemporaneity of man and the elephant on this continent during the period of the Loess. They must have inhabited together the shores of the great inland fresh-water sea or expansion of the rivers, in which the Loess formation was deposited. It furnished the first distinct and incontrovertible proof of this fact that he was aware of. Bones of mastodon, elephant, and other extinct animals had been frequently found in the Loess of the Mississippi Valley, but hitherto no human remains had been ascertained with certainty to belong to it. Mr. Worthen of the Illinois Geological Survey had reported an instance of arrow-heads being found together with bones of extinct mammalia in an altered drift covered by Loess near Alton; but the circumstances, geologically considered, seemed to admit of some doubt on the question of their contemporaneousness. But here no room would seem to be left for any other rational hypothesis. Both the arrow-head and the vertebra must have been deposited in the still waters of the lake, or been drifted to the spot by the same moving waters of the Loess period. The arrow-head, certainly, could not have got there if it had belonged to a more recent period. But it is still possible that the vertebra may have been washed out of some older deposit, by the action of a river, and been swept down into the lake; or it may have been frozen into a mass of ice, and been carried down by the river and dropped to the bottom on the melting of the ice. The presence of mastodon bones with the arrow-head, in the Benton County case, has been accounted for in this way. The presence of the arrow-head proved the existence of man in the alluvial period only; but, in this instance, the arrow-head must have been contemporary with the older Loess deposit; and the bones of mastodon, elephant, and other extinct species of mammalia, are so abundant in this deposit, not only in Nebraska, but in other parts of the Mississippi Valley, that no doubt can remain that these animals were also contemporary with the Loess.

In the instances reported by the late Dr. Koch (Trans. St. Louis Acad. of Sci. vol. 1. pp. 61 & 117) of arrow-heads found together with the bones of mastodon, one in the alluvial bottom of the Pommes de Terre River in Benton Co., Mo., and the other in the bottom land of the Bourbeuse River in Gasconade Co., Mo., it was possible to explain the facts stated by him as being the result of more recent changes in the local alluvial drift of the river valley. Dr. Wislizenus (ibid. p. 168) endeavored to account for all the phenomena in this way, and, in the latter case, by supposing that Indian fires had been built over the spot at a time long subsequent to the deposit of the bones, and the whole afterwards covered by alluvial overflows. He was well acquainted with Dr. Koch, and did not question the veracity of his statements. Judge Holmes had himself assisted Dr. Koch in putting his article into shape for publication in the Transactions, and questioned him minutely as to the particulars stated, and could certify that the circumstances mentioned were positively asserted by him to be true. Nor had he any reason for doubting the truthfulness of Dr. Koch. As lately suggested by Prof. J. D. Dana, it is true that Dr. Koch was not a thoroughly scientific and practical geologist, and he gave some scope, perhaps, to his imagination in the matter of theorizing upon his facts; but he had had some experience in such things, and might be allowed to be capable of observing the facts which he stated, however incompetent to apply the requisite tests for a certain conclusion. But the facts observed and reported were not absolutely conclusive of the matter, though carrying much weight of probability.

In this new discovery in Nebraska, we have facts well ascertained by a competent observer; they are not open to the same kind of explanation; and they seem to afford the necessary confirmation of the supposed contemporaneity of man and the mastodon and elephant in this valley.

Dr. Geo. Engelmann gave some results of his observations on the vernation of American Oaks. He had observed great differences in the vernation of different species, some having conduplicate, and others revolute foldings; again, in others the budding leaves are concave or convex, or (at least in one species) inflexed. But the vernation does not seem to furnish distinguishing characters between the two principal sections, the White and Black Oaks.

J. A. Dacus, Geo. W. Letterman, and Dr. G. Hambach were elected Associate Members.

The name of Dr. Samuel Aughey was proposed for corresponding membership, and that of A. L. Whitley for associate membership.

June 5, 1876.

C. V. Riley, President, in the chair.

Twelve members present.

The Corresponding Secretary read a letter from Prof. Hinrichs, of Iowa State University, acknowledging his election as Corresponding Member, and presented to the Academy 19 pamphlet publications of Prof. Hinrichs.

Dr. Geo. Engelmann read the following communication on certain fungi of the Grape and Oak, specimens of which were laid before the Academy:

OAK AND GRAPE FUNGI.

Some fifteen years ago I presented to the Academy an account, with microscopic drawings, of two of the most destructive fungi of our grapevines. One of them is the "Mildew," a downy white coating on the underside of the leaves, the peduncles of the just forming fruit and the very young berries themselves causing the leaves to wither and the young fruit to shrivel and fall off. That fungus was classed as *Botrytis*, and is now known as one of the *Peronosporæ*, another one of which constitutes the potato disease. This appears at the time of flowering or soon afterwards.

The second, and, I believe, more common and more destructive fungus, attacks the full-grown, yet green berries, and destroys them. After penetrating the tissue with its mycelium, it appears on the surface of the berry as a minute discolored spot, always on the side, which enlarges, and produces black pustules visible to the naked eye, which at last kill the berry and cause it to dry up, emitting at the same time their millions of spores. This fungus, described as *Phoma viticola*, makes its appearance in the latter part of July and in August.

I exhibit to you, to-day, another grape fungus which is new to me, and seems to have been unknown to those grape growers with whom I have conversed. A yellowish-brown spot, a few lines in diameter, appears on the leaf, on the upper side of which a good eye, or a glass, will discover a number of very minute black specks. These are little globules, 0.13–0.15 line in diameter, which have a little opening at the top from which they emit their microscopical spores by the thousand. These oblong or oval spores are one-celled, and have a diameter of 0.013 or 0.014 line.

This fungus belongs to the family of *Coniomycetes*, and to that group which live on decaying vegetable matter. Those yellow spots are the decaying substance, but their vitality has been destroyed by the mycelium of the fungus; those still more minute threads which penetrate the tissue in every direction, exhaust and kill it, and thus form what we may call their fruit, the perithecia, which when mature emit the spores. It belongs to the genus *Depazea*, of which many species, mostly leaf-inhabiting, are described and it may be called *Depazea Labruscæ*—Grape-leaf Spot.

This parasite makes its appearance earlier than the others mentioned above, viz., just before and during the flowering period, and attacks, as far as known, only the leaves, which, where abundant, it kills, and thus cripples the plant: it is also found, though rarely, on petioles and peduncles. Dr. Wislizenus informs me that it attacks indiscriminately all grape varieties, but more the lower leaves of a stock than the upper ones; while he finds the *Phylloxera* galls on the uppermost not yet full grown foliage.

I present to you another fungus, on oak-leaves, which show the same yellow decayed spots; but here you have to look for the perithecium, the fruit, if we may call it so, of the fungus, to the lower side of the leaf, and it is not a black gobule as in the grape-leaf, but a brown elevation, little darker than the surrounding spot. I find no pore at the top, but suppose that it emits its spores through a rent. These are very different from the spores of the *Depazea*, being elongated, usually curved and septate, or forming three or four distinct compartments; the spores are a little longer than those of the grape spots, the perithecium is twice as large as that of the grape.

The septate spores indicate that it belongs to the genus *Septoria*, and the fungus may bear the name of *Septoria querci.*

It is necessary to remind you, that, though we know a great many forms of fungi, we know the life history of only a very few. It is certain of some, and very probably of many, that they constitute transition states of other, more highly developed fungi, and only when we shall have become acquainted with the different phases of their development shall we be able to appreciate their importance and counteract perhaps their destructive action.

Mr. Riley remarked on the above communication, that, with regard to *Peronospora viticola*, according to his experience, it came much later in the season, and did not attack the fruit; and cited as corroborative a recent paper by Prof. W. G. Farlow, published in the Bulletin of the Bussey Institution, where the ground is taken that by shriveling up the leaves, and permitting the fruit to ripen, the fungus is actually beneficial. This singular opinion of Prof. Farlow may hold good in the more Northern States, where the fungus is only moderately abundant; but in this latitude the fungus has just the contrary effect, and, by prematurely robbing the vine of its leaves, prevents the maturing of the fruit. Acres of Delaware failed to ripen fruit from this cause last year.

The fungus, described as *Depazea Labruscæ*, suddenly appeared after the few cold days that succeeded unusually warm weather toward the end of May. It did most injury by attacking the petioles and peduncles, making thereon darker spots than on the leaves, and often cauterizing the parts. As suggested by

Dr. Engelmann, it is probably but the transition state of some other fungus.

Mr. Riley likewise submitted the following

ENTOMOLOGICAL NOTES.

Mexican Jumping Seeds.—He exhibited the moths (*Carpocapsa saltitans*) which he had recently reared from the Jumping Seeds brought before the notice of the Academy at its meeting of Dec. 6, and by their side the moth of the common Apple-worm (*Carpocapsa pomonella*) to show the close generic resemblance of the two.

Periodical Cicada.—He also exhibited specimens of this curious insect in the pupa and perfect states, recently received from Mr. Chas. McCorkle, of Lexington, Va. This insect is commonly called the "17-year locust," but the latter term properly applies to the ravenous Orthopterous insects which occasionally devastate our Western country. Eight years ago Mr. Riley had shown that there were 13 as well as 17 year races of this Periodical Cicada, and in a chronological history of the species had at that time predicted that "in the year 1876, and at intervals of 17 years thereafter, they will in all probability appear from Raleigh, North Carolina, to near Petersburg, Virginia; in Rowan, Davie, Cabarras and Iredell counties in N. C.; in the valley of Virginia as far as the Blue Ridge on the east, the Potomac River on the north, the Tennessee and North Carolina lines on the south, and for several counties west; in the south part of St. Mary's County, Maryland, dividing the county about midway east and west; in Illinois, about Alton; and in Sullivan and Knox counties, Indiana."

The specimens from Mr. McCorkle were proof of the correctness of the prediction. While this insect requires 13 or 17 years, according to the race, for its underground development, the actual development had never been watched from the egg to the mature insect. In 1868 he had collected together in a particular spot near this city a large number of the hatching eggs of a 13-year brood which will appear here again in 1881, and he had been able to obtain and note the development of the larvæ every year since. They are now about two-thirds grown.

Only the male Cicada sings, and the Rhodian bard, Xenarchus, notes this peculiarity when he says,

"Happy the Cicada lives,
Since they all have voiceless wives."

Silkworms on Osage Orange.—He also exhibited cocoons and spinning worms of the common Mulberry Silkworm (*Sericaria mori*) reared on Osage Orange. The worms were a cross between the best French and Japanese races, and he had reared them for five years on Osage Orange with no reduction in quantity or quality of silk, and with great increase of vigor and healthfulness. There is no reason why our ladies might not be dressed with silk from our own native hedges.

Transformation of a Butterfly.—He also exhibited a large denuded branch of the Black Willow (*Salix nigra*) with about 40 chrysalides, and a number of the prickly larvæ of the Antiopa butterfly (*Vanessa Antiopa*), a beautiful insect with deep purple wings and yellow borders, common to Europe and America. The larvæ, when young, are gregarious, and the tree from which the branch was taken had been entirely denuded by them. Some of the larvæ were just changing, and admirably illustrated how the suspended chrysalis state is assumed. Ordinarily rare, the species was quite abundant in this vicinity the present year.

Dr. S. Aughey, of Lincoln, Neb., was elected Corresponding Member, and A. L. Whitley was elected Associate Member.

A communication was then read by Mr. Washburn on Solar Heat.

June 19, 1876.

C. V. Riley, President, in the chair.

Twelve members present.

The Corresponding Secretary read a letter from Dr. Samuel Aughey, acknowledging his election as Corresponding Member.

The Corresponding Secretary presented to the Academy in behalf of Mr. Amos Sawyer, of Hillsboro, Ills., a spear-head, an arrow-head, and several pieces of chipped chert, from an Indian mound near Hillsboro. Mr. Sawyer states that near that place there are several groups of mounds, three to five in a group, the mounds being twenty to thirty feet in diameter, and three to four feet high. They are covered with oak trees, some of which are three hundred years old. In the centre of the mounds, innumerable pieces of chipped chert, and some arrow and spear-heads, like those now presented, are frequently found. There is no flint in that part of the country. The chert comes from the limestone obtainable there.

Dr. Geo. Engelmann remarked, in regard to the recent cool weather, that the lowest observed temperature was 49° F., occur. ring on Saturday, the 17th. In past years, the temperature had not unfrequently fallen to 50° in the month of June, and 45° is not rare, while in one year it fell as low as 42°. No injury seems to be done by such cool weather.

Mr. Riley stated that the grape-rot, which had set in in various parts of Jefferson and St. Louis counties, had been checked by the present cool weather.

G. C. Broadhead presented a supplementary note to a former paper on the

"AGE OF MISSOURI PORPHYRIES." *

Having just examined a suite of the Huronian rocks of New Brunswick, also those of Massachusetts, I find them to be made up of a variety of Porphyries, identical in appearance, and apparently in composition, with those of Southeast Missouri; in fact, their resemblance is such that if I had been shown such specimens without a knowledge of their locality, I should at once have pronounced them to be from Missouri.

I would remark that these Eastern rocks are of various shades of color, from light red, or pink, to black and gray, both coarsely porphyritic and cryptocrystalline, and have also similar intrusive dykes of Dolerite, Diorite, and Porphyrite, like those of Missouri. We may, therefore, call our Missouri porphyries *Huronian.*

ENTOMOLOGICAL NOTES.

New Wheat Destroyer.—Mr. Riley exhibited specimens of a worm that was just at this time devastating the wheat fields of parts of Kansas, and particularly of Dickinson County. It does not eat the blades, but attacks the heads. Specimens had been sent to him last week by Mr. John W. Robson, of Cheever, but in transit they had all eaten out and escaped from the paper-box in which they were enclosed. On the way, however, they had molted, and from the heads alone Prof. Riley had determined the species to be *Leucania albilinea*, though the insect had never before been reported from the West as injurious. Other specimens just received from Prof. F. H. Snow, of the State University at Lawrence, and from Mr. Jno. Davis, editor of the *Tribune* at Junction City, proved the correctness of the determination. The species is generically allied to the common Army-worm, and may be popularly called the Wheat-head Army-worm. As it had never till lately attracted unusual attention, too little was yet known of its habits to warrant any suggestion as to the best mode of destroying it.

Mite Parasites of the Colorado Potato-beetle.—Mr. Riley also exhibited a specimen of *Doryphora* 10-*lineata* that was so completely covered with a mite parasite belonging to the *Gamasidæ* and allied to the European *Uropoda vegetans*, that the point of a needle could not be placed on any part of the beetle's body without touching one of the parasites. He estimated that there were over 800 of the mites, and they had killed their victim. Aside from the toad and other reptiles—the crow, rose-breasted grosbeck, and domestic fowls, among birds—which prey on this potato pest, he had, in his Reports, figured or described no less than twenty-three insect enemies that attack and kill it. Only one of these is a true parasite, and the mite exhibited made the second or just two dozen insect enemies in all.

He mentioned the fact, in this connection, that the Doryphora had reached into New Hampshire, and was doing great injury along the Atlantic coast.

* Trans. St. Louis Acad. Sci., vol. iii. No. 3, p. 366.

Geo. W. Lettermann stated that he had made a collection of the birds of this county, which he would be glad to present to the Academy.

G. J. Engelmann moved that a committee of five, including the chair, be appointed to consider the means best adapted to advance the interests of Archæology—whether it be to establish a Section or a Committee on Archæology—and to devise such rules and regulations as may seem necessary for the good government of such section or committee. The motion carried, and the chair appointed the committee as follows: N. Holmes, W. B. Potter, G. J. Engelmann, Wm. H. Pulsifer.

October 2, 1876.

C. V. Riley, President, in the chair.

Ten members present.

A letter was read from Mariano Barcena, a Corresponding Member of the Academy, which accompanied a publication of this gentleman on Mexican Meteorites.

Vol. I. of the Proceedings of the Davenport Academy of Science was presented by the Corresponding Secretary, and the Academy ordered a complete set of our Transactions (No. 1 of vol. i. excepted) to be sent in exchange.

Judge Holmes announced to the Academy the decease of Dr. M. M. Pallen, one of the founders of the Academy, and moved that a committee of three be appointed to draft resolutions of respect to his memory. The President appointed N. Holmes, E. Sander, and M. L. Gray, to constitute such committee.

CENTENNIAL INSECTS.

Mr. Riley made the following statements in regard to the insect pests at the Centennial Exposition:

It has been feared by many that the exhibition of foreign grains, preserved fruits, etc., at Philadelphia, might be the means of introducing strange insect pests, and articles have been written by different parties, stating that the foreign products on exhibition were badly infested, and that great harm might result. They were particularly noticeable in the collection from Brazil. There are certain species affecting preserved grains, roots, fruits, woolens, and other products, which have been already carried to most parts of the civilized world, and are cosmopolitan, and the presence of such at Philadelphia should cause no alarm. But if there are such as are yet unknown in the United States, the case is very different, and the greatest precaution should be taken by the Centennial authorities to prevent their spread, by condemning and burning the specimens in which they occur, or by submitting them to some process of scalding or heating that will utterly destroy all insect life. It is therefore very important to have the species determined. During my recent stay in Philadelphia I took pains to look into this matter, with the following result:

1. *Bruchus granarius L.*, in the Brazilian exhibit. An European species, imported into New York a few years ago, but not yet widely spread.

2. *Bruchus fabæ* Riley, in Jamaica beans. A species that has of late years been quite injurious to our own beans. It is treated of in my Third Report, supposed to be indigenous, and referred by our best authority, Dr. Geo. H. Horn, to *obsoletus* Say.

3. *Calandra oryzæ* (Linn.) An elongate, reddish-brown snout-beetle, about $\frac{1}{10}$ inch long. Abundant in Brazilian grains and in the exhibit of our own Department of Agriculture. A cosmopolitan species, supposed to differ from *C. granaria* in lacking wings and in other minor particulars.

4. *Silvanus surinamensis* (Linn.) A brown elongate beetle, about $\frac{1}{10}$ inch long, with three narrow ridges on top, and six teeth each side of the thorax. In foreign and native grains of different kinds. Cosmopolitan.

5. *Butalis cerealella* (Oliv.) A small yellowish, Tineid moth, with long fringes to the wings. In different collections, both native and foreign, and particularly in the Egyptian exhibit. Preys on all kinds of grains. Introduced many years ago into the Southern States, and now all over the country. Cosmopolitan.

6. *Ephestia zeæ* (Fitch). A somewhat larger, reddish-brown moth, of the same family, with the basal third of front wings pale yellow. Very common throughout the country in various kinds of grain and dried plants. Described by Fitch as North American, but found also in the Egyptian exhibit.

All these species do their injury in the larva state, and they are all I was able to obtain. There is not one of them that does not occur in the country, so that no alarm need be felt at their presence. In the case of No. 1, only, it behooves the authorities to make some endeavor to prevent its being scattered over the country, as it is at present confined to the vicinity of New York city.

Mr. B. Pickman Mann, of Cambridge, has sent me a moth, new to my collection, and belonging apparently to the *Crambidæ*, which he obtained from the Egyptian exhibit, and I was unable to obtain or determine a small Tineid from a case containing fine Italian straw goods in the main building. There may also be other specimens not noticed by me, and, in order to prevent as far as possible the great benefits of the Exposition from being marred by subsequent evil, it would be wise in the authorities, and they owe it to the country, to cause one of the many competent Philadelphia entomologists to make a thorough examination, and report with suggestions before the Exhibition comes to an end.

October 16, 1876.

C. V. Riley, President, in the chair.

Eleven members present.

Judge Holmes, chairman of the Committee to whom was intrusted the work of devising means for the promotion of the study of Archæology, reported the following amendment to the Constitution, under which a Section on Archæology could be organized:

ARTICLE VII.—*Of Sections.*

SECTION 1. To encourage and promote special investigations in any branch of science, members of the Academy may form sections, which shall be constituted as herein provided.

SEC. 2. For the formation of a section, written application shall be made to the Academy, at a regular meeting, by not less than six active members. On the approval of this application, by the affirmative votes of two-thirds of the members present at the next regular meeting, the section shall be established, and the names of the petitioners shall be recorded on the minutes as its founders.

SEC. 3. Sections may increase the number of their members by election, and may also appoint correspondents; but only members and correspondents of the Academy shall be elected members or correspondents of any of its sections.

SEC. 4. The officers of each section shall be a chairman, a secretary, and a curator, who shall be elected by its members at the first meeting of the section, and subsequently at the first meeting in January of each year.

SEC. 5. The collections and books of each section are the common property of the Academy. Donations of books and specimens made to or for any section, shall be received as donations to the Academy for the use of that section.

SEC. 6. A report of the proceedings of each section shall be submitted to the Academy at least once every month. Papers read before any section with a view to publication by the Academy, shall take the same course as papers read before the Academy.

SEC. 7. On all points not herein provided for, each section shall be governed by the constitution, by-laws, orders, and usages of the Academy.

Judge Holmes also presented the following resolutions, which were unanimously adopted:

Resolved, That the Academy of Science has learned with profound regret of the decease of Moses M. Pallen, M.D., one of the founders of the Academy, and for twenty years an active and worthy member, who departed this life, in this city, on the 24th of September last, in the sixty-seventh year of his age, and that we desire in this manner to record our respect for the memory of our lamented associate. Dr. Pallen was born in King and Queen's County, in the State of Virginia, in 1810, and graduated at the University of Virginia, at Charlottesville, and received his medical education at the Medical College of the Maryland University at Baltimore, and after a few years' practice at Vicksburg, Miss., came to St. Louis in 1842, where he soon acquired an extensive practice. During the Mexican war Dr. Pallen acted as consulting surgeon at the U. S. Arsenal at St. Louis; was city health officer in 1849, the year of the cholera; and was for more than twenty years a distinguished Professor in the St. Louis Medical College, and for several years President of the St. Louis Medical Society. By his varied scientific attainments, and useful counsels and support, Dr. Pallen contributed much to the prosperity of the Academy from its first foundation, and was, as we all know, eminent in his profession, in which he was too arduously engaged to admit of his devoting himself to any special scientific research; but he was always highly esteemed for his learning and virtues, in all public and private relations, during a long and useful career of faithful service.

Resolved, That these resolutions be entered and published among the proceedings of the Academy.

The Corresponding Secretary made his report, calling attention to a publication by Daniel Wilson, in the *Canadian Journal*, on the Relation of Brain Weight to Mental Strength. The result reached by the author is that there appears to be no definite relation between brain weight and mental ability. While many great men have possessed large brains, many have also possessed comparatively small ones, while other large and apparently healthy brains are almost wholly inactive.

Mr. Nipher remarked that the same could be said in regard to bodily weight and muscular work. Evidently, in both cases, the achievement depends not only upon absolute capability, but also upon the disposition to work.

Prof. Potter gave the results of his analysis of the Peruvian lignite which had been referred to him:

ANALYSIS OF PERUVIAN LIGNITE.

The proximate analysis showed:

Moisture	11.15
Volatile combust.	12.35
Fixed Carbon	70.55
Ash	5.95
	100.00
Sulphur	0.205

Prof. Potter stated that while the proximate analysis is important, and gives a tolerably fair idea of the value of a fuel, it is by no means enough for the determination of its true calorific power. In Germany the ultimate analysis is almost wholly depended upon in obtaining the calorific power, while in this country, where we do things in a hurry, the proximate analysis is used. Prof. Potter remarked that both were important. He had therefore made an ultimate analysis of the Peruvian lignite with the following results:

Moisture	11.15
Fixed Carbon	70.55
Carbon in volatile matter	4.05
Hydrogen " "	1.884
Oxygen	5.169
Hydrogen with Oxygen	0.646
Nitrogen	0.396
Sulphur	0.205
Ash	5.95
Combined Water	5.815

From the known heating power of the various combustible materials here shown, the calorific power of this lignite was determined to be 80.4 per cent. of that of pure carbon. Prof. Potter finds the mean calorific power of Colorado lignites to be 79 per cent. of that of pure carbon. Prof. Potter will prepare a more complete paper for publication in the Transactions.

Mr. Riley exhibited a flint spear-head and hoe, found in this county, the property of Mr. D. C. Lee, and also a water-urn, with rounded bottom, which had been washed from the bank of the Arkansas River, and was found floating down the stream. The decoration of this urn was exceedingly interesting, consisting of the conventional wave-scroll so often seen in Greek ornament. The figure was large, and was laid on in two colors, white, and a red somewhat darker than the color of the material used in construction of the vessel.

Edwin A. Leslie, Charles Knower, John W. Sutherland, and Frederick F. Hilder, were elected to associate membership.

November 6, 1876.

Vice-President Albert Todd in the chair.

Twenty-two members present.

EXPERIMENTS IN BINOCULAR VISION.

Mr. Nipher made some remarks and described the following experiments in Binocular Vision, the essential features of which were published in *Nature*, Aug. 10:

1. Fold a sheet of writing-paper into a tube about an inch in diameter. Look through the tube at some distant object with one eye, and look towards the open hand with the other eye, the edge of the hand being

in contact with the tube. The dissimilar objects producing unlike images upon the retinæ, the sensations blend, and a hole will appear to be cut through the palm of the hand, through which the tube passes. That part of the tube between the eye and hand will appear to be transparent, as though the hand were seen through it.

This experiment is very old, but seems not to have found its way into scientific literature.

2. Replace the hand by a sheet of unruled paper, upon which a drop of ink has been placed. By proper management, the ink-blot may be made to appear within the tube, by so placing the paper that the hole, which is apparently cut through it, coincides with the blot. Ordinarily the blot will then appear opaque, the paper immediately around it and apparently within the tube being invisible. The blot appears as it were suspended in space. By concentrating the attention strongly on objects seen through the tube, especially if they are strongly illuminated, the blot becomes more hazy, transparent, and may even be made to disappear altogether. The mental effort necessary to do this cannot be maintained more than a few seconds, and the spot will reappear. If the effort to cause the spot thus to disappear be kept up, the attention being strained to its highest pitch, the blot will disappear and reappear at regular intervals of a few seconds, the absolute time depending upon the illumination. It appears as though the organs exerted become fatigued, and, relaxing for a few moments, refreshment sets in, which again renders possible the exertion necessary in causing the blot to disappear. It is possible that these experiments may be so made as to throw some light upon the conditions necessary in fixing the attention. Interesting experiments may also be made by substituting a fragment of a plane mirror for the sheet of paper. Looking through a rather large tube at a distant object with the right eye, the reflected image of the left eye will appear staring up the tube, the adjoining parts of the head being invisible.

3. Substituting for the ink-blot a small hole cut through the paper, and the small hole can also be made to appear within the tube, distinguishing itself by its different illumination, the surrounding paper being invisible, unless attention be directed too strongly to the paper in which the hole is cut. The relative illumination of the small hole and the space immediately around it depends upon the relative illumination of objects upon which the tube is directed, and that of the sheet of paper exposed to the other eye.

4. Keeping the same arrangement, place at a distance of one foot from the end of the tube a sheet of paper, so that objects beyond it are still visible; arrange matters so that it is visible to the eye looking through the tube, but not to the other, directed at the small hole in the paper sheet. This second sheet will now appear to be traversed by a hole the same in size as that cut through sheet No. 1.

Cutting a small hole in sheet No. 2, matters are easily arranged so that it appears within the hole which was before seen within the tube. These experiments may be utilized in showing the simultaneous accommodation of the two eyes.

5. Tubes of this kind, blackened on the inside, are very convenient in studying color sensations. Using two such tubes, look through one with the right eye—say, at red; through the other with the left eye at green paper, illuminated by the direct solar ray. The color sensations fade with mavelous quickness. Transferring both eyes to either color—say, red—the eye fatigued by green sees the red greatly intensified, the effect being rendered the more striking by the simultaneous impressions received by the two eyes. Experiments in the combination of color sensations will readily suggest themselves.

The editor of the *Scientific American* has written something quite similar to some parts of this communication (Oct. 14), but a comparison of it with my communication to *Nature* will show that I am not the borrower.

Mr. Shepard Cabanné was elected an Associate Member.

November 20, 1876.

Vice-President Todd in the chair.

Ten members present.

The Corresponding Secretary read the following letter from Mr. Riley, dated Manhattan, Kansas, Nov. 11th:

Parasites on Eggs of *Caloptenus spretus*.

A large proportion of the locust eggs throughout the country are being destroyed by parasites, predacious insects, and other enemies. Some are addled from excessive moisture, while a few have prematurely hatched; but the hopes that some people are building on these facts are not warranted. If nine-tenths of the eggs deposited over large parts of Kansas, Iowa, Nebraska, Minnesota, etc., should from one cause and another fail to hatch next spring, there will still be young locusts enough to devour every green thing, and the people should prepare for the worst. With a mild, alternately freezing and thawing winter, the destruction of the eggs may be such that the injury will be comparatively slight next spring, but this will not do to count on. The people throughout this section (Kansas) are in good spirits, and are organizing the better to meet the threatened evil. Let the worst come that can, they are in much better condition to meet the injury than they were in 1874-75. Corn is plentiful and cheap.

I have discovered four new enemies of the locust eggs. One—the most common and efficient—is a new species of *Anthomyia*, which I shall describe as the *calopteni*; the second is the common flesh fly, *Sarcophaga carnaria*: the third is the larva of some *Hymenopteron* belonging doubtless to the Ichneumon flies, and not yet reared to the perfect state; and the fourth is the larva of a ground beetle (*Carabidæ*) of the genus *Harpalus*.

The Secretary read another communication from Mr. Riley, on "Locust Flights East of the Mississippi." He had examined the locust swarms of Ohio, Illinois, Georgia, and South Carolina; and specimens sent him showed at once that they were not the Rocky Mountain Locust, but species more or less common every year in the localities where they occurred, and comparatively harmless. Hence the idea held by the unscientific that the Western locust plague had overstepped the limits entomology prescribes to it, and is upsetting the conclusions of science, is unfounded. The causes which limit the eastward flight of the Rocky Mountain Locust are briefly these:—The power of flight of any insect that has a limited winged existence must somewhere find a limit. Experience has shown that these locusts have never extended, in a general way, east of a line drawn a little west of the centre of Iowa, and, as long as the present average conditions of wind and climate prevail, it is reasonable to suppose that they never will. The species is at home and can come to perfection only in the high and dry regions of the northwest, where the winters are long and cold, and the summers short; and whenever it migrates and oversweeps the country to the south or southeast, in which it is not indigenous, the changed conditions are such that the first generation hatched out in that, to it, unnatural climate, either forsakes it on the wing, or perishes from disease or the attacks of insect enemies.

Mr. Nipher remarked that one expression in Prof. Riley's paper appeared to him an unfortunate one—one well calculated to mislead the unscientific—viz., that entomology "prescribes" the limits of the locust plague. Past experience may have been of such a nature that its limits may be *predicted* with some degree of certainty.

This idea was concurred in by Dr. G. Engelmann, who brought up many cases to show that we can base such predictions upon experience only. He mentioned the well known case of the potato-beetle, which, when potatoes began to be cultivated in Colorado, pushed its way eastward to the Atlantic States, and may even reach Europe. The weeds of the Atlantic and middle States are largely from Europe, and mainly from England; those of the Pacific coast are largely from Spain. A leguminous plant, *Lespedeza striata*, now exceedingly common from Virginia southward, came originally, no one knows how, from South

America. For several years it was known only in limited localities along the coast, finally spreading, rooting out many noxious weeds, completely covering barren places where other plants could not grow, and affording abundant and nutritious pasturage. Dr. Engelmann insisted upon the idea that experience alone could teach us, whether, in such cases, a plant or animal would flourish under the new conditions.

Dr. G. J. Engelmann exhibited a characteristic mound-builder's skull, comparing it with the skull of a Sioux Indian, and with that of a white woman recently found by himself and Prof. Potter in a mound, where it had lain 30 years. The last mentioned skull was interesting, as showing the large amount of animal matter yet remaining in it, the bones of the skeleton being quite fatty.

Dr. Engelmann also called attention to the conflicting estimates made by eminent authorities in regard to the mental capacity indicated by the mound-builder's skull, and gave the following characteristics as being the result of careful studies made by himself and Prof. Potter:—Anterior-posterior axis short; *foramen magnum* placed posteriorly; occipital region flat, and often obliquely compressed. There is nothing to indicate very great, or very inferior intellectual power, as is so frequently claimed.

Mr. Nipher remarked that in some mound explorations made in Iowa during last summer, he had been struck by the absence of certain bones which one would have expected to find preserved, while sometimes fragile bones remained in tolerably good preservation. He described one case of a skull, the facial and frontal bones of which were so wholly gone that their outline could not be followed, even after their former position became known. The teeth lay in the soil in the same positions which they held when in the jaw-bones, which had wholly disappeared. Of the teeth, nothing remained but the enamel cap, the dentine having also decayed. The back of the head (which was down) with the temporal bones remained, *together with the cochleæ of the ears*. In another case (an intrusive burial), the pelvic bones were present, and the bones of one leg, the extremities of the former being almost perfect; the other leg was wholly wanting. A single phalange was also found.

Judge Holmes remarked that some effort should be made to estimate the relative age of mounds in different parts of the country.

The amendment to the Constitution, offered October 16, was unanimously adopted.

G. J. Engelmann, F. F. Hilder, W. H. Pulsifer, F. E. Nipher, J. J. R. Patrick, and W. B. Potter, offered a petition for the formation of an Archæological Section.

Charles Heissler and Dr. C. A. Todd were elected Associate Members.

December 4, 1876.

C. V. Riley, President, in the chair.

Fifteen members present.

The Corresponding Secretary presented a number of scientific papers which he had received, and devoted a considerable time to a discussion of the results accomplished by the late Arctic expedition, stating that, in his opinion, it had been far more valuable to science, in the discoveries relative to the Arctic regions, than was generally accredited. It had demonstrated that what had previously been called "President's Land," had really no existence whatever. It has also demonstrated that there was no open sea around the north pole, as had so long been supposed.

The official report to which Judge Holmes referred is to be found in *Nature*, Nov. 2.

Dr. G. Engelmann exhibited specimens of seed-bearing leaves of the Sago palm, *Cycas revoluta*, and spoke about the physiogical and anatomical character of the *Gymnosperms*, which order comprises the *Cycadaceæ* and the *Coniferæ*. The former in our country are represented by the *Zamia integrifolia* of South Florida, which also, like many of its allies, contains an abundance of amylaceous substance in its trunk, and for this is now highly prized by the settlers, as it was formerly an important article of food for the aborigines. The second and much better known family of Gymnosperms are the *Coniferæ*, to which our Pines and Junipers belong. The *Gymnosperms* must be considered as the lowest type of flowering plants, only a few degrees removed above those that propagate without proper flowers, the *Cryptogams*. Intimately connected with this lower development is the early appearance of such plants, in the geological series, many ages before real flowering plants made their appearance on our globe.—The cycadaceous plants are the prototypes of the monocotyledons, and especially of the palms, and the conifers those of the dicotyledonous trees. Among animals, the Marsupials hold a similar position to the ordinary Mammals, and they are also geologically older than the more complete animals, which they seem to shadow forth.

Mr. Riley remarked that such facts were of great interest to the evolutionist, pointing as they do to the divergence, in time, of the more widely separated forms from some primitive types, of which in the cases cited the Sago palms and the Marsupials are the present and possibly modified representatives.

Mr. Riley spoke at some length upon the "Geographical Range of Species." He regretted his absence at the last meeting, when his article on "Locust Flights," in which he argued that the *Caloptenus spretus* could not permanently thrive south of the forty-fourth parallel or east of the one hundredth meridian, was discussed, and exceptions taken to its conclusions by Dr. Engelmann and Prof. Nipher. The subject was an interesting one, and the principal difficulty in the way of properly apprehending the facts was found in the failure in the popular mind to discriminate between species. Dr. Engelmann had instanced the Colorado beetle's spread to the Atlantic; but there was a great difference between the spread of a species in nature, and that spread which is aided or influenced by man. He was very well aware that species do spread, and he had in his 2d Report laid particular stress upon the different weeds and insects which have been imported from Europe. He had also in the introduction to a little work on "Potato Pests," now being published, dwelt at length on the same subject; but he did not think that any single instance could be furnished of a species which had in our time extended or contracted its range without the aid of man. It was in not keeping in view this difference between the natural range of a species, and that range as affected directly or indirectly by man, that the objection made to his paper lacked force.—By careful study of past experience of nearly a century; by weighing all the other conditions, he had ascribed certain eastern limits beyond which the Rocky Mountain Locust could not perpetuate itself or do continued damage, and he regretted to find Dr. Engelmann, on what he must believe were insufficient grounds, lending the weight of his authority to the opposing statement that there is not sufficient evidence for the opinion. If he were to announce that he had discovered the *Œneis simidea* in the Mississippi Valley, or in Missouri, every well-informed entomologist would at once declare it a mistake, and say he had confounded it with some other butterfly, because the *Œneis* is known to be confined to the alpine regions of Labrador and the White and Rocky Mountains, and is absent from all the intermediate country. The classified knowledge we have on the subject establishes certain limits outside of which the species does not thrive, and there is every reason to believe cannot, except by man's assistance; and the same may be said of a whole lot of alpine and sub-alpine plants. The same is true of many insects and other animals.—Past experience shows that the Rocky Mountain Locust cannot change its habits. It is indigenous to the sub-alpine heights of the Northwest, and its individual life is bounded by the spring and autumn frosts. Species are sometimes found to be limited in a wonderful way to certain areas, and it cannot be explained why some can and others cannot adapt themselves to different conditions. The genuine Colorado Potato-beetle spread eastward through man's agency, as the intermediate territory was settled. The bogus Colorado Potato-beetle, however, did not and does not spread in the same manner, as it cannot subsist on the cultivated potato.—As to the objection to the expression "prescribe," the word has various synonyms, one of which is "establish," and few would fail to see that it was used in this last sense.

Dr. Engelmann then said, as his name had been mentioned in the discussion, he would offer a few remarks. The Potato-beetle and its allied *Doryphora* would furnish examples to sustain his views. One has shown its ability, within the past fifteen or twenty years, to spread itself over a wide range of country, while the other, its congener, had remained confined in its original area. Twenty years ago the Potato-beetle was as little known as its congener. It did not feed on potatoes until the potato had been cultivated in its native country; the other stuck to its original food, but might, for all we know to the contrary, have increased its range as easily as the beetle. Another dreadful scourge, the *Phylloxera*, had also spread alarmingly, through man's aid, during past years; and now the question comes up, might not the Rocky Mountain locust also spread with the assistance of man? May not the increasing wheat fields be an inducement for them? and may they not in time be able to adapt themselves to circumstances of climate, etc.? It was impossible to say what, if any, limits were marked out for them. He instanced examples of foreign plants, such as the Canada thistle, and several parasites which were known to thrive in this country, and which are now plentiful. He also instanced a *Cuscuta*, which suddenly came up in several parts of Europe some years ago, and did considerable damage to the lucerne fields. This plant was a native of Chili, and was introduced into Europe with the so-called alfalfa seed, and was a pest for ten or fifteen years. It has now entirely disappeared from Europe, but has suddenly appeared in California. Fifty years ago it had been believed that the cholera would not reach Europe or America, and forty-five years ago, when it did travel westward, that it would be excluded from high elevations; but it has since attacked Switzerland, and spread widely through Mexico. The geography of plants and animals was a comparatively recent science. Longitude, latitude, altitude, and all that we call climate, certainly do limit certain species, but only the experience of many years can teach us what those limits are for each individual kind.

Mr. Riley, in reply, said that facts such as those cited by Dr. Engelmann might be multiplied *ad infinitum*, and that he had done much to record them. He insisted, however, that they had little to do with the argument in point. The locust is omnivorous; it will feed even upon animal matter, and so it will not be influenced by man's agency. There has been but little change in the country, between here and the Rocky Mountains, as to locust-food supply, and that country affords the locust no more nutriment now than before settlement. By gradually spreading from year to year, as the *Doryphora* has done, the species might conform to the new conditions, but the transition was sudden from the high and dry climate of the locust's native home to the more moist lowlands of the Mississippi Valley. Man cannot introduce them faster than the winds and their own wings have done. Former experience proved their inability to thrive in this climate. Specimens hatched in Pennsylvania as well as in Nebraska did not become acclimated. And if the species could sustain itself here, it would probably, in a few generations, become so modified that it would lose its present injurious character.—The subject had many sides. He had discussed it at length in his official writings, and, as he had laid stress on the very fact that Dr. Engelmann insists on, viz., that experience alone could guide, there was little difference of opinion after all. The difference is that, as against the contrary opinion, entomologists consider that the experience in the matter of this locust question warrants the conclusions they have drawn.

Mr. Nipher called the attention of the Academy to an improvement in electric lights. The pieces of carbon have heretofore been placed end to end, attached to opposite poles of a battery, and it had been necessary to keep the points of carbon together by means of clumsy and expensive clock-work. Jabloschkoff had improved upon this mode, however, by placing the carbon side by side, with an insulating plate between them, and their ends barely projecting over the end of the insulating plate, melting it down as they burned away. This obviates the necessity for the cumbrous clock-work which has always been necessary to keep the two opposing points at the proper distance from each other. He thought the electric light would soon come into general use for lighting factories, railway depots, etc.

Judge Holmes criticised Mr. Darwin, and some of his supporters, for ignoring the cause of evolution, and confining their attention to the laws according to which the evolution takes place.

Mr. Riley thought that neither Mr. Darwin, nor many of his supporters, denied the existence of the cause, but simply declined to discuss this point for reasons which appear to them sufficient.

It was resolved to devote the second meeting in January to a discussion of some plan for securing a permanent hall or building, where the library and cabinet of the Academy may find proper accommodations.

The petition for the formation of an Archæological Section was granted.

Mr. J. J. R. Patrick was elected an Associate Member.

December 18, 1876.

C. V. Riley, President, in the chair.

Twelve members present.

ON APPLYING MUSCULAR WORK.

Mr. Nipher gave the following communication on the most favorable manner of applying muscular work:

Although labor-saving machinery is being constantly devised, it seems to have the effect of increasing the amount of work accomplished rather than of releasing individuals from the necessity of labor. Hence it seems to be of growing importance to find the laws regulating muscular action. Long ago it was experimentally proved by Coulomb, that a man walking up stairs without any load, and raising his burden by his own weight in descending, could do as much work in a day as four men working in the ordinary way with the most favorable load.

Similar isolated experiments have been made by Jevons, Haughton, and myself, which have been published in *Haughton's Animal Mechanics*, London, 1873, and in later scientific journals.

Although a workman, or a horse, when working with any given tool or machine, will adapt himself to it, working with a velocity which enables him to do a maximum, it by no means follows that the conditions might not be so changed that a greater amount of effective work might be done with the same effort.

To take a case in point: Haughton observed some fish-women gathering shell-fish on the ocean beach. The beach back from the water several rods was very rough and rocky. Farther back it was smooth and furnished good walking. Starting from the edge of the water, and going straight to the market of the neighboring town, they would have to walk for a long distance over the rough, stony beach. On the other hand, by walking back at right angles to the water-mark, they would soonest get to good walking, but they would have a greater distance over which to carry their burdens. The course which they actually took was an intermediate one, and Prof. Haughton found that these people, ignorant and unthinking as they were, were selecting directions which made their work a minimum. But, of course, the conditions under which they were working might have been so improved that more useful work might have been accomplished with the same effort.

Another illustration is afforded in the series of experiments which I present to you this evening. The experiments were made upon the gymnasium swing.

Many of the evolutions performed upon it can be made equally well upon swings of any length; with others it is different. When the evolution is such that the swing in one direction marks a period of exertion, while the return is comparatively a period of rest, then the evolution cannot be equally well performed with swings of all lengths.

One of the most useful exercises is made as follows: Reaching up and grasping the rings, let the swing be started, and at the beginning of a forward swing the feet are thrown above the head, the legs being flexed. As the forward swing closes, the legs are extended and the arms flexed, the body being thus thrown upward and outward. Here, also, by some practice, one learns to accomplish the swing with a minimum of exertion, which a good gymnast always does; nevertheless the number of swings, before exhaustion takes place, varies with the length of the ropes, as is shown in the following series of experiments made upon myself:

NIPHER.

l.	t.	n.
12	4.5	10.0
11	4.3	12.2
10	4.1	12.8
9	4.0	15.4
8	3.9	15.2
7	3.8	13.0
6	3.7	10.6

l, distance from point of suspension to centre of hands; t, time of one complete oscillation (forward and back); n, number of oscillations before exhaustion.

It will be observed that n reaches a maximum where $l =$ about 8.5 ft. or where the time of a full swing is between 3.9 and 4.0 seconds.

Another series of experiments was made upon Mr. Cunningham, a young man about 5 feet 2 inches in height, and of light build. The maximum value of n is here reached when the length of the rope was about 10 feet, and here the time of a full swing was about 4.1 seconds.

CUNNINGHAM.

l.	t.	n.
12	4.3	14.0
11	4.3	16.3
10	4.1	17.0
9	3.8	14.6
8	3.7	12.6

In order that this and similar evolutions may be elegantly performed, the time for the full swing, when loaded with any person, should be four seconds.

The cause of rapid fatigue with long swings is, that the body must be held in a constrained position for too long a time. With very short swings, the muscles are forced to work with too great a velocity.

The muscular action is here too complex to allow of any mechanical discussion, but the general results are exactly what the discussions of Prof. Haughton might have enabled us to predict.

Mr. Nipher remarked, that an experience of several years in the investigation of this subject had enabled him to devise a method of investigation which promises useful results, but he had not the means with which to carry on the investigation.

Mr. Riley made a few remarks about the anticipated locust injury next summer. The soil in a large portion of Minnesota, Iowa, Colorado, Kansas, Nebraska, Texas, and Arkansas, and in about sixteen counties of the State of Missouri, was thickly planted with locust eggs. He was receiving eggs from every one of the sixteen Missouri counties affected by them (four counties in the extreme northwest corner of the State, and twelve counties in the southwest portion of the State) almost daily, and was therefore being kept constantly informed as to the condition of these eggs in all the counties. A great many of the eggs hatched in his office within a week after their arrival here, and it followed that a week's warm weather next spring would be sufficient to hatch them all out, provided they were not killed meanwhile. The only kind of weather that would be at all likely to kill them was changeable weather, alternating suddenly between very mild and very cold. Although the locusts hatched next summer throughout the West will probably be more numerous than in 1875, their devastations will probably be less, for the reason that the farmers will this time be better prepared for them on account of the experience of the past.

Mr. Todd called the attention of Mr. Riley to a newspaper paragraph announcing that seven car-loads of silkworm eggs had passed through Omaha yesterday on their way to France, and he asked the Professor how the eggs were packed to preserve their vitality.

In reply, Mr. Riley described the mode adopted by silkworm growers in Japan, specialists who grow the worms only for their eggs, and who are constantly engaged in transporting them. The eggs are first separated in some liquid and are then sifted upon silk paper, previously covered with a thin coat of paste. The eggs adhere to the paste on the silk papers, and the latter are packed in boxes constructed purposely for them, and are then ready for shipment.

January 15, 1877.

President C. V. Riley in the chair.

Twelve members present.

The Corresponding Secretary submitted the following annual report:

To the President of the Academy of Science.

I have to report that the operations of this office have been continued in the usual manner.

No. 3 of vol. iii. of the Transactions was published last spring, and sent to our correspondents. During the year 385 copies, of all numbers, have been disposed of by way of exchange; 35 numbers have been sold for cash, and 9 numbers were sent to the order of an agency at Salem, Mass., which have not yet been paid for; and there remain in my hands 29 copies of various numbers. The total number of copies received of all Nos. by the Corresponding Secretary was 458.

The demand for our Transactions seems to be increasing from year to to year. No. 3 of vol. iii. has been sent to 209 foreign correspondents, and to 102 home societies and individuals.

The whole number of our foreign exchange list is now 217. Of these, the following 18 have been added this year:—The Entomological Society, London; La Fondation P. Teyler van der Hulst, Harlem; The Royal Irish Academy, Dublin; Naturforschende Gesellschaft, Chemnitz, Sax.; La Société Paléentologique, Bruxelles; La Société Malacologique, Bruxelles; Società dei Naturalisti, Modena; Verein der Naturforschende, Reichenberg; Observatorio de Madrid, Madrid; Department of Mines, Sidney, N. So. Wales; Naturforschende Verein, Grätz; Society of Arts and Institutions, London; Instituto historico e geographico do Brazil; Commission géologique de l'Empire du Brazil; Naturhistorischer-medicinische Verein, Heidelberg; Naturwissenschaftliche Verein, Kiel; Naturwissenschaftliche Verein, Karlsruhe; L'Institut National Genevois, Geneva.

The following have been added to the home list:—Boston Public Library, Boston; Mass. Historical Society, Boston; Mr. J. C. Schroyer, Cincinnati; Cincinnati Society of Nat. History, Cin., O.

We have received publications in exchange, for 1875-6, from 119 foreign societies and from 36 home societies. And, in addition to these, we have received 99 volumes and pamphlets as donations from individual correspondents; among these were 9 vols. 4to of the Works of Sir William Jones, from Mr. Wm. Lucas, and 4 vols. of the Geological Survey of Ohio, from Mr. J. C. Schroyer of Cincinnati. We have also received from the Smithsonian Institution vols. xx. and xxi. of the "Contributions to Knowledge," and 7 vols. of the Smithsonian Report, to complete our sets. I may add that we receive regularly the valuable publications of the U. S. Geological and Geographical Survey of the Territories, the Bureau of Education, the Chief of Engineers of the U. S. Army, and the U. S. Naval and Astronomical Observatory at Washington.

As it is well known to members, No. 1 of vol. i. is out of print. This number is frequently called for to complete sets of our Transactions, and it is very desirable that it should be reprinted as soon as practicable.

Our foreign exchanges are carried on for the most part, as heretofore, through the Smithsonian Institution.

The receipts and expenditures of the Corresponding Secretary for the year 1876 have been as follows:

Receipts	$89 77
Expenditures	68 79
Balance in hand	$20 98

The detailed account is herewith submitted, showing that of this amount received, $55.35 was derived from the sale of the Transactions, and $30 was drawn from the Treasurer. The expenditures were entirely for freight, postage, and stationery.

At my request, the Librarian has kindly undertaken to furnish me with a memorandum of any volumes, or parts of volumes, that are wanting to complete full sets of the several series of publications which our library contains. It is probable that the few missing numbers may be easily supplied. Respectfully submitted.

Jan. 1st, 1877. NATHANIEL HOLMES, *Corr. Sec'y.*

The Treasurer's report showed that the annual collection had amounted to $664.00, and the amount now in the treasury is $159.71. The amount yet due from members is $418.00.

The Chairman of the Library Committee reported that 600 books and pamphlets had been received during the year, of which 417 are foreign exchanges. He strongly recommended that some steps be taken to secure rooms which would serve as a place of meeting, and in which the collections and library can be suitably arranged.

The Academy then listened to the following address by President Riley:

Gentlemen and Fellow-Members of the Academy:—In accordance with a long-established custom, in retiring from the position with which you honored me a year ago, I take advantage of the occasion to cast a summary glance at the more important achievements that have marked the past twelve months in our field of mutual labor. In surveying this field from a general or international standpoint, one is overwhelmed with a sense of its vastness; and where, in almost every special department, one or more good-sized volumes are annually published to chronicle the titles or to give the merest abstracts of papers published, and the briefest digests of work accomplished, it is manifestly impossible, in a brief address, to give any adequate idea of the world's progress in science during a single year—even were any one man competent to do so.

Science, at one time, belonged to the few — the learned. She was paraded on such high stilts, clothed in such uncommon garb, that the gulf intervening between her votaries and the masses precluded all affection or appreciation for her by the latter. To the tendency of the one class to break the cold, stiff crust of technicality which environed them, and to the increased intelligence of the other, must in great measure be attributed the extraordinary advancement of science of late years, and its increasing popularization. She to-day belongs, not to the few, but to the multitude; and merely to chronicle her progress has become an art. The collector in Nature's treasure-store, though thirsting for all knowledge the mind is capable of, and loth to slight any specimen whatsoever that may cross his path, yet, knowing the shortness of individual human life, passes by the majority of the objects which he meets with, and confines his attention to those which more particularly belong to the department which he has made a specialty of, and which he consequently best understands. Let me in the same way pass over the great multitude of interesting subjects that confront the chronicler of a year's progress in science, and confine myself to a few of the more conspicuous events, and more particularly in American science and in paths most trodden by our own members, and, hence, most familiar to us.

PHYSICS.

A. M. Mayer has continued his researches in acoustics, determining the conditions under which one sound may obliterate another.

C. A. Young, of Hanover, N. H., has devised a method by which the spectra of higher orders (even to the eighth or tenth) produced by gratings, can be used for spectroscopic work. These are to be preferred, as their dispersion is greater, and lines which appear single in those of lower orders are seen double in the eighth or tenth spectrum. Ordinarily these spectra overlap, and Young separates them by refracting them with a prism in a direction at right angles to the direction of the dispersion by the grating. With this contrivance he has just demonstrated the displacement of lines in the solar spectrum due to solar rotation, thus proving the applicability of Doppler's principle of light—a theory which the researches of Van der Willigen and Secchi had caused astronomers to doubt.

A. H. Rowland, of John Hopkins University, has made important studies in the distribution of magnetism in bar magnets. He reaches the conclusion that hardening is more useful in short-bar magnets than in needles, and that boring a hole in the centre of the magnet is, in general, hurtful. J. Trowbridge, of Harvard, demonstrates experimentally that by distributing the fine wire of an induction coil upon two straight electro-magnets (instead of one), whose poles are provided with armatures consisting of bundles of thin, soft iron plates, the strength of the spark is increased 400 per cent. when large condensers are used.

A. S. Kimball, of the Worcester (Mass.) Institute of Industrial Science, has investigated "Sliding Friction on an Inclined Plane," and finds that the co-efficient of friction is a function of the velocity when the inclination of the plane is constant; that, with the same velocity, it increases with the inclination.

Among our fellow-members, Prof. F. E. Nipher has devised a lecture galvanometer, for lantern projection, which can be used in showing the presence of thermo and induction currents, and can also be used as a differential galvanometer. He has also shown the unequal distribution of errors in numbers written from memory, and has devised a method of measuring the strength of memory, an investigation in which he is yet engaged. He has also continued his investigations on the laws of muscular exertion; and has devised new and curious experiments on binocular vision.

ARCHÆOLOGY.

Much interesting work in this field has been done during the year by the Davenport (Iowa) Academy of Science, No. 1, vol. 1., of whose *Transactions* is largely given to the subject, and is most creditable. Mr. F. W. Putnam has completed the work left unfinished by the late Jeffries Wyman, on the "Fresh-Water Shell Heaps of the St. John's River, Florida." Our Academy has published the reports of observations and discoveries made by Prof. Gage, respecting his examinations of mounds and graves in Illinois, Mississippi, and Missouri, and also of those made by Mr. Conant, near New Madrid, Mo., of remains of an ancient Indian town, and the opening of mounds in which were found skeletons and pottery.

Prof. Potter and Dr. G. J. Engelmann, from the committee appointed to examine mounds, have had surveys made of several fortified villages in Southeast Missouri. Mounds have been opened, and skulls and pottery obtained, the former characteristic of the mound-builder type. Graves have been opened on the Illinois bluffs in St. Clair County, where skulls of the type of the modern Indian were found. Some mounds examined in the Okaw bottom yielded skeletons unaccompanied by pottery or weapons, while stone graves and other mounds in the same vicinity inclosed fragments of bones and pottery.

Mounds on the bluffs and in the bottom in the vicinity of the large Monk's Mound, opened by Dr. F. C. A. Richardson, contained some skeletons. Messrs. Hilgard and Patrick, of Belleville, Illinois, have made a careful and most valuable survey of Monk's Mound, and an interesting discovery of burnt and broken human bones was made by Mr. Hilgard in some of the stone graves opened by him on the Illinois bluffs. A number of the large series of mounds in the Arcadia Valley, Mo., were opened, and nothing found; so also mounds on the Missouri River were opened without result. Mr. Howland, of Buffalo, N. Y., made a most valuable discovery of horn and copper in a mound near Alton.

The Academy has appropriated, in all, $120.31 to defray the expenses of the committee, and most of the specimens obtained are in charge of Prof. Potter, at Washington University, for want of room and cases in our present quarters. Next to the publication of our Transactions and care of our library, whatever funds we may have to spare cannot be more profitably used than in prosecuting this Archæological work.

The interest created by the Archæological work done by the committee has resulted in the formation of an Archæological Section of the Academy, which organized on the 10th inst., and elected W. B. Potter, ***Chairman***; F. F. Hilder, ***Secretary***, and G. Hambach, ***Curator***.

Division of labor is most desirable where the laborers are many and the field of labor is large. Where, as in our own case, however, the laborers are few, there is strength in union, and I question the wisdom of the separate section, because it withdraws just so much from the interest and value of the meetings of the main body, and all the sectional work could be done by a committee. The American Association formed an Archæological section in 1875, but the experience of 1876 proved the course unwise. There were not enough papers to maintain continued interest in the section, and those interested in maintaining it were kept from attending the general Section B.

ZOÖLOGY.

Many of the most interesting contributions in this department have been made through Hayden's Bulletins of the U. S. Geological and Geographical Survey of the Territories. Mr. J. A. Allen has continued his interesting papers on the "Geographical Variation in Birds and Mammals"; and indeed the various laborers in this field of Zoölogy have been so active that I must forego all mention of work in the different departments, and confine my remarks to the work in my own specialty more particularly. The study of the Arthropoda is less popular than that of the higher animals, but not less important. The Insecta alone in species outnumber all other animals, and a glance at the *Zoölogical Record*, published in London, England, is sufficient to show that the devotees of Entomology equal in number those of all other branches of Zoölogy, and that the literature of the subject is proportionally great.

Among the important contributions to Systematic Entomology, Le Conte's long-looked for *Rhyncophora of America N. of Mexico* holds high rank, and is a most admirable and philosophical treatise of a difficult group of beetles, which the author is led to believe are the oldest geologically, and, consequently, the most synthetic of present Coleoptera. Packard's *Monograph of the Geometrid Moths* is a classical and admirable review of an extensive family of moths Osten Sacken's *Prodrome of the Tabanidæ* of the United States, and his papers on Syrphidæ, are also noteworthy. The Entomological Club of the American Association for the Advancement of Science was very largely attended, and certain much-needed rules for guidance in nomenclature discussed and partly adopted. A vast number of Hübnerian generic terms, ignored by almost unanimous consent for the best part of a century, have of late years been adopted by some of our lepidopterists, and made to usurp the place of those which had been long accepted and were familiar. It has come to such a pass that a paper by an author who adopts the innovations is unintelligible even to the specialist. Few but those who proposed the changes have adopted them, and the large majority of working lepidopterists believe that there is not sufficient reason for flooding the science with such a mass of new terms.

Two factions have thus grown up, and it is greatly to be desired that, by the adoption of rules for guidance, harmonious views and harmonious work may result.

The collections made by Capt. Fielden, of the British Arctic Expedition, add some interesting and unexpected facts to our knowledge of the distribution of insects upon the globe. Frail butterflies and moths, belonging to families and genera common with us, were taken in Discovery Bay in 81° 42′ N. latitude, and some even a degree farther north; while a bumble-bee and an Ichneumon-fly in *Hymenoptera*, and various mosquitos (*Culicidæ*) and black-flies (*Similium*) in *Diptera* that were also collected, show that honey-producers, parasitic species, and animal tormentors, exist in those high latitudes.

Considerable progress has been made in Economic Entomology.

The Colorado potato-beetle has attracted much attention in the Eastern States, and has abounded to that extent along the Atlantic coast, as not only to destroy all potatoes, but to prove a positive nuisance to persons. I lay before you a little pamphlet entitled *Potato Pests*, which largely treats of this insect, and was published in order to meet the demands made for the information in my earlier reports, which are no longer to be had. I also lay before you a colored placard published by the German Government, to be used on all vessels plying between the United States and Germany, and which is a literal carrying out of my recommendations for preventing the introduction of the pest into Europe. The Commissioners of Customs in England have also published a similar order directing the officers of the out-door department of the service to look for and destroy any beetle answering a description which accompanies the order.

The Grape Phylloxera has continued to interest our grape-growers, especially those of California, and to vitally concern the people of France. The remedy still most practicable and most relied on is the grafting of the susceptible European vine on to the resisting American varieties, as recommended by me, and the demand for cuttings of some of our varieties has not fallen far short of the 14,000,000 sent over in 1875-6. The issue of the impregnated egg from the root-inhabiting type of this insect has been proved to be the agamic gall-producing type, and the specific identity of the two thus still more strongly and absolutely confirmed. There has been, for some years past, no doubt on this point in the minds of all investigators who had given the subject most careful study; but the opposite view was sustained and given a show of support by some very insufficient experiments made by the entomologist to our Department of Agriculture.

Some of the researches in Economic Entomology in Missouri have been laid, in outline, before the Academy, and others will appear in my official report. I shall not detain you, therefore, with any account of my own work. But there is one subject that cannot well be passed over; it is the

LOCUST SCOURGE.

For us, the locust problem just now transcends all others in economic entomology. It will be remembered, that, in opposition to contrary opinion widely circulated, I expressed my belief, a year ago, that in Missouri, Kansas, and Nebraska, first, there would not hatch as many locusts in the spring as would naturally hatch in ordinary seasons from indigenous species; second, that, compared with other parts of the country, those States ravaged by locusts in the spring and early summer of 1875 would enjoy the greater immunity, during the same season of 1876, not only from locust injuries, but from the injuries of most other noxious insects; that, in short, the people of the ravaged section had reason to be hopeful rather than gloomy; that they certainly would not suffer in any general way from locust injuries in the early season; and that the only way in which they could suffer from the migrating pest was by fresh swarms, later in the year, from the far Northwest.

Like the other opinions as to the future doings of this insect which I had on previous occasions expressed, this last was fully warranted by subsequent events, and the States mentioned have seldom enjoyed such immunity from insect depredations as in the spring and summer of 1876. Later in the year, however, the Rocky Mountain locust overran a large part of the western country, and, while in most instances they came too late to seriously affect maturing crops, they have laid eggs over large parts of Minnesota, Nebraska, Kansas, and Colorado, and in more restricted portions of Iowa, Missouri, Texas, and Arkansas. Throughout the region named, injury, more or less serious, may be expected next spring. Should nine-tenths of the eggs be destroyed, there will yet hatch enough young insects to devour everything green, if no steps be taken to prevent the injury.

The winter has so far been favorable to the preservation of the eggs, which, with few exceptions, are yet sound; and while much alternately thawing and freezing weather between now and spring may destroy the large bulk of these eggs, such a favorable result will not do to rely on. Our farmers should expect the worst, and be prepared for it. "Forewarned, forearmed." Indeed, I am glad to say that they are very generally anticipating and preparing, where two years ago they were comparatively indifferent. They are profiting by the experience of 1874–5, and by what has, of late years, been written upon the subject. This is more particularly the case in Kansas, Nebraska, and Iowa,—and, I regret to say, less so in Missouri; for, in some of our counties that are threatened, there is no organization, and little preparation, to meet the enemy next spring. In our own State the injury will be confined, as it always has been, and, I believe, ever will be, to the western counties. The middle western counties, which most suffered in 1875, i.e. the portion of the State in which the winged insects reached farther east in 1874, and laid most eggs, will not suffer next spring. Such are the counties of Platte, Clay, Jackson, Lafayette, Cass, Johnson, Bates, Henry, Pettis, and Benton. In these counties the farmers have little or nothing to fear, except as they receive a few straggling and comparatively harmless bevies of the winged locusts in June and July from the neighboring country.

THE COUNTIES THAT WILL SUFFER are—1st, Atchison and Holt, and the western half of Nodaway and Andrew, in the extreme northwest corner: 2nd, McDonald, Barry, Jasper, Lawrence, Barton, Dade, Cedar, Vernon, more particularly in the southwest half; Polk, in the northwest third; Hickory, in the southwest third; and St. Clair, in scattering places.

The locusts came into all these counties last fall, very generally ate off the fall wheat, and filled the ground, near its surface, with their eggs, in most parts quite thickly; and in all of them we may expect more or less injury next spring from the young locusts.

With few exceptions the wheat was killed, and the ground will have to be resown in the spring. Having, in my official reports, treated fully of the means tobe adopted to prevent the injury, I will simply state that they are sufficient, with concert of action, to enable the farmer to protect his crops from the unfledged insects. Yet a State bounty law for the collection and destruction of the eggs and young insects would greatly assist, and I would earnestly urge our Legislature to enact some such law as I have suggested on page 138 of my last report.

Against the winged hordes, as they sweep down from the northwest, the farmer is powerless, and it is the manifest duty of Congress to make some effort to palliate an evil which is national in its character. My views that the destructive swarms that sweep down upon our fertile valley have their origin in the Rocky Mountain region of the northwest, are well known to the members of the Academy. They have been very generally accepted as correct, and Dr. Packard, editor of the *American Naturalist*, in an article of the present month's issue of that journal, though confessing himself at first skeptical as to the correctness of those views, indorses them since his visit to Kansas and Colorado in 1875.

The insect is not indigenous to Missouri and many of the other Western States that it occasionally devastates, and there is much yet to learn of its native habitat and breeding-places. There is not only a possibility, but a strong probability, that, by having the proper investigations made, we may be able to prevent its incursions into the more fertile country. As I have elsewhere remarked, "The fact that the agriculture of the United States is of equal importance with all other interests of the country combined, is so often asserted and admitted that it needs no enforcing. This industry not only feeds our own 40,000,000 mouths, but supplies the staff of life to millions in foreign lands. Surely, then, it is most important to study and investigate those causes which affect it injuriously and arrest its development, among which injurious insects play such an active part.

"When, as in the past few years, the prosperity of nearly the whole country between the Mississippi and the Rocky Mountains is jeopardized, and the whole Nation suffers most sensibly from locust ravages, National measures should be taken to investigate the causes, and to endeavor to prevent the recurrence of such disasters in the future. Congress owes it to the farmers of the West that some effort be made to relieve them, as far as it is in human power to do so, of this insect burden, which is doing more than any other to crush them.

"In the present case, it is not merely the question of saving to the Nation, in future, such vast sums of money as this insect has taken from the producers of some of the Western States—amounting during the past few years to nearly a hundred million dollars; it is a question affecting the welfare of whole commonwealths on this side of the Mississippi, and the ultimate settlement of a vast tract of country extending from the base of the Rocky Mountains eastward, to which settlement the ravages of the locust in question offer the most serious obstacle."

A CONFERENCE OF THE GOVERNORS

of Missouri, Illinois, Iowa, Kansas, Nebraska. Minnesota, and Dakota, was held at Omaha last October, to consider this all-important locust problem, and I lay a copy of the official report before you. The conference memorialized Congress on the subject, and asked for a Commission of five, to consist of three entomologists and two practical men of experience with the locusts, to be appointed by the Chief of the Geological and Geographical Survey of the Territories, and approved by the Secretary of the Interior, the duty of which Commission it shall be to examine into the history, nature and habits of the insects, and to suggest means of destroying them, and remedies against their ravages; and it asks, for this purpose, that the sum of $25,000 be added to that part of the sundry civil appropriation bill providing for said survey of the Territories in order to pay the expenses and salaries of such Commission.

The National Agricultural Congress, at its meeting in Philadelphia last September, unanimously prayed for similar action, and many prominent agricultural and horticultural societies in the West have done likewise. I have for three years pleaded for some such national legislation, and let us hope that the demands being made will not go unheeded. The time is most opportune, for a Commission created this winter would have an opportunity, that may not occur again for years, of studying and experimenting on the young insects from Texas on the South and Missouri on the East, in addition to their investigations in the extreme Northwest.

BOTANY.

The study of plants having always been a favorite one with naturalists, the rough botanical work of naming and classifying them has, in Europe, been pretty well accomplished, there being scarcely any new forms to be discovered, except, perhaps, among the Cryptogamia. Botanical study has there, as a consequence, legitimately turned to the structure and functions of the different parts, and our European friends begin to look down, perhaps a little too proudly, on systematic work, which is not less essential than the other, and must always precede it. As Americans we have enough to do yet to master the mass of material, and, while not neglecting anatomy and physiology, must needs study the forms, their development and affinities. Thus the *Flora of California*, the first part of which has just been published in the report of the California Geological Survey, gives a most important and long-needed account of the vegetation of the Pacific coast, so different in many respects from that of the eastern part of the continent. The Gamopetalæ are by Gray, and the Polypetalæ by Watson and Brewer. Up to this time we have had no connected history of the Flora of the whole United States. The classical Flora of Torrey and Gray, published nearly forty years ago, but never completed, remained far behind the progress of the science. Later work has been scattered in numerous isolated journals or other publications—often difficult of access. Botanists, therefore, hail with delight the announcement that Prof. Gray has now passing through the press his *Synopsis of the Flora of N. A.* It is eagerly looked for both at home and abroad. Many other laborers in this field have, during the year, contributed their share, and the papers presented by Mr. Meehan to the Philadelphia Academy of Science are particularly noteworthy. Mr. Meehan is conservative, and does excellent work. An ardent observer, he seems to delight in the discovery of exceptional facts that seem opposed to the general observations and conclusions of some of the leading workers in botany, and from this tendency not unfrequently attaches too much importance to such exceptional facts, but even misconstrues the real facts. In recent papers on the "Fertilization of Flowers by Insect Agency," he has insisted on the scarcity of insects in the Rocky Mountains, and the non-scarcity of seed in the colored flowering plants there. In truth, however, as I know from my own experience and that of others, no region is richer in pollinigerous and pollinizing species,—the Hymenoptera, and the Mordellidæ and the Meloidæ in Coleoptera, being exceedingly abundant, and the Diptera also abounding, especially the more hirsute Tachinidæ, that are particularly well adapted to carry pollen. Our honored member, Dr. Engelmann, has given us an exhaustive paper on the interesting Agaves, naming one of the most elegant species after our esteemed fellow-citizen, Mr. Henry Shaw; also a preliminary study of the difficult American Oaks, which is a most valuable and highly appreciated contribution to the classification of the genus.

Few who have not done similar work appreciate the amount of labor and close application in the closet which such a philosophical resumé implies, of a subject that has before been treated of at so many hands; and it is interesting to note that in this, as in all other monographic work where large experience is brought to bear, the tendency is to greatly reduce the number of previously accepted species, and thus add weight to the assumption of evolutionists, that species have a conventional rather than a real existence in nature.

In cryptogamic Botany, the articles by Prof. W. G. Farlow in the Bulletin of the Bussey Institution are noteworthy. The work of the microscopist to the department of Agriculture in this line has often been open to criticism; and, after the fungus caricatures and unimpressive dissertations that have on some occasions appeared in the pages of the reports from said Department, it is refreshing to read Prof. Farlow's papers on Black Knot, Grapevine Mildew, and other destructive funguses.

EVOLUTION.

The visit of Prof. Huxley to America must be looked upon as an event in the progress of evolution in this country—not that he laid before us anything new, but because he brought in succinct form, and so conspicuously before the public, some of the best arguments in favor of the doctrine. All great truths that oppose long established popular belief must needs belong to the few when nascent. Struggling to overcome the embargo which prejudice and ignorance always set in their path, they at last win acceptance from the mass of thinking men, who by that time wonder how there could ever have been serious objection to the new light. The doctrine of evolution has very nearly reached this second stage: and it must be gratifying to those who from the first accepted Darwin's conclusions, to be able to witness the revolution that has taken place on the subject in the minds of naturalists, and is fast taking place in the minds of the people. Seven years ago, in discussing the theory of natural selection as exemplified in two of our common butterflies, I stated my belief that the idea of the development of species by a conceivable process would in time not only supersede the old idea of special creation, with naturalists—that it would come to be recognized as a law: but that the liberal-minded theologian would come to revere the names of men like Darwin, who help to a higher conception of creation, "instead of anathematizing them, and charging to their doctrines those atheistic tendencies which in times past have been vainly charged to those of so many other great, clear-thinking, discovering minds." Late events have justified the belief. Future events will, I believe, justify it further, since, in my humble opinion, the idea of evolution is founded on fact, and, like a gem freed from the deposits which for ages have hidden its lustre, will shine all the brighter as the obstacles which surround it are removed by the light of truth.

Professor Gray has done good service in bringing together his various essays on Darwinism under the title of *Darwiniana*. Always interesting and enjoyable, Professor Gray tells heavily against the popular but erroneous idea that Darwinism is atheistic, by showing how ably it may be supported by "one who is scientifically and in his own fashion a Darwinian, philosophically a convinced theist, and religiously an acceptor of the 'creed commonly called the Nicene' as the exponent of Christian faith." In treating of the considerations which have led so many working naturalists to accept the derivative hypothesis, Prof. Gray uses the following language, which I strongly commend to those who find fault with Darwinians for not discussing or attempting to explain the remote origin of life: "They leave to polemical speculators the fruitless discussion of the question whether all species came from one or two, or more; they are trying to grasp the thing by the near, not by the farther end, and to ascertain, first of all, whether it is probable or provable that present species are descendants of former ones which were like them, but less and less like them the farther back we go."

GEOGRAPHICAL.

Explorations in many unexplored or little known parts of the world have been carried on, and the different Government expeditions in our own country have been particularly active. The return of the British Arctic Expedition created an unusual interest, and the scheme which Capt. Howgate, of the Signal Service, has lately advocated for successfully reaching the North Pole, by establishing temporary colonies north of lat. 81° N., near the shore of Lady Franklin's Bay, is well worthy the consideration of Congress.

METEOROLOGICAL.

The tornado in Warren County, Iowa, was among the most serious and disastrous that have been known in this part of the country, and that in St. Charles County, in our own State, was quite severe; but all our meteorological excesses dwindle into insignificance as one reads of the terrible nature of the late hurricane in the East Indies, which engulfed whole islands and towns, and sent hundreds of thousands of human beings to untimely death.

The meteor that passed over this region, from S.W. Kansas to N.W. Pennsylvania, on the evening of the 21st of last December, was one of the most brilliant ever witnessed here.

The work of the Signal Service continues to grow in popular favor and in usefulness, and the appearance of the volume just published by the Smithsonian Institution, entitled "Tables of the Distribution and Variation of the Atmospheric Temperature in the United States," marks an important event in Meteorology.

The Meteorological Congress, assembled at Vienna in 1873, submitted a proposition urging the establishment of stations for taking one simultaneous observation daily, of such character as to be suitable for the preparation of synoptic charts. Immediate organization was begun, and by July 1, 1875, when the first International map was issued from the Signal Office at Washington, reports were received from 268 stations, so distributed as to carry the observations all around the Northern hemisphere on land. Since that time the number of stations has been increased to 397, and now, with the view of further extending the system, General Myer has succeeded in getting the coöperation of the Navy Department, which has issued orders to commanders of all vessels to have one observation made daily on all ships, wherever situated, at 7:35 A.M., Washington mean time. It is hoped that the similar coöperation of all nations will be received.

OUR TRANSACTIONS AND PROCEEDINGS.

At the annual meeting for 1873 we resolved from that time forth to publish the Journal of Proceedings in installments of sixteen pages, and that it be the Recording Secretary's duty to prepare an official report of said proceedings for the press, the pages to be numbered in Roman numerals. This was accompanied by other resolutions providing for the speedy publication of papers accepted for the Transactions. The object sought by the resolution was to keep the work of the Academy before the world, and to encourage contributors by giving them printed copies of their contributions as soon as possible. The different signatures are to be kept by the publishers until such time as enough have accumulated to make a number. There is indeed much to be gained in this gradual method of publishing, over the former custom of waiting till sufficient material for a number had accumulated; and it is to be regretted that we have not issued one or two signatures of Proceedings since our last number was distributed. The custom of publishing an official abstract of our Proceedings in the *Western*, to some extent renders less urgent the strict carrying out of said resolutions, and the editors of the magazine deserve our sincere thanks for their courtesy; nevertheless, the reports therein published are necessarily condensed, and I would respectfully call our Recording Secretary's attention to the resolutions. Many of the subjects discussed at our meetings are interesting to the public, but lose much by the time our Transactions are distributed, and we should endeavor to let shine what little light we may possess, and not to be too exclusive. We should also endeavor to send out at least one number of our Transactions each year, however small the number may be, or even if composed principally of proceedings. We owe it to the large number of home and foreign societies which so liberally exchange with us.

OUR LIBRARY.

Our library increases rapidly with the annual addition of our exchanges, and forms to-day the only general collection of scientific works in the city, and the best west of the Alleghanies. For two or three years very little work has been done upon it, except as the Academy has appropriated money therefor. Our Librarian has been at the same time Librarian of the Public School Library, and his care, or rather non-care, of our exchanges has neither deserved nor received much praise. While, however, we may regret that Mr. Bailey has, from cause whatsoever, taken little interest in the Academy or its library of late, it must not be forgotten that he has excuse: 1st. In the stated lack of shelf room; 2d. In our agreement with the Public School Board, one clause of which reads as follows: "All books in the form of collections or libraries which are deposited by said parties in the building aforesaid to be placed under the care of the managers of the Public School Library, to be kept together and used as a reference library exclusively; members of the Public School Library to have the privilege of using said collections; members of the organizations owning said collections or libraries to pay the same fees that annual subscribers to the Public School Library pay (not to exceed three dollars per annum), provided that said members use said collections; said libraries and collections to be classified and catalogued by parties owning the same, or at least under their direction."

BUILDING—MUSEUM.

Soon after we were burned out of house and home, in May, 1869, the Board of Public Schools most generously offered us quarters, and we have regularly met ever since in this Polytechnic building, and had our library and the remnant of our museum herein deposited. Our meetings were first held in the northeast corner room of the third floor, then in the southeast corner of the same, and, finally, in this session room. An agreement was entered into between the Academy and the Board in December, 1868, and as, by some strange oversight, no copy thereof was transferred to the minutes, there are few of our members who fully understand the terms of agreement. From the original document, which I have been at some pains to procure, and which I lay before the Academy for preservation in its archives, it appears that neither party to the contract can dissolve it until notice has been given at least six months prior by the party intending such dissolution to the other party of the contract. In this connection, it is proper to recall that nearly five years ago, or in February, 1872, Dr. J. B. Johnson encouraged us to believe that a gift of $1,200 or $1,500 might be made to the Society: whereupon he was appointed a committee of one to act on the subject. As we have never had a definite report, I would suggest the dismissal of the committee. Subsequently, by deed dated June 8, 1872, the late James H. Lucas donated to the Historical Society and the Academy a lot of ground for building purposes on the south side of Locust street, in block 515. Unfortunately the deed was conditional, and unless built upon within five years after conveyance of the deed, the lot reverts to the donor. This, added to the fact that two societies are equally to share the lot, may perhaps explain why the gift has hitherto remained unavailable. Soon after the donation there were held frequent meetings of a joint committee from the two societies, appointed to get subscriptions and obtain plans and estimates for a building. By direction of this committee, two plans for a building have been made—one at an estimated cost of from $60,000 to $80,000, the other at from $40,000 to $50,000. At a joint meeting of the two societies, December 2, 1872, a separate Finance Committee was appointed, consisting of S. B. Johnson, Silas Bent, and Albert Todd, on the part of the Historical Society, and Dr. McPheeters, Mr. Lynch, and Enno Sander, on the part of the Academy. A stock subscription book has been opened and $1,200 subscribed; beyond this, little if anything has resulted from the labors of this committee, and I would suggest the appointment of a fresh one. This question of a building is most vital to the success of our Academy. By the terms of the deed, the Lucas lot is subject to forfeiture by the 8th of June next, unless by that time the erection of a building for the uses of the societies shall be begun in good faith, and completed "without unreasonable delay," and it is for us to determine whether to forfeit our claim, or make a vigorous effort to secure it for all future.

Nothing is so essential to our prosperity as a permanent abode, where we can have our meetings in the midst of our specimens and surrounded by our library. Such surroundings have a stimulating influence, and the museum increases the interest of papers or discussions by furnishing illustrations. The early prosperity of the society was in no small measure due to the commodious rooms granted by Col. O'Fallon, and we must never expect greatly increased prosperity until we settle in quarters of our own. I care not how plain and unpretending a building we commence with. Let it only be recognized as the St. Louis Academy of Science, and we shall receive a support from the citizens of St. Louis such as we can hardly hope for under existing circumstances. Under the protection of the Board of Public Schools our library and cabinet are lost on the public as a distinctive feature of the Academy, and they are, and have been for some time, so cramped that there is no possible room for expansion. Go to New York, Buffalo, Albany, Philadelphia, Boston, Cambridge, Baltimore, Chicago, San Francisco, and the museum is one of the city institutions. Instructive as well as entertaining, it is one of the first things sought by the visitor from abroad. Many minor towns have their museums; and yet St. Louis, the fourth city of the Union, still lacks one. Are we not ourselves largely to blame? I cannot believe that the wealthy men of this city are so lacking in public spirit and liberality that they would, if properly appealed to, refuse to rear a structure that would be a credit to us and to them. The Academy of Science is one of the institutions of St. Louis, and in proportion as it is honored before the world, in that proportion does the city profit. "Cast thy bread upon the waters, for thou shalt find it after many days." The liberal support of an academy of science, the proper encouragement of scientific research, are among the things that not only redound to the honor and credit of a community, but which may be, and almost always are, productive of increased material welfare and prosperity.

The comforts and conveniences of present civilized existence are almost entirely due to achievements in the domain of science, applied to human requirements; and the field of discovery is still open before us. When the State of New York supports a State Museum of Natural History at Albany, and the City of New York appropriates $500,000 for a museum building; when Philadelphia subscribes a still greater sum for a like purpose,—surely St. Louis ought not to beg long for $40,000! St. Louis, by her central position, would naturally attract and receive the bulk of the very rich treasures constantly gathered from the bosom of the Mississippi Valley, did she offer inducement to collectors in the way of a substantial and safe museum building. She centres a region unsurpassed in the wealth of its archæological, ethnological, geological, mineralogical, and natural history specimens; and the records of the past fascinating history of this valley, which rightfully belong to us, have been and are now fast passing from our reach, and enriching Eastern and foreign museums. For reasons sufficiently apparent, many of the most successful collectors of museum material remain single, or, if married, are intestate; if the collector have a family, the children generally inherit different tastes. In either case the tendency on the part of such collector is to will his collection to some institution that will duly care for and appreciate it. Without a building we cannot profit by this tendency. But the need of such a building is urgent and obvious, and I am glad that, by recent resolution, the next meeting of the Academy is set apart for consideration of this subject.

I shall not anticipate that discussion by giving you in advance my views as to the best ways and means of obtaining one; but let me express the hope that something feasible and practical will result from it.

WHAT HAVE WE ACCOMPLISHED?

Many of our citizens, and some who are good paying members of the Academy, but who do not attend its meetings, occasionally ask, "What have we done. or are doing?" The cry of *cui bono?* is always heard in this practical age. Our Society, for reasons already stated, bounded into prosperity soon after its organization. The war and the fire checked that prosperity, and we lost a museum that was fairly representative of the general Zoölogy and Botany of this region, and contained many valuable specimens in Comparative Anatomy, Ethnology, Palæontology, Geology, and Mineralogy. Since the fire we have been creeping along slowly but progressively, and, notwithstanding there is room for improvement, we have

JUST CAUSE FOR CONGRATULATION.

When I go back in mind to my early connection with the Academy, and remember the trials of 1869, when, in mourning the loss of workers like Shumard and Baumgarten, in addition to that of our museum, scarce a half dozen of us gathered around our ever faithful Recording Secretary. the late Spencer Smith; when our Associate Members numbered not fifty, and we were in debt and unable to publish our Proceedings; when I recall those critical days, and then consider what we have done in the past few years, I feel that we have cause for congratulation. We have during the year published No. 3 of vol. iii. of the Transactions, and, as our Corresponding Secretary's report shows, there is an increasing demand for the different numbers of our publications, 385 numbers having been disposed of by exchange and 35 numbers sold. This number contains, with many fine illustrations, articles on the following subjects:—Iron Manufacture in Missouri, Schmidt; Remarks on Canker-worms and Description of a new Genus in Phælænidæ, Riley; Notes on the Natural History of the Grape Phylloxera, Riley; On a New Form of Lecture Galvanometer, Nipher: Notes on Agave, Engelmann; Notes on the Yucca Borer, Riley; The Rocky Mountain Locust and the Season of 1875, Broadhead; The Meteor of December 27, 1875, Broadhead; Archæology in Missouri, Conant; Age of our Porphyries, Broadhead; Oaks of the United States, Engelmann.

Among the minor communications of the year the following may be mentioned:—Meteorology of 1875, Engelmann; American Antiquities, Holmes; Porphyritic Rocks of Southeast Missouri, Broadhead; Mounds of New Madrid, Conant; Meteorology of March, Engelmann: On Distribution of Errrors in Numbers written from Memory, Nipher; Oviposition of *Leucania unipuncta*, Riley; Man and the Elephant in Nebraska, Holmes; Grape and Oak Fungi, Engelmann; Periodical Cicada, Riley; Entomological Notes, Riley; Centennial Insects, Riley; On Lignites, Potter; Binocular Vision, Nipher; Geographical Range of Species, Riley;

Sago Palm, Engelmann; On the most Favorable Manner of applying Muscular Work, Nipher.

During the year we have elected 19 Associate and 6 Corresponding Members, and we now have 2 Life and 109 Associate Members. Death has taken 3 members from us, viz., Mr. Pomeroy, Mr. A. Steitz, and Dr. M. M. Pallen, one of the founders of the Academy. We have paid out $120.31 for archæological work, $94.62 for cataloguing and other work on the library, and $525.08 for publishing our Transactions. There is, nevertheless, a balance in the treasury of $159.71.

THE JETTIES—CAPT. EADS.

Our Academy may also feel justly proud of the magnificent engineering achievements of one who has twice honored the chair which I now resign, and whose fame will never fade so long as our city has a history. The result of Capt. Eads's work in building the South Pass jetties has not only demonstrated the soundness of the theory on which he has acted, but has already secured an open channel to the Gulf of Mexico more than twenty feet in depth and two hundred feet in width. This gives to the distinguished projector of this great national work his first payment of half a million, and the work still goes on, deepening and widening the channel from day to day. Its complete consummation, with a permanent channel of thirty feet, will be worth untold millions to the West and to the whole world.

CONCLUSION.

And now, not to weary you, let me say that, while we lack many of the material requirements of an efficient scientific body, we have a rich and boundless field for observation before us. It has been frequently remarked in Europe that the scientific work of institutions is, in intrinsic value, in inverse ratio to the magnitude of their buildings, or elegance and costliness of their Memoirs. Let us take courage from this experience, and remember that our present inability to build up the more outward evidences of labor does not neccessarily preclude real investigation.

Unfortunately, such outward signs, together with immediate usefulness, are more apt to invoke popular favor and support than the quiet pursuit of science for truth's sake. The brilliant discoveries of a Morse, a Fulton, a Stephenson, a Faraday, which invoke universal admiration, are the exception, and few men not engaged in the work of science appreciate what she is accomplishing for the amelioration of the race; and our business men, engrossed with their daily commercial pursuits, and frequently duped by scientific charlatans, are too apt to consider scientific men visionary and impractical. Did they pay more deference to science—did they more liberally encourage scientific work,—they would suffer less from such pretenders. Only those who have made some progress in knowledge become aware of how little they know, and are able to discriminate between the bogus and the real; and the failure to thus discriminate has been productive of more loss to our commerce, and our industries generally, than would have liberally endowed all the scientific institutions in the land.

As Dr. Draper, in his late address before the Chemical Society, well remarks:—"There are among us some persons who deprecate science merely through illiterate arrogance; there are some who, incited by superficiality, * * * dislike it; there are some who hate because they fear it, and many because they find it in conflict with their interests. * * * Let us not return railing for railing; but, above all, let us deliver unflinchingly to others the truths that Nature has delivered to us." Let us, I may add, as members of the Academy, endeavor to teach that, while man is the interpreter of Nature, science is its right interpretation. Let us, in entering this, the twenty-first year of our Academy's existence—this second centenary of our republic, so darkened by political complications—determine to do all we can for the advancement of science, which is the great power of the age.

The election of officers then took place, with the following result:

President—Charles V. Riley.
1st Vice-President—George Engelmann.
2nd Vice-President—Silas Bent.
Corresponding Secretary—Nathaniel Holmes.
Recording Secretary—F. E. Nipher.
Treasurer—Enno Sander.
Librarian—
Board of Curators—W. B. Potter, G. J. Engelmann, J. R. Gage.

Geo. W. Letterman presented the Academy with the egg-case of a shark, and some mollusk shells, from Atlantic City.

The names of Prof. Crunden, Dr. O. C. Bates, and B. I. Van Court, were proposed for associate membership, while those of Gustavus Hilgard, J. Weber, and John Koelle, were proposed for corresponding membership.

February 5, 1877.

C. V. Riley, President, in the chair.

Thirteen members present.

The President stated that, at a former meeting, the Academy had resolved to make the consideration of securing a proper place for the Academy meetings the special order of business for the present meeting.

After transacting the business of the evening, the following elections were made: Prof. F. M. Crunden, O. C. Bates, and B. I. Van Court, were elected Associate Members; and G. Hilgard, and I. Weber, of Belleville, Ills., and John Koelle, of Berkner Station, Ills., were elected Corresponding Members.

February 19, 1877.

C. V. Riley, President, in the chair.

Eight members present.

Dr. Engelmann presented several botanical publications to the Academy in behalf of Agostino Todaro, of Palermo; also a number of concretions, resembling *unio* shells in form, from Walter H. Darby.

Dr. Engelmann stated that a specimen of *Agave Shawii*, described by him in former papers, is now in bloom in the greenhouse of Mr. Shaw. This plant came from the Mexican boundary line south of San Diego. The scape has been growing since August last, and is now about 7 feet high and nearly 3 inches through. Although the individual flowers are not showy, the plant as a whole is very striking in appearance.

Judge Holmes gave an interesting resumé of recent researches on the geographical distribution of animals, and was requested to prepare a paper on the subject for publication in the Transactions.

Prof. H. C. Ives and Charles Taylor were elected to associate membership.

March 5, 1877.

C. V. Riley, President, in the chair.

Ten members present.

Mr. Hilder introduced to the Academy Mr. F. W. Sidney-Hamilton, late of the British navy, who entered into an interesting relation of his observations and experiences in Southeastern Africa. He stated that about five years ago he had taken a trading and exploring company up into the regions of the Limpopo and Zambeze Rivers, and into the Blueberg Mountains. His progress was checked by the ravages of the tsetze fly, which is so fatal to horses and cattle, and he remained for several days in an almost circular valley of considerable extent at the foot of the Blueberg Mountains. He noticed a ridge of rock that had the appearance of a wall or fortification, and seemed to almost encompass the valley, and, on inquiry among the Kafirs, he learned that it was the remains of an aqueduct that had some time or other supplied an extensive city with water. The wall in some cases crossed crevices or depressions, and then, instead of continuing as a solid wall, it was continued by a row of pillars, on the top of which rested the aqueduct. As viewed from a distance, the workmanship was excellent. He saw nothing resembling the arch in any of these constructions. He was unable to visit the ruins of the city as a war was waging between the native tribes. With his glass, however, he could make out a watch-tower of very old style, built of stone, with elevated lookouts provided with loopholes. He found large quantities of glazed tiles, evidently of ancient manufacture, some of bright vermillion and some of blue color. He also saw very large mounds, evidently artificial. During the few days he remained, many interesting relics were brought to the camp by natives living near the ruins of the old city. One native brought a lot of sweet potatoes in an old bronze helmet: another person brought a very old double-edged sword, of Byzantine style; a piece of breast-plate was also secured. Numerous circumstances went to show that a superior race of people had, many hundred years ago, occupied that valley. Among other things, he got a very small article resembling a "castle" or "rook" in chess, which was made of copper, silver and bronze, and which had evidently been subjected to great heat. The people or tribes who had lived there for many generations could give no account of the people who left these relics, but all admitted that they must have been a very superior race. About the same time, Mauch discovered relics evidently of the same race of people at Zimbava. A rite similar to circumcision is practised among the Kafirs, and the youths are generally taken in numbers to some valley in the mountains to have it performed, while at the entrance to the valley a rock-snake (*Python*) is suspended on a pole. No one seems to have any knowledge as to where or how this custom originated, but it has been handed down from generation to generation.

Speaking of the immense gold resources of the Abyssinian country, he stated that there were old pits that had evidently been dug hundreds of years ago, and that many persons believed that this was the land of the Queen of Sheba. He also stated that fire-arms are not effective in the hands of the natives; for the Kafirs have a notion that a rifle shoots the hardest when the sight is raised highest, and consequently if the enemy is at close quarters the shooting is not effective, the balls invariably passing over the heads of the persons shot at.

Mr. Nipher exhibited a radiometer, and in answer to questions gave some of the results of the latest investigations upon the theory of its action.

Dr. G. J. Engelmann exhibited a sandstone statuette of crude workmanship, which had been handed him by Mr. Lee, of Kirkwood, a Corresponding Member. It was donated by Gen. A. G. Wilson, of Tennessee, and was turned up by a plow on his farm about ten miles from Nashville. Dr. Engelmann said that he knew of only two other such specimens — one owned by Dr. Patrick, of Belleville, and the other by a gentleman at Anna, Illinois. This specimen, like the others, exhibited none of the Indian characteristics, but the features, outline of face, and position, all corresponded with the figures on the pottery made by the Mound-builders.

Mr. Hilder exhibited a miniature copy of the London *Times*, brought to Paris by a carrier pigeon during the siege.

Dr. G. Engelmann made a few remarks in regard to the vernal development of vegetation. He stated that there were marked individual differences in this regard. Several soft maples, near Shaw's Garden, were already far advanced and began to bloom two weeks ago, while others near them are quite backward. He also stated that the extremes of development from year to year were about a month apart. In the years 1842 and 1843, the times of average development were nearly at the observed limits, spring vegetation being over a month later in 1843 than in 1842.

Dr. G. Seyffarth, of Yorkville, N. Y., and L. de Koninck, of Liege, Belgium, were elected Corresponding Members.

March 19, 1877.

A. Todd in the chair.

Eight members present.

The following note from Mr. G. C. Broadhead was read by the Secretary:

METEOR OF JANUARY 3, 1877.

In Sec. 2, T. 46, R. 2 W., Warren County, Missouri, in the valley of a tributary of Charette, about sunrise, whilst Wm. H. Lee, D. McLane, Wilford Lee and John H. Hanna were grinding axes, they heard a sound at first resembling a steam-whistle, approaching from a great distance in the northwest, growing louder as it approached, and somewhat resembling the noise produced by the passage of a cannon ball through the air. Looking up they saw something strike the limb of a tree and fall with a crash to the ground. Approaching the spot, about seventy-five yards from where the men were, they found a mass of broken stone of unusual appearance and hot enough to melt the snow and frozen ground (there was about five inches of snow on the hard frozen ground). The men found the smaller pieces warm, but not too warm to handle. The mass was much broken, and from fragments collected it was estimated to have been about eighteen inches long, sugar-loaf shaped, and weighing something less than a hundred pounds, and having a black crust on it about one-sixteenth of an inch thick. No explosion was heard. Examining the spot, I find that the bolide came from the northwest crushing through the trees, breaking in two a grape-vine one and a half inches in diameter, and a sugar-tree limb an inch in diameter. Striking the side of a tree near the ground, a portion flew off at right angles to the left about sixty or seventy feet, scattering many small fragments about. The main mass went into the ground about four inches, shivering much of it into dust, and throwing many pieces into the dry gravelly bed of a stream sixty feet in front. Many very small pieces were found scattered about, but searchers have picked up nearly all, including those of minute size. I cannot hear that any noise was heard away from the spot, or anything seen.

G. C. BROADHEAD.

Pleasant Hill, Mo.

Prof. Potter exhibited a few fragments of this meteorite which had been sent to him. No examination of it has yet been made, but it appears trachytic, with very fine metallic grains disseminated through it.

H. B. Howland, of Buffalo, and F. W. Putnam, of Salem, Mass., were elected Corresponding Members.

April 2, 1877.

A. Todd in the chair.

Ten members present.

W. B. Potter, chairman of the Archæological Section, made a monthly report, of which the following is an abstract:

The total number of members is at present eighteen, of whom fourteen are Associate and four Corresponding Members.

A valuable collection of stone implements from the Arcadian Valley, in Iron County, Mo., has been presented by Mr. Thomas A. Robinson, of Arcadia.

An expedition has been planned for a thorough exploration of certain mounds of Southeastern Missouri during the present spring, and it is to be desired that the Academy aid in the enterprise.

The Academy voted the sum of one hundred dollars ($100) for the use of the Section.

Dr. G. Engelmann made the following report on

THE METEOROLOGY OF MARCH, 1877.

After a very cold December, 10 degrees below the average of 42 years, and a cold January, 2½ degrees below the average, we had a very mild February. 4½ degrees above the average, and by the mildness of that month the character of last winter was so much modified, that it was not one of the coldest in that period; still it fell nearly 3 degrees below the average, and only six winters out of forty-two were colder, among them those of two, four, and five years ago.

February was so very constantly moderate, that the temperature in the warmest part of the day always ranged above the freezing point. Animal as well as vegetable life felt the genial influence of coming spring. Geese and swans returned northward. Bluebirds appeared again, and on the 17th I observed open blossoms on a number of soft maple trees (*Acer dasycarpum*), while our elms a few days afterwards prepared to burst their buds. But colder weather soon checked them, and March with 9 degrees on the 4th, 6 degrees on the 9th, and heavy snows on the 8th and especially on the 24th, put us back seemingly into mid-winter. Thus these maples and elms are not in bloom yet; the earlier were killed, and the later have not yet recovered.

The winter was an extremely dry one, especially in December, and also in February; but March has given us (and the agriculturists are especially thankful for it) plenty of rain and snow — nearly four inches — while the three preceding months together had not more than half as much.

Theodore C. Link, Augustus Krieckhaus, and Oscar W. Collet were elected to associate membership.

April 16, 1877.

Dr. Geo. Engelmann, Vice-President, in the chair.

Fourteen members present.

The Corresponding Secretary read a letter from Dr. L. de Koninck, with acknowledgments for his election as Corresponding Member.

The Corresponding Secretary read by title a paper by Dr. G. Seyffarth on "The Correction of the Present Theory of the Moon's Motions, deduced from the Record of Classic Eclipses," which was referred to the Publication Committee.

Mr. Nipher exhibited an apparatus designed to give an alarm in case of fire breaking out in a building, a bell being guaranteed to strike as soon as there was heat enough to perceptibly raise the temperature; also an apparatus which would infallibly detect any negligence on the part of a night watchman in making his rounds. In his explanation he said:

The best way to prevent the loss of life and property by fire is to prevent the fire. There are two methods of discovering fires in their early stages: one by the use of night watchmen, the other by the use of automatic heat-alarms. Either of these means may be used alone, but it is better to combine them. For controlling the movements of the night watchman many devices have been put before the public. Without stopping to point out the particular failings of any of them, I only need to say that the instrument should fulfill these two conditions: it must be so constructed that it will not get out of order; and, second, it must be so arranged that the watchman cannot tamper with it without immediate and certain detection. This instrument which we have here, invented and manufactured by Chas. Heissler, fulfills both of these conditions in a very satisfactory way. It requires a battery in the office, from which two wires lead to each station the watchman is to visit, connecting them with a key. Connection is also made in the same circuit with a recording instrument, kept in the office. The watchman makes his rounds, changing all the keys, turning them all to the right and then to the left in successive rounds. The changing of the keys reverses the current in the recording instrument, where a little pencil at the completion of each round marks a line on a time-dial showing when the watchman finished his round. Should any one key be omitted, the circuit will be open and no record made. If the current is closed twice in succession without the reversal of the keys, it is shown on the recording instrument.

The heat-alarm is an instrument which, by ringing a bell, indicates any rise in the temperature of the surrounding atmosphere. The instrument can be adjusted, if desired, so as to ring the bell on the approach of a man, the radiant heat of the human body being sufficient to affect the instrument at a distance of two feet. The heat of a spirit lamp will set it ringing from a distance of two feet. The instrument can be most delicately set in basements and places where an even temperature is maintained. It can be set for any temperature, and has been successfully introduced into hotels.

The principle of the heat-alarm depends upon the unequal expansion of brass and steel. Two strips of these metals, four inches long, are soldered together along their entire length. One end being fastened to a firm support, the warping of the bar on being heated or cooled is made to close a circuit and ring a bell. Of course, it may be used as a cold-air indicator.

Mr. Nipher asserted that these instruments had been brought to such perfection, that any building which was worth protecting might easily be so protected that it need not burn. If the heat-alarm is delicately adjusted in a place where the temperature varies greatly, it will occasionally give an alarm when there is no fire. This is, however, a necessary failing in all fire-alarms, and need not occur often. The city fire department is also troubled in this way. Where the instruments are put in solely to bring down the rates of insurance, it may often happen that this will be the only good secured, for they are readily adjusted so that they will neither give false alarms nor real ones. The contacts in the instrument are all of platinum, and its simplicity of construction in only equalled by its delicacy.

Dr. Seyffarth sends the Academy five photographs of the sarcophagus which, thirty years ago, he purchased in Trieste for the Academical Museum at Leipzig. The sarcophagus is of cedar wood, and has preserved its specific odor during a period of 3400 years. It contains nearly 3000 figures, cut in demi-relief with great skill. The photographs are said to represent every line of the original.

Silas Bent presented the Academy with twenty-two exceedingly fine specimens of Corundum from North Carolina. He remarked that this is the only locality where Corundum is found "in place."

Chas. K. Ramsay was elected to associate membership.

May 7, 1877.

Dr. Geo. Engelmann in the chair.

Sixteen members present.

Dr. G. I. Engelmann, chairman of Committee to confer with

Managers of the Mercantile Library with a view to securing accommodations for the Academy, reported that considerable progress was being made in the negotiations.

Mr. Hilder, Secretary of the Archæological Section, made a verbal report of the proceedings of the section during the past month, giving an interesting account of the explorations now being conducted by the section in New Madrid Co.

Dr. Geo. Engelmann read a proposition from the Department of Agriculture offering to donate to the Academy a set of specimens of American woods, provided that they be exhibited in proper cases and the collection be accessible to the public.

On motion, it was resolved that the offer be accepted, and that the collection be placed for the present in the St. Louis Museum of Arts and Sciences.

H. A. Voelkner, Dr. Ambrose F. Everett, Willis N. Graves. F. E. Roessler, and Gen. J. H. Simpson, were elected Associate Members.

May 21, 1877.

C. V. Riley, President, in the chair.

Seventeen members present.

Mr. Collet presented in behalf of the Abbé Cyprian Paraguay, of the Bureau of Religious Statistics, Canadian Government, four volumes of the Census of the Dominion of Canada, 1870–71.

Mr. Hilder made a verbal communication on the symbolic meaning of certain decorations found on the pottery of the Mound-builders.

The President was instructed to invite the American Association for the Advancement of Science to hold its session of 1878 in St. Louis.

Prof. Nipher exhibited Hipp's electric clocks, showing the method of transmitting uniform time to a system of clocks.

On motion, Mr. Collet and Judge Holmes were appointed a Committee to confer with other organizations in regard to the erection of a building for their common use.

Samuel M. Green, of Cape Girardeau, and F. M. Dyer, of Charleston, Mo.. were elected Corresponding Members.

June 4, 1877.

Dr. Geo. Engelmann in the chair.

Twelve members present.

Dr. Geo. Engelmann made the following communication on the Meteorology of the past spring, remarking that differences between his observations and those made either in the heart of the city, or farther out into the country, are readily explained by radiation from buildings and pavements, and the prevention of terrestrial radiation by smoke-clouds.

The temperature of the spring months, March, April and May, was low, and in consequence of the development of the spring vegetation late, as we all know. We may recollect that the spring of last year was earlier, and especially the month of May much warmer; we then at once come to the conclusion that this present was the coldest and latest spring. But meteorological records will teach us differently; they also inform us that it was not the wettest spring, nor the wettest May, on record.

The average temperature for May *in St. Louis* is 66.2 deg.: that of this year was 63.5. The coolest May I have observed was in 1838, also in 1867, with 60.5 deg.; and the warmest, in 1860, with 72 deg. Three times in 42 years May was cooler than this year (in 1838, '57, '67) and three times of the same temperature. It will be noted that these low temperatures in May have come almost every ten years; for 1847 the temperature was the same as this year. I have tried to ascertain whether this seeming periodicity holds good for the whole spring, or the whole year, or for other months of the year, especially for October, which is considered as conforming pretty nearly to the mean temperature of the year; but I have failed to confirm such a supposition.

The temperature of March was 5.8 deg. below the average for the month, that of April 2.0, and of May, as has been stated, 2.7 below; the whole spring, consequently, was 3.5 deg. below the average; and I find only five springs in 42 years cooler than the past one (those of 1837, '43, '57, '67 and '75). But the mean temperatures are not so important to us as the extremes are: under the extremes we suffer most, we ourselves individually as well as through their action on vegetable life and development. March was wintry almost throughout, but in April we had only a few days, in the beginning of the month, of hard frost; at the same time the temperature rarely rose over 70°; only once, on the 23d, it rose over 80°: but on the last day a frost, light in the city, but severe in many localities in the neighborhood, did some damage to the vegetation. In May the temperature was also moderate, often scarcely warm enough for the season, and with me only rose up to 86°, while in the city it reached 90°.

The past month of May appeared a very wet one, not only to us inhabitants of the city, but perhaps still more so to those that live in the country. The fall of rain, however, was not so very heavy, scarcely more than

$2\frac{1}{2}$ inches, while the average rainfall for May is here $4\frac{1}{2}$ inches, such as it was in 1875 and 1873, in 1872 even $6\frac{1}{2}$ inches: but lighter rains fell very often, for the first sixteen days of the month almost daily, so that the ground during that period never could become dry.

The greatest average rainfall is always to be expected in this region in June, and the first few days of this month seem to verify this old experience, and may harm the farmer and cause the rivers to overflow. I will not go back further than to remind you that in 1875 we had over 10 inches and in 1873 nearly 9 inches of rain in that month. The average I find to be 5 inches.

Mr. Hilder exhibited a long-necked vessel of the form so commonly taken from the mounds, the decoration of which is quite elaborate. The groundwork is red, on which, near the base of the neck, is inscribed in a darker red, four crosses surrounded by circles. Two of these, which are 180 deg. apart, are surrounded by a representation of the sun. The lower part of the vessel is also decorated with small circles, some of which do, and some do not, contain a cross within them.

Col. Croswell gave an account of his expedition, promising a paper for the next meeting.

E. M. Bosley was elected an Associate Member.

June 18, 1877.

Dr. Geo. Engelmann in the chair.

Nine members present.

W. B. Potter, chairman of the Archæological Section, made a monthly report of the work of the Section, of which the following is an abstract:

As the result of the expedition to S.E. Missouri, carried on by the Section, 326 specimens of pottery have been obtained, an engraved shell of great interest, 18 skulls, and a number of bones of associated animals, besides a large amount of valuable information.

The Section has undertaken the publication of a work, on the ancient remains of this region, to be composed of several parts, as follows: Part I. to include results of surveys of mounds and other works, with sketches and sections, accompanied by descriptive text; Part II., Description of the Pottery found, with lithographs of characteristic and peculiar forms; Part III., Human and other animal remains; Part IV., Implements.

Mr. Croswell read a paper on "Mound Explorations in Southeastern Missouri," which was referred to the Publication Committee.

W. B. Potter exhibited specimens of copper implements from Wisconsin, and iron ore celts from Missouri.

Caleb Croswell, Chas. A. Pearce, Geo. O. Carpenter, and Geo. Class, were elected to associate membership.

October 1, 1877.

Dr. G. Engelmann in the chair.

Nine members present.

Dr. G. Engelmann made the following report on

THE TEMPERATURE OF THE SUMMER.

The last week was hot, and so were a few days in the middle of the month. But we have had much warmer Septembers; and the average for this month, 68.8 degs., did not even come up to the average for September in 42 years, which I have found to be 69.1 degs.; the warmest September I have observed was that of 1865, with 75.5 degs., the warmest day of that month indicating 93.5 degs. But in other years the temperature rose still higher yet; in 1872 to 96 degs., and in 1864 to 102 degs. The coolest September I have observed was that of 1865, with only 63.2 degs. mean temperature.

In October the temperature has several times risen to over 90 degs., and as late as 1872 it reached 89 degs., on October 3rd.

And now about the summer temperature, our impression is that it was a delightful cool summer. And so it was also according to thermometrical observation. The following little table shows that every month was a little below the average, not so much as to make it a cold or uncomfortable summer, and it gives also the warmest and the coolest summer months and summers in 42 years:

	1877.	Av. 42 Yrs.	Highest	Date.	Lowest	Date.
June	74.1	74.7	78.8	1876	70.3	1839 1863
July	78.7	79.2	83.5	1854 1874	73.7	1848
August	75.1	76.7	81.4	1851	72.7	1875
Summer	76.0	76.9	80.1	1854	73.7	1848

Mr. Croswell exhibited an engraved tablet, and three vessels, the decorations of which were quite unique. They will be figured in the Atlas of Missouri Archæology, now in preparation by the Archæological Section.

October 18, 1877.

C. V. Riley, President, in the chair.

Fifteen members present.

F. E. Nipher made a communication on "The establishment of a Missouri Weather Service."

This Service is shortly to be established under the auspices of Washington, which is to be regarded as the "central station." For the present, only stations of second grade will be established, the observations being made upon rainfall, cloudiness, wind and phenomena, such as early and late frosts, the flowering of common trees, very high or low temperatures, etc. Special blanks will also be issued for the record of phenomena observed during storms.

The observers will also report upon the success of various crops in their respective counties, with the causes of failures.

Forty-eight* persons in different parts of the State have already volunteered to make such observations. The observations will begin Dec. 1, 1877. As soon as practicable, a system of stations of higher grade will also be established, where more complete instrumental observations will be made.

Mr. Nipher also made a communication upon "A Cheap Recording Instrument for Robinson's Anemometer and the Anemomescope," of which the following is an abstract:

The design of this instrument is to record the number of miles of wind during each twenty-four hours, and to record the direction of the wind at the completion of each mile.

The battery circuit is completed as usual through the dial of the anemoter, passing thence to the shaft of the wind-vane, and thence by one of eight wires (corresponding to the eight principal points of the compass) to the recording magnets. These are four in number, provided with double coils (as in the relay of the duplex telegraph), each coil being connected with one of the wind-vane wires, and with the battery. A change of the current from one to the other coil of the same magnet reverses the polarity of this magnet. The magnets are provided with polarized armatures the polarity of which is not reversed. The armatures are held midway between the poles of their respective magnets by means of delicate springs, and carry recording pencils which are in contact with a revolving drum. Each armature (by its vibration to right or left when the circuit is closed in the anemometer) registers two different directions. The revolution of the drum is *regulated* by the descending weight of a common 24-hour

* This number has now (Nov. 20) increased to seventy.

clock, the moving power being a weight, from which a string passes around the axle of the drum. The drum rotates once in 12 hours. At the end of this time the clock strikes for 12 hours, and, as the striking is finished, the descending clock-weight strikes a spring, releasing a weight which deflects the revolving drum longitudinally half an inch. The drum is then in position to record the succeeding 12 hours. This instrument can be extemporized in any properly equipped laboratory.

LOCUST EXPERIENCE.

Mr. Riley made some extended remarks on the locust problem, of which the following is a synopsis:

During his recent trip to British America, he had been able to clearly define the Northern limit of the insect's permanent breeding grounds as not extending beyond the third prairie steppe or plateau. It often extended in its migrations across the second and first prairie steppes, but very rarely reached beyond the North Saskatchewan. The experience of the year had been most valuable, and matters relating to the Rocky Mountain locust had turned out precisely as he had, from time to time, anticipated. In his studies of this insect he had previously been able to deduce three general rules which might be stated as laws governing the insect in the Lower Missouri and Mississippi valleys. These were, first, the Northwest origin of the more wide-spread and disastrous swarms; second, the return migration toward the Northwest of the insects that hatch in the country South of the 44th parallel and East of the 100th meridian; third, the Eastern limit of the insects' spread, at a line broadly indicated by the 94th meridian. All these rules had been strengthened and borne out by the present year's experience. Mr. Riley was now able to add a fourth rule, viz., that this locust seldom, if ever, lays eggs thickly for two consecutive years in the same locality. He remarked that there was a deal of consolation in this rule for our Western farmers, since it was a guarantee that a year of thick hatching and great devastation will be followed by a year of immunity.

MITE TRANSFORMATIONS.

Mr. Riley gave an account of his observations and experiments on *Astoma gryllaria* LeBaron.

He has, during the summer, proved by experiment that, as he first suggested over three years since would be the case, this little six-legged mite, which preys parasitically on the winged locusts, is the larval form of ***Trombidium sericeum*** Say, a larger, eight-legged mite that preys upon the eggs of the locust. Hatching from minute eggs laid in loose masses in the ground, ***Astoma*** the form crawls on to the locust, fastening and swelling as a tick does on a dog. The ***Astoma*** at last drops from the locust to the ground, where it slowly goes through its transformation into the ***Trombidium***. As wherever the locusts abound this ***Trombidium*** also necessarily prevails upon the ground ready to pounce upon the locust eggs, it is no wonder that the female locust instinctively avoids such localities in ovipositing.

Hon. Henry Overstolz, Jno. B. Maude, and Judge Chas. Speck were elected members.

November 5, 1877.

The President in the chair.

Ten members present.

Dr. Geo. Engelmann announced a paper on the *Agave Shawii*, giving a verbal outline of the same, and presenting lithographs to accompany the same. Referred to the Publication Committee.

Mr. Riley then read a paper "On the Larval Characters and Habits of the Blister-beetles belonging to the Genera *Macrobasis* Lec. and *Epicauta* Fabr.; with Remarks on other Species of the Family *Meloidæ*": followed by a short paper, entitled, "On a remarkable new Genus in *Meloidæ* infesting Mason-bee Cells in the United States."

Mr. Riley also read by title the following papers, which with those previously named were referred to the Publication Committee: "Additional Notes on *Megathymus yuccæ*"; "Further Remarks on *Pronuba yuccasella*, and on the Pollination of Yucca"; "On the Differences between *Anisopteryx pometaria*, Harr. and *Anisopteryx æscularia*, W.-V., with Remarks on the Genus *Paleacrita*."

Dr. Engelmann remarked that during the present night the temperature of the air would fall below 32° F. for the first time during the present autumn. During the last 40 years, there have been 10 years, when, as in the present year, there has been no black frost in October. In other years such frosts have occurred as early as Oct. 2d, but not earlier.

H. W. Tivy was elected to associate membership.

November 19, 1877.

The President in the chair.

Nineteen members present.

Dr. Forbes laid before the Society, as a contribution from Mr. F. A. Brewer, of Santa Barbara, California, a specimen of the tarantula.

With reference to this giant among spiders, Prof. Riley stated that it was the *Mygale Hertzii*, and that there was an erroneous impression prevailing as to the effects of its bite. It was not as deadly as was generally presumed. Wherever this spider occurred it was followed by a peculiar digger-wasp (*Pepsis formosa*) that preyed upon it. The female wasp was armed with a formidable sting, and. awaiting her opportunity, she thrust it through the back of the spider. The effect was instantaneous, the spider falling over paralyzed and helpless. This was the immediate effect, but there was another still more wonderful. The tarantula was not killed, but reduced to a state of coma, and would survive for a long period if not utilized for food by the wasp's progeny. The wasp, after stinging the spider, would drag it to a hole dug by her, and, after laying her egg under it, would cover it over. The wasp larva preyed upon the food thus carefully provided.

Mr. Riley read a paper on "A new Oak-gall on Acorn Cups," which was referred to the Publication Committee.

Mr. R. D. Grant, of the Missouri Pacific R.R., exhibited to the Academy specimens of wood and masonry showing ravages made by some insect, of which he also exhibited specimens. The rafters of an engine-house of the Missouri Pacific R.R. had been so injured that the roof had to be removed; and the cement of the brick walls, built 14 years ago, was found to be perforated in all directions.

Mr. Riley determined the insect to be the common White Ant (*Termes flavipes*), and mentioned several other similar cases of its ravages that had come under his notice. He also read the following communication

ON THE OVIPOSITION OF SAPERDA BIVITTATA SAY.

Notwithstanding all that has been said and written of the Round-headed Apple-tree Borer (*Saperda bivittata*), which is one of the worst insect enemies of the orchadist, its eggs have never hitherto been described. Nor has anything that is at all accurate bee*n* published of its mode of oviposition. The egg is pale rust-brown in color. 3 mm. long. $\frac{1}{3}$ as wide in middle, flattened so as to have a depth of about $\frac{1}{3}$ the width. The shell is fairly tough and resisting: it is not sculptured, but is sufficiently plastic, when laid. to receive impressions from the wood fibres between which it is pressed. The embryo lies straight within the shell, and the newly-hatched larva differs from the full-grown larva in size alone.

The female beetle makes an incision in the bark, causing it to be split from $\frac{1}{5}$ to sometimes $\frac{1}{2}$ an inch. The incision is often made entirely through the bark, and the egg is thrust between the bark and the liber at right angles to one side of the slip, from $\frac{1}{8}$ to $\frac{1}{4}$ of an inch from the aperture. Sometimes the bark is but partially penetrated, in which case it is pried open to one side of the aperture for the reception of the egg. In either case the egg is accompanied by a gummy fluid which covers and secures it in place, and usually fills up the aperture. In young trees, with tender bark, the egg is usually thoroughly hidden; while in older trees it is sometimes so shallowly embedded as to be readily seen. The ovipositor of the female beetle is withdrawn and invisible in repose, but may be exserted. It is horny, broad, flattened, with a thin edge. It is probably strong and sharp enough to penetrate soft bark without any previous work of the jaws, as I can find no sure indication of mandibular action in the punctures I have examined.

Dr. G. Engelmann submitted for publication a paper on "The Junipers of North America, including Mexico." The Doctor said the most common of the junipers of this country was the red cedar, though the name of cedar was a misnomer. It was no relative to the cedar of Lebanon, and bore no resemblance to it. It had probably been given its name by the early settlers on account of its wonderful durability, and perhaps by reason of its fragrance. It was the only species of conifer found in so wide a a range, extending from ocean to ocean.

Dr. G. Engelmann spoke as follows on the

GEOGRAPHICAL DISTRIBUTION OF NORTH AMERICAN FLORA.

It is well known that the broad belt of timberless land which stretches from the Hudson Bay regions across the valleys of the Upper Mississippi, Missouri and the western confluents of these rivers through Texas and into Mexico, separates the floras of the *eastern*, *wooded*, from the *western*, *mountainous*, regions of North America. This belt has a flora of its own, which, singularly enough, is little influenced by latitude, at least in its prevailing features, many of the characteristic plants stretching from Manitoba down to the Rio Grande.

The Atlantic and Pacific floras are so completely separated by this belt that scarcely any species of tree of one side is found on the other. Our Red Cedar constitutes one of the very few exceptions.

The Eastern Flora is generally divided into the strictly Atlantic Flora and that of the Mississippi Valley. The former includes that of the Alleghany Mountains down to their western declivities, and to the headwaters and upper valleys of the western streams.* What we may call the Flora of

* Among the interesting facts connected with this floral limit is that the true *Quercus Prinus* is not found west of this line of demarkation, while westward it is represented by

the Mississippi Valley extends westward as far as our common timber trees do, and down into Texas.

In this connection, Dr. Engelmann spoke of the change of the character of the original Floras through the agency of man. On the Atlantic coast and in the adjacent country the English settlers evidently introduced many of their weeds, nearly 300 European species being now more or less naturalized. more or less widely spread there. Not half of them have thus far made their way to the Mississippi, but every year some new immigrants arrive and make themselves at home here. Spaniards and Frenchmen brought with them to the Gulf coasts a few other intruders, and Spaniards again brought others into California, some of which, e.g. the wild oats (*Avena fatua*) and the little cranebill (*Erodium cicutarium*) have completely overrun the country, so that for a long time they were considered indigenous.

In the great seaports, another mode of introduction of foreign plants has lately attracted a good deal of attention: I mean that by means of the ballast of ships coming from distant countries, or wool, hides, hay and other products brought by them. Very few of such plants, however, have become naturalized or have spread; they remain only as temporary or adventitious members of our Flora.

A recent means of extending the area of plants is through cattle droves from the southwest, and especially through the extension of railroads. In this way a good many southwestern and western plants have found their way into Missouri. Such foreign plants often take hold of extensive grounds as "the fittest to survive," to the detriment of the native Flora.

It is, therefore, important to observe and note the original Flora of a new region at the time of its first settlement, and then watch the progress of the gradual change which pasturing and cultivation of the soil and the various pursuits of man do produce. I have to some extent done this in this neighborhood, and can say that I have seen great changes in the local Flora during the 45 years in which I have been acquainted with it. Some plants have disappeared, others have come in—and weeds of all sorts have vastly increased: a fit subject for a future paper.

December 3, 1877.

The President, in the chair. Twenty members present.

The Academy was presented with a mound skull, a stone axe, and two flints, the gift of Capt. W. P. Hall, of the Davenport Aca-

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Q. Muhlenbergii, which, however, also extends eastward, though in a limited degree. The same may be said of *Vitis Labrusca*, which is properly eastern, but is found also on the headwaters of streams flowing westward; farther west it is represented by *V. æstivalis*, common to both floras, some western forms of which have often been mistaken for *Labrusca*.

demy of Science. The skull was found 8 ft. below the surface, in a mound on Buffalo Creek, two miles below Louisiana, Mo.

It was remarked by Mr. Hilder, that the marked posterior flattening shown by this skull was artificial.

Dr. G. Engelmann gave the following

REPORT ON THE METEOROLOGY OF NOVEMBER, 1877.

The month of November, just past, was generally considered a mild and a rainy month; but, referring to my records, I find that its mean temperature of 41 degrees (at my station on the outskirts of the city) is considerably below the average, which is nearly 43°. November of 1870 had a mean temperature of 46°.5; 1867, 48°.2, and 1849, even 51°.8, the warmest November I experienced here. On the other hand, ten Novembers in 42 years showed less than 40° mean temperature, that of 1838 only 34°.2, the coldest of all.

The moisture and fall of rain was considerable; but with me not more than a little over 3 inches, which is about the average for the month. I have found the rainfall varying from 8.63 inches in 1847, 7.48 in 1869, and 6.24 in 1850, to 1.10 in 1845; 0 91 in 1875 to no rain at all in 1865.

The mean temperature for the autumnal months I found 55°.8, which is very nearly normal. As September and November were a little cooler than usually, this is owing to the higher temperature of October, which was nearly 3½ degs. above the average.

Mr. Nipher remarked that the anemometers located at the Signal Service Office, and at Washington University (distant from each other less than a mile), frequently varied in their daily rates as much as 50 miles in a run of 250 miles. These differences compensate each other in two or three weeks, so that the monthly rate is not appreciably affected. He had mounted one of the signal service anemometers upon the University building, and found the two instruments to agree satisfactorily in their daily readings: but, even here, gusts of air were found to vary the rates for smaller intervals of time.

It will be the subject of a future investigation to determine the relation between the distance between the two instruments and the time required for the differences to compensate each other.

Dr. Herman Nagel was elected to associate membership.

December 17, 1877.

The President in the chair. Sixteen members present.

The following paper was read by the President:

ON MIGRATORY BUTTERFLIES.

Many quadrupeds that multiply rapidly often acquire the migratory propensity. This is especially true of rats and lemmings, of the migrations of vast numbers of which numerous interesting accounts are recorded. Many insects, normally non-migratory, also exceptionally congregate and migrate in vast swarms; and this is especially the case with butterflies, flights of which, and particularly of the Yellows (genera *Callydrias* and *Colias*) and the Whites (genus *Pieris*), have been reported from Equatorial and South America, and from different parts of Europe. Vast flocks have also been observed at sea. The newspapers in the Southwest and the Signal officers were constantly reporting the passage over Iowa, Kansas, Missouri and Texas of swarms of butterflies during the months of September and October last. These consisted, in every case were determinations were made, of the Archippus butterfly (*Danais Archippus*), which is the principal species known to thus migrate in North America.

In an account of the swarming of this butterfly, published in 1870 (*3d Mo. Ent. Rep.*, p. 151), I wrote as follows:

"It would be difficult to give any satisfactory reason for this assembling together of such immense swarms of butterflies. * * * There are two significant facts connected with them from which some corollary might be deduced, namely, that only those species which have a very extended range are known to form such flocks, and that they always travel, under these conditions, in a southerly or southwesterly direction.

"Mr. Bates* gives an interesting account of the uninterrupted procession of butterflies belonging to the genus *Callydrias*, which passed from morning to night in a southerly direction across the Amazon, and, as far as he could ascertain, these migratory hordes were composed entirely of males."

As I have abundantly proved by examination of specimens since the above was written, the individuals composing the swarms of our Archippus butterfly comprise both sexes; if anything, the females prevail. No satisfactory explanation of these swarms has been given, but I think they are, for the most part, due to an instinctive tendency to reach a warmer country in which to hibernate, and to a failure of food in the country where they developed. The flights almost always occur in the autumn, when the milk-weeds (genus *Asclepias*), upon which alone the larva of this butterfly feeds, have perished. The instinct to propagate is, therefore, at the time in abeyance. The butterflies, unable to supply themselves with sweets from flowers, are either attracted in quantities to trees that are covered with honey-secreting plant-lice or bark-lice, or else they must migrate southward, where flowers are yet blooming. All insects acquire the migrating instinct when crowded together through excessive multiplication. The Archippus butterfly hibernates within hollow trees and in other sheltered situations. Southerly timber regions offer most favorable conditions

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* Naturalist on the River Amazon, vol. 1, p. 249.

for such hibernation. Under the most favorable conditions a large majority perish. A portion of the females survive the winter. Such hibernated individuals, upon awaking from their winter torpor, make at once for the prairies, where the milk-weeds most abound. Faded, and often tattered, they may be seen flying swiftly over such prairies, for the wings of the species are strong and large. I have no doubt but that they travel thus for many hundreds of miles, keeping principally to the north, and, ere they perish, supplying the milk-weeds here and there with eggs. A fresh brood is produced in less than a month, and these extend still farther north, until we find the species late in the growing season as far up as the Saskatchewan country, where it can scarcely successfully hibernate, and from whence the butterflies instinctively migrate southward. We can thus understand how there are two, three or more broods in southerly regions, but only one toward British America.

The exceptional flights noticed in the spring, and which, so far as recorded, take place quite early and in the same southerly direction, find a similar explanation. They may be looked upon as continuations of the autumn flights. Hibernating in the temperate belt, the butterflies are awakened and aroused, upon the advent of spring, to find the milk-weeds not yet started; and they instinctively pass to more southerly regions, where the spring is more advanced. In short, these migrations find their readiest explanation in the instinct of the species to lengthen the breeding season and to extend its range, and the prevailing winds at the particular seasons are of a character to assist it. There is a southward migration late in the growing season in congregated masses, and a northward dispersion early in the season through isolated individuals—this dispersion keeping pace with the advance of spring toward the north. It is a notable fact that the two butterflies which most display this migratory instinct, viz., the species in question and the Painted Lady (*Cynthia cardui*), have the widest range of known species. This last is cosmopolitan, occurrring in all four quarters of the globe; while our Archippus, originally confined to America, though ranging from Canada to Bolivia, appears to be following the milk-weeds, wherever these are, through chance or purpose introduced. It has lately spread over some of the islands of the Pacific to Queensland and New Guinea, and over the Azores to Europe—such spread necessarily indicating great power of long-sustained flight, since the milk-weeds are not plants of commercial value, and it is highly improbable that the species has been carried in any of the preparatory states on ships.

It was suggested by the President that the Missouri Weather Service might render itself useful in noting the migration of birds, animals, insects, etc.

Dr. G. Engelmann presented some engravings from an English journal of a microscopic fossil fungus of the carboniferous formation allied to *Peronospora infestans.*

In consequence of some recent statements by Prof. A. J. Cook, of the Michigan Agricultural College, the President desired it to go on record that he totally disagreed with the Professor as to there being any connection between the work of *Phylloxera* and the ordinary grape-rot.

Dr. G. Engelmann then read a paper on the "Firs of North America."

Mr. E. H. Long and Dr. J. H. Leslie were elected to associate membership, and Prof. R. D. Irving of the University of Wisconsin was elected Corresponding Member.

GENERAL INDEX.

☞The italic figures refer to the Proceedings.

ERRATA.

CORRECTIONS AND ADDITIONS.

Page 24, line 33. Mr. Baker gives 150–180 as the number of leaves of *Y. recurvifolia.*

" 26. " 5. They are *always* thus tipped, much more sparingly in some species than in others; hair usually 1-celled, sometimes articulated.

" 27. " 20. The ovules of *Y. Treculiana* are among the thickest of any.

" 28, " 11. Read "does" for "seems to."

" 29. " 8. Dr. Engelmann found the pods of *Y. aloifolia, Treculiana, baccata,* and *brevifolia,* perforated and the seeds eaten by the larvæ.

" 32, " 17. Read "2.0" for "2.5."

" 33. " 23. They reach nearly to the same northern latitude.

" 34. " 27. Add to "floribus," "pendulis."

" 42, " 22. Leaves of young plants nearly flat, whence discrepancies in descriptions.

" 46. " 2. Dr. Wislizenus ascribes to them the same height.

" 26. They rather belong to or near *Y. angustifolia*: only the fruit will decide.

" 48. " 33. Read "subnudis" for "nudis."

Yucca spinosa, HBK. n. gen. i. 289, is made up of the flower of a Yucca and the leaves of *Dasylirion acrotriche.* (See p. 24, note.)

Yucca acaulis, HBK. ib., is a *Fourcroya.*

Yucca? parviflora, Torr. Bot. Mex. Bound. 221, constitutes the genus *Hesperaloë*, Engelm. King Bot., 40th par. 497.

" 81. " 14. Strike out the "a."

" 121. " 3d from bottom, for "ĸ" read "♄."

" 349, " 12, for "*scoparius*" read "*furcat.*"

" 351, ¶ 3, line 1, after "*Globe-Democrat*" add "correspondent from St. Joseph."

" 382, line 3d from below, read "Wheeler's" for "Whipple's"; other errata in this article are corrected on p. 387 and farther on.

" 390. " 11th " " " "Pluk." for "Pluck."

" 428. " 15, read 22h. instead of 22d.

" 430, " 2, " 24ˢ " 24.

" 432, " 3, " +412 " —412.

" 433, " 2, " +692 " —692.

" 434, " 2, " +715 " —715.

" 435, " 5, " +6+8+759 " —6.

" 436, " 3, " +38+40+791 " —38.

" 448, " 4 from below, read "were" instead of "was."

" 450. " 13, read "—43" instead of "—41."

Page 465, line 11 from below, read "Sunday" instead of "Monday."
" 473, " 5 " " " τινῶν instead of τινών.
" 477, " 12, add καὶ εἴκοσι ἐτῶν.
" 479, " 6, read "*non*" instead of "not."
" 541, " 20, read "Verrières" for "Verrière."
last line, " "*coccinea*" for "*tinctoria*."
" 585, under the figures, read "Fig. 7," "Fig. 8," for "Fig. 7 & 8."
" 589, line 15, read "DC." for "De."
" 17, " "Schlechtendal's" for "Shlecktendal's."
" 8th from below, read "Sitgreaves'" for "Sitgreave's."

Page xliii. line 10, for "bunches" read "branches."
" liv. " 6, for "cynthta" read "cynthia."
" lxxix. " 13, for "*piscidium*" read "*piscicidium*."
" cxxxix. " 14, for "Mellenchamp" read "Meliichamp."
" cxciii. " 27, for "arsenate of copper" read "arseniate of soda."
" ccxxxix. " 14 from bottom, for "of light" read "to light."

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CORRECTIONS AND ADDITIONS.

Page 24, line 33. Mr. Baker gives 150–180 as the number of leaves of *Y. recurvifolia.*
" 26, " 5. They are *always* thus tipped, much more sparingly in some species than in others; hair usually 1-celled, sometimes articulated.
" 27, " 20. The ovules of *Y. Treculiana* are among the thickest of any.
" 28, " 11. Read "does" for "seems to."
" 29, " 8. I have found the pods of *Y. aloifolia*, *Treculiana*, *baccata*, and *brevifolia*, perforated and the seeds eaten by the larvæ.
" 32, " 17. Read "2.0" for "2.5."
" 33, " 23. They reach nearly to the same northern latitude.
" 34, " 27. Add to "floribus," "pendulis."
" 42, " 22. Leaves of young plants nearly flat, whence discrepancies in descriptions.
" 46, " 2. Dr. Wislizenus ascribes them the same height.
" " 26. They rather belong to or near *Y. angustifolia*; only the fruit will decide.
" 48, " 33. Read "subnudis" for "nudis."
" 81, " 14. Strike out the "a."
" 121, " 3 from bottom. For "ĸ" read ♄.

Page xliii, line 10, for "bunches" read "branches."
" liv, " 6, for "cynthta" read "cynthia."

Yucca spinosa, HBK. n. gen. I. 289, is made up of the flower of a Yucca and the leaves of *Dasylirion acotriche*. (See p. 24, note.)

Yucca acaulis, HBK. ib., is a *Fourcroya*.

Yucca? parviflora, Torr. Bot. Mex. Bound. 221, constitutes the genus *Hesperaloe*, Engelm. King Bot., 40th par. 497.

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