University of the State of New York

NEW YORK STATE MUSEUM

Fiftieth Annual Report

OF THE

REGENTS

1896

VOL. 1

REPORT OF DIRECTOR, BOTANIST AND ENTOMOLOGIST

TRANSMITTED TO THE LEGISLATURE FEBRUARY 5, 1897

ALBANY
UNIVERSITY OF THE STATE OF NEW YORK
1898

University of the State of New York

REGENTS

STATE OF NEW YORK

No. 48

IN SENATE

FEBRUARY 5, 1897

FIFTIETH ANNUAL REPORT

OF THE

NEW YORK STATE MUSEUM

To the Legislature of the State of New York

I have the honor to submit herewith, pursuant to law, as the 50th annual report of the University on the New York State Museum, the reports of the director of the museum, of the geologist and paleontologist, of the botanist, and of the entomologist, with appendix.

ANSON JUDD UPSON
Chancellor

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NEW YORK STATE MUSEUM.

Report of the Director, 1896.

REPORT OF THE DIRECTOR.

ALBANY, N. Y., *Sept.* 30, 1896.

To the Honorable the Regents of the University of the State of New York:

GENTLEMEN.—I submit herewith my report for the fiscal year just ended.

Owing to the reduced condition of the appropriation for the State Museum, the year has been to some extent one of disappointment, inasmuch as the work originally planned could not be carried out; but a marked improvement has been made in the condition of several of the collections, and with the promise of additional funds for our work, the outlook is more encouraging. The personal work of the Director during the first part of the year, was devoted to the completion of the Bulletin on the Mineral Resources of New York which was distributed last April, and which also appears as an appendix to the Forty-eighth Annual Report of the State Museum, now in press. The remainder of the winter months were occupied in supervising the work on the mineralogical and palaeontological collections and in gathering material for the publications in preparation. These are, a bulletin on "Road Materials in New York" and a guide to the geological collections of the Museum.

On account of the total lack of funds for obtaining new information, these publications have progressed but slowly, but they will be finished during the coming year.

During the past summer, the Director made an examination of the gypsum quarries near Mumford, New York, the sandstone quarries at Medina and the salt works at Syracuse; he also attended at Buffalo, the meetings of the National Education Association and the American Association for the Advancement of Science. At the request of the Chairman of the State Museum Committee, the preparation of a catalogue of geological museums in the United States and Canada has been undertaken, and the first draft is herewith communicated.

The Museum assistant, Mr. J. N. Nevius, has kept a diary of his detailed work, and from this record the greater part of the following report is prepared.

A large part of the time of the assistant curator during the past fiscal year has been occupied in giving to the collections a more scientific arrangement and a more attractive appearance.

The principal work has been the rearrangement of the palaeontological collection on the second floor; the collection of nuclei for a synoptical geological collection, and for a collection of birds' nests with eggs; the determination of specimens (chiefly mineralogical) brought to the Museum for identification; the distribution of loan collections of minerals to institutions under the University; and the installment of several important additions to the collections.

The work on the palaeontological collection of New York state occupied all of the winter months. The specimens had been mounted on wooden blocks covered with paper. This had become badly soiled and faded, as had also the labels, which could be read only with great difficulty. The collection had, besides, not kept pace with the progress of this science, in the last few years, so that much of the nomenclature was out of date.

A supply of terra cotta "ingrain" wall-paper was obtained and cut to fit the blocks. The specimens were then removed, a few at a time, and the blocks covered with the new paper; the labels were revised and rewritten, the old name appearing in parenthesis where possible. The authority chiefly used for this work was "North American Geology and Palaeontology," by S. A. Miller; referring doubtful cases to the "Palaeontology of New York."

Several unrecorded figured specimens were found. These were labeled with a green diamond-shaped lozenge, bearing numbers referring to volume, plate, and illustration where figured in the "Palaeontology of New York."

In returning the specimens to the cases, they were arranged in their natural classes; the lowest class in a geological horizon being placed first, and so upward to the highest form; the genera being arranged alphabetically.

The block bearing each specimen is numbered (under the label), and the same number occurs on both the old and new label. The old labels are stored in the order in which they were removed, and by this system of numbering, can be produced at a moment's notice.

During the year five field excursions were made by Mr. Nevius in the interests of citizens of the state.

Mr. W. A. Ray, of Rayville, Columbia county, had a deposit of impure bog-ore (limonite) on his farm, which he wished investigated, as a possible source of mineral paint. He also wanted some traces of limonite investigated. A trip to the locality revealed the fact that bog-ore was being formed from iron derived by alteration of pyrites in the decomposing Hudson River shale in the immediate vicinity. The deposit was neither sufficiently extensive, nor of good quality for use as a pigment.

The small deposits of limonite were in the Calciferous-Trenton limestone, and gave no evidence of extensive deposits near at hand. They were but small accumulations of limonite along joints and fractures, and were without doubt derived from alteration of pyrite (or possibly siderite) near by.

Other excursions were taken at the request of Dr. E. J. Fisk, of Troy—the object sought being an ore of manganese. At a quarry in the Hudson River shale opened for road-metal, about two and a half miles west of Watervliet, some fairly good specimens of psilomelane had been found. The ore occurs in small, irregular pockets, rarely affording more than a few pounds of ore to the cubic yard. But the shale being badly fractured, as is usual in this region, gave free access to percolating water, and this agent had left a thin, shiny black film of psilomelane on the rock surfaces along the interstices, wherever it could penetrate, so that to a hasty glance the whole rock-front appeared to be rich in manganese.

The other excursions were beyond the boundaries of the state, but further than the collection of specimens for the museum, nothing of importance was accomplished.

During the year five institutions under the State University have been supplied, under the proper authority, with the loan collections of minerals made up from the duplicates of the museum collection.

The institutions supplied are:

1 State normal college, Albany
2 Albany female academy
3 White Plains union school
4 Athens union school
5 Naples union school.

Four new collections of about one hundred specimens each were prepared, two of which are still on hand.

During the winter the storeroom in the basement of State Hall was ceded to the State Engineer and the southeast pavilion on the fifth floor of the Capitol was set apart as a storeroom for museum property. All the duplicate minerals and other property of the museum stored in the basement of the State Hall were removed to this pavilion.

The property of the state on the fifth floor of the Capitol, which was returned from the World's Columbian Exposition, has suffered much from exposure, and required much attention at different times when work on the Capitol necessitated shifting its position. To preserve it from frequent moving and from molestation, the Director applied to the Capitol Commissioners for an assignment of space for its preservation. It has, accordingly, been placed in the two curtain rooms on the east front and fenced in, and is now protected from violence.

The collections of quadrupeds and reptiles have been provided with new and corrected labels, and the specimens have been cleaned.

The unattractive arrangement of the quadrupeds and birds is necessitated by the crowded condition of the museum, as these specimens must now be placed where they will fit, instead of where the proper classification would place them. This gives them the appearance of being in storage, rather than on exhibition to instruct the public.

An opportunity being offered by Mr. Charles Miller, jr, of Grand Rapids, Mich., to exchange New York Unionidae for those of Wisconsin and Michigan, a list was prepared of the duplicates of these shells.

The garnets in the general mineral collection have been studied and the species of each specimen determined and noted on the label.

Mr. G. V. Bailey, formerly with Ward's Natural Science Establishment, and later with the Smithsonian Institution, was employed for about ten days in repairing the fossil vertebrates. He repaired some of the plaster casts which had been broken, and put the Ellenville mastodon tusk in good condition, fixing in place many loose fragments of the interior and of the enamel.

He removed and repaired the right tusk of the Cohoes mastodon and replaced it in its proper position; soaked the dry parts of the skeleton with a thin solution of glue, and coated them with paraffine to exclude the air. His work was highly satisfactory and of great benefit to the specimens.

The case of precious and semi-precious stones has been somewhat rearranged; the labels revised and rewritten.

The collection of shells from Mazatlan, Mexico, presented by P. P. Carpenter, has been cleaned and the broken specimens repaired.

In order to better illustrate the composition, gradation from acid to basic series, and other relations, of the Rosenbusch Collection of Massive Rocks, which is exhibited on the second floor for the use of students; a translation has been made of Rosenbusch's table of massive rocks, and is placed near the collection. This table shows at a glance the essential constituents of the rocks; their gradation into each other; the method of naming the sub-varieties; and the general relations of the rocks to each other.

The drawers in the cases on the second floor have been numbered consecutively, and a catalogue prepared showing briefly the contents of each.

The outer row of table-cases on the second floor contained a series of rocks illustrating the stratigraphic geology of the state, but as this feature is more fully shown in the wall-cases on that floor, it was deemed advisable to use the tables-cases for a new feature.

A scheme has been prepared for an " Introductory " or " Synoptical " geological collection, and the nucleus of the collection has been roughly arranged. This collection purposes to illustrate, as far as possible with the limited space and means at hand, geological terms and definitions; varieties of rocks; conditions of rock formation; appearance due to formation; and the formation of topography.

Specimens, photographs, models, and cross-references to other collections, will be used in illustration. As such an exhibition is a rarity in American museums, and as it would be of great value to teachers having students beginning the study of geology, as well as to intelligent visitors who desire a little insight into this subject, this collection should receive much more time and attention than can be given to it under present conditions. As far as carried out the collection has been arranged according to the following preliminary scheme:

I Rock-forming Minerals

- A Primary minerals which mingle with others to form rock masses
- B Minerals which form entire rock masses
- C Common, but accessory minerals
- D Minerals derived from others by alteration
  - 1 Remaining in situ
  - 2 Transported to a distance
- E Vein-forming minerals

II Rocks

- A Classification of rocks
  - 1 Sedimentary rocks
    - 1 a Fragmental rocks
      - i Formed by weathering and erosion. In parallel series are shown the unconsolidated and the consolidated, as gravel, conglomerate; sand, sandstone; clay, shale, etc.
      - ii Volcanic, fragmental
      - iii Organic fragmental
        - calcareous
        - siliceous
        - carbonaceous
        - ferruginous
        - phosphatic

1 b Crystalline rocks
i Altered sediments
ii Chemical precipitates

2 Massive Rocks

2 a Acid series
(quartz and orthoclase prominent)

2 b Intermediate series

2 c Basic series

(quartz and orthoclase usually absent. Magnesia-iron silicates and basic feldspars predominant)

3 Schistose rocks
(metamorphic rocks)

B Rock characteristics

1 Characteristics of stratified rocks

1 a Lamination

1 b Jointing

1 c Preservation of foot-prints, mud cracks, etc., in strata

1 d Fossils

i Animal life
formation)
) of fossils
preservation)

ii Vegetable life
formation)
) of fossils
preservation)

2 e Coloring

2 Characteristics of crystalline rocks

2 a Micro-crystalline structure
2 b Macro-crystalline structure
2 c Banded structure
2 d Amygdaloidal structure

2 e Porphyritic structure
2 f Basaltic columns
2 g Concentric structure

III Decomposition of rocks
soil formation

When this collection has progressed somewhat further than at present it is proposed to publish a handbook devoted to the subject, to aid the specimens in expressing the illustrations. A synopsis of such a handbook is being carried forward with the additions to the collection.

Another collection, new to the museum, that was started during the past year, is that of birds' nests and eggs. The majority of these were collected by the assistant curator in the vicinity of Albany—the remainder were presented to the museum by Mr. Robert Warwick, of Fleming, N. Y. The nests are mounted on walnut blocks with the natural limb, or tuft of grass, in which the nest rested, placed in its natural position; thus showing the various methods used by the birds in attaching the nests, or in screening them from enemies.

The eggs are placed in the nests in the exact position in which they were discovered—though the natural arrangement of the eggs in the nest appears to follow no law. Specimens of the male and female birds are placed by the nest of their own species.

All the space that can be allotted to this exhibition is already filled. This is to be regretted, as such an exhibition is far more interesting and instructive than isolated collections of the birds, eggs, and nests, and the lack of space to expand this collection is but another illustration of the great difficulties to contend with in giving the museum an attractive appearance, and a higher educational value.

In the appendix to this report will be found a list of this collection, also lists of additions to ornithological and oological collections.

One of the smaller oak cases used at the Columbian exhibition was brought from its storage place in the Capitol, put in repair, and used to exhibit the large specimens of green fluorite, from McComb, St. Lawrence county. This specimen was unfortunately broken in transit from Chicago.

In June, Mr. Eaton, of Canandaigua, was given permission to take measurements and make models of parts of the Cohoes mastodon skeleton. He desired the information in his work of restoring some bones of a mastodon belonging to Vassar college.

To fill a few of the gaps in the general mineralogical collection, a number of specimens were purchased of George L. English, of New York. A list of this purchase appears in the appendix to this report.

A valuable addition to the ornithological collection was the purchase through Ward's Natural Science Establishment of a part of the Austin F. Park collection of birds. Most of those purchased are young birds—which are almost unrepresented in the museum. They were mounted by Ward in the form adopted by the museum, and have been installed in the cases with the old birds of the same species. A list of this purchase appears in the appendix to this report.

A few more specimens of New York state petroleum from the Columbian exhibition were found in the Capitol, and installed with the other specimens on the third floor. A list of the petroleum collection appears in the appendix to this report.

The wall-cases on the second floor containing the stratigraphic geological collection have been cleaned and the specimens put in somewhat more attractive form. This collection needs further attention, to fill gaps and replace inferior specimens.

Many specimens, chiefly geological or mineralogical, have been identified for visitors—and questions concerning them answered.

The need of a proper handbook of the museum, to explain the collections and give a brief sketch of each of the sciences represented, is keenly felt, and will soon be met. Such a pamphlet will add immeasurably to the educational value of the museum, and, being carried home by visitors, will keep up their interest in science and tend to educate their powers of observation.

For the ensuing year the following improvements suggest themselves as being worthy of early attention:

1 The completion of the synoptical geological collection.

2 The advancement of the economic geological collection of the state. (This invaluable addition was started long ago and work suspended on account of lack of funds to gather material.)

3 New cases and an entire rearrangement in the mineralogical department; in order to gain the necessary room to exhibit the excellent collection belonging to the museum—and to make room for future growth.

4 New labels for the minerals. A label with no printing except species and variety name, having blank lines for addition of locality, etc., is contemplated.

5 A rearrangement of the New York state stratigraphic geological collections, and a new set of labels for them.

6 The rearrangement of the collection of ophidia now in the museum.

In addition to this administrative report, the Director communicates herewith two scientific papers, which form an appendix to it. These articles are respectively, The Geology of the Crystalline Rocks of Southeastern New York, and The Origin of the Serpentines in the Vicinity of New York City, by F. J. H. Merrill. A preliminary list of geological museums in the United States and Canada is also printed.

RECORD OF ATTENDANCE AT THE MUSEUM.

From October 1, 1895, to September 30, 1896, total attendance	52,003
Greatest monthly maximum, August	6,268
Greatest daily maximum, September 9	683

Additions to the Museum Collections

Ornithology

A COLLECTION OF BIRDS' NESTS AND EGGS DONATED BY ROBERT WARWICK

COMMON NAME	Scientific name	No. of eggs	Locality
Hermit thrush	Turdus aonalaschkae pallasii, Cab	3	Fleming, Cayuga county
Red-winged blackbird	Agelaius phoeniceus, L	4	Fleming, Cayuga county
Long-billed marsh wren	Cistothorus palustris, Wils	6	Fleming, Cayuga county
Rose-breasted grosbeak	Habia ludoviciana, L	4	Fleming, Cayuga county
Yellow warbler	Dendroica aestiva, Gmel	5	Fleming, Cayuga county

EGGS

DONATED BY ROBERT WARWICK (*continued*)

COMMON NAME	Scientific name	No of eggs	Locality
Vesper sparrow	Poocaetes gramineus, Gmel	4	Fleming, Cayuga co.
Field "	Spizella pusilla, Wils	4	Fleming, Cayuga co.
Song "	Melospiza fasciata, Gmel	4	Fleming, Cayuga co.

COLLECTED BY J. N. NEVIUS

COMMON NAME	Scientific name	No of eggs	Locality
Chipping "	Spizella socialis, Wils	3	Glenmont, Alb. co.
Catbird	Galeoscoptes carolinensis, L	5	Kenwood, Alb. co.
Long-billed marsh wren	Cistothorus palustris, Wils	6	Newark Meadows, N. J.
Rose-breasted grosbeak	Habia ludoviciana, L	1	South Orange, N. J.
Swamp-sparrow	Melospiza georgiana, Lath	4	Bethlehem, Alb. co.
Indigo bunting	Passerina cyanea, L	4	Kenwood, Alb. co.
Chipping sparrow	Spizella socialis, Wils	3	Glenmont, Albany county
Song sparrow	Melospiza fasciata, Gmel	3	Kenwood, Albany county
Baltimore oriole	Icterus galbula, L	...	Kenwood, Albany county
Black-billed cuckoo	Coccyzus erythrophthalmus, Wils	2	Kenwood, Albany county
Swamp sparrow	Melospiza georgiana, Lath	5	Albany
Wood thrush	Turdus mustelinus, Gmel	3	Normansville, Albany county
Wood thrush	Turdus mustelinus, Gmel	4	Normansville, Albany county
Bobolink	Dolichonyx oryzivorus, L	4	Albany
Catbird	Galeoscoptes carolinensis, L	4	Kenwood, Albany county
Red-eyed vireo	Vireo olivaceus, L	4	Kenwood, Albany county
Red-eyed vireo	Vireo olivaceus, L	3	Kenwood, Albany county
Cowbird	Molothrus ater, Bodd. (In nest of Red-eyed vireo.)	2	Kenwood, Albany county
Phoebe	Sayornis phoebe, Lath	*5	Castleton, Rensselaer county
Phoebe	Sayornis phoebe, Lath	5	Ithaca, (1894)
Acadian flycatcher	Empidonax acadicus, Gmel	5	Bethlehem, Albany county
Scarlet tanager	Piranga erythromelas, Veiil	2	Orange, N. J.
Indigo bunting	Passerina cyanea, L	3	Kenwood, Albany county
† Indigo bunting	Passerina cyanea, L	3	Kenwood, Albany county
Oven-bird	Seiurus aurocapillus, L	4	Bethlehem, Albany county
† Yellow-throated vireo	Vireo flavifrons, Vieill	1	Kenwood, Albany county

* Eggs broken. † Contained cowbird's eggs.

Birds

Donated by A. J. McHarg

COMMON NAME	Scientific name	No. of specimens	Sex	Locality
Barred owl......	Syrnium nebulosum, Pors.	1	♀	N. Scotland

By Purchase

COMMON NAME	Scientific name	No. of specimens	Sex	Locality
Red-tailed hawk.	Buteo borealis, Gmel......	1 young	♀	Greenbush
Short-eared owl.	Asio accipitrinus, Pall	1	♂	N. Albany
Saw-whet owl...	Nyctala acadica, Gmel.....	1	♀	E. Albany
Hermit thrush..	Turdus aonalaschkae pallasii, Cab	2	♂ & ♀	Green Island

By Purchase from the Austin F. Park Collection

COMMON NAME	Scientific name	No. of specimens	Sex	Locality
Kumlien's gull ..	Larus kumlieni, Brews.....	1	♀	Green Island
Leach's petrel...	Oceanodroma leucorhoa, Vie	1	♀	Lansingb'g
Ruddy duck.....	Erismatura rubida, Wils...	1	♂	Rens. co.
Corn crake......	Crex crex, L...............	1	♀	Cohoes
Swallow-tailed kite	Elanoides forficatus, L.....	1	♂	Pittston, Rens. co.
Iceland gull	Larus leucopterus, Faber ..	1 young	♀	Lansing'bg
Double-crested cormorant	Phalacrocorax dilophus, Sw. & Rich	1	♂	Troy
Barrow's golden eye	Glaucionetta islandica, Gm.	1	♂	Green Island
American Sparrow-hawk ...	Falco sparverius, L........	2 young	♂	"
Red-shouldered hawk.........	Buteo lineatus, Gmel	5 young 2 "	♂ ♀	Rens. co.
Marsh hawk	Circus hudsonius, L	1 young	♂	"
Sharp-shinned hawk.........	Accipiter velox, Wils	2 "	♂	"
Cooper's hawk..	" cooperi, Bonap...	1 " 1 "	♂ ♀	"
Green Heron....	Ardea virescens, L.........	2 " 1 "	♀ ♂	Green Island
Least Bittern ...	Botaurus exilis, Gmel......	1 young	♂	"

Collected by J. N. Nevius

COMMON NAME	Scientific name	No. of specimens	Sex	Locality
Ruby-throated humming bird.	Trochilus colubris, L.......	1	♂	Kenwood.
Indigo bunting..	Passerina cyanea, L	1	♂	"
Yellow-bellied flycatcher.....	Empidonax flaviventris, Baird	1	♂	"
White-breasted nuthatch	Sitta carolinensis, Lath....	1	♂	"
Maryland yellow throat	Geothlypis trichas L.......	1	♂	"
Canadian warbler	Sylvania canadensis L.....	1	♀	"
Bay-breasted warbler	Dendroica castanea, Wils..	1	♂	"

Mineralogy

BY DONATION.

Quartz Crystal (1) from Theresa, Jef. co., N. Y., presented by J. L. Davison, 55 Waterman st., Lockport.

Bindheimite & Limonite (1) from Arabia Mine, Lovelock, Humbolt co., Nevada, presented by John Bridgford, of Albany.

Magnetite, from Hawley, Franklin co., Mass., presented by W. S. Snyder, of Green Island. In sharply defined, perfect crystals 1-12 inch. Occur disseminated through a disintegrating rock and were collected by "panning."

Magnetite (2) from Shaftsbury, Bennington co., Vt., presented by W. S. Snyder. Has a strongly marked schistose structure and flattened grains. Associated with quartz and epidote.

Carborundum (artificial). Several specimens donated on request by the Carborundum Company, of Niagara Falls.

Graphite (3) from Oneida county, N. Y., presented by W. S. Wright, of Syracuse. Occurring in slightly altered Hudson River shale.

Hornstone (2) from Amsterdam, N. Y., presented by John Hegeman, of Amsterdam.

Psilomelane (var. harzmanganite, Brush) (1) from Mass., presented by W. S. Snyder, of Green Island.

Psilomelane (1) from Shaftsbury, Bennington co., Vt., presented by W. S. Snyder, of Green Island.

Psilomelane (5) } from South Wallingford, Rutland co., Vt., pre-
Kaolin (3) } sented by G. W. Bradley, Manchester Depot, Vt.

Psilomelane (1) from Cleveland, Oswego co., N. Y., presented by C. S. Laraway, of Cleveland, for determination.

Garnet (var. almandite) (2) from N. Carolina, presented by W. W. Jeffries, of Philadelphia.

By Exchange.

Opalized Wood (2), Grass Valley, Nevada co., Cal., and

Rubellite in Lepidolite (2), San Diego co., Cal. Received from Field Columbian Museum in exchange for Triplite from Stoneham, Maine.

By Purchase from George L. English.

Manganite (1), Negaunee, Mich.
Gothite (1), Negaunee, Mich.
Turgite (1), Salisbury, Conn.
Olivine (2), near Webster, N. C.
Insect in Amber (2), Baltic Sea
Amber (1), Baltic Sea
Thaumasite (1), Burger's Quarry, West Paterson, N. J.
Diabantite (1), Burger's Quarry, West Paterson, N. J.
Sal-ammoniac (1), Vesuvius, Italy
Copalite (1), East Indies
Muscovite (1), near Henry, Lincoln co., N. C.
Clinochlore (1), Tilly Foster Mine, near Brewster, N. Y.
Orpiment (1), Mecur Mine, Mecur, Utah
Cuprite, var. Chalcotrichite (1), Morenci, Ariz.
Cyanite, var. Rhaetizite (1), Pfitch, Tyrol
Lorandite & Realgar (1), Allchar, Macedonia
Cronstedtite (1), Cornwall, England
Epsomite (1), Villa Rubia, Spain
Crocidolite (loose fibres) (1), Cochabamba, Bolivia
Crocidolite (1), Griqua Land, South Africa
Pyrite (altered) (1), Pelican Point, Utah Lake, Utah
Leucite (1), Monte Somma, Vesuvius, Italy
Leucite (1), Albana, near Rome, Italy
Leucite in lava (1), Albana, near Rome, Italy
Chalk (1), Dover Cliffs, England
Polybasite (4), Two Sisters' Mine, near Lawson, Colo.
Blue Spinel (2), Island of Ceylon
Natron (1), Lake Texcoco, Mexico
Rhodocrocite (1), John Reed Mine, Alicante, Lake Co., Colo.

BY COLLECTION.

Pyrolusite, psilomelane, magnetite: Several specimens of these minerals with associated rocks were collected in three trips, on request of Dr. E. J. Fisk, of Troy, who was investigating some manganese deposits in this region.

First excursion, three miles west of Watervliet, Albany co., N.Y.

Second; two miles south of North Bennington, Vt.

Third; Charlemont, Franklin co., Mass.

Psilomelane, pyrolusite & limonite: A series of these minerals containing varying percentages of each were collected by J. N. Nevius at the South Wallingford, Vt., Manganese mines, on the request of Dr. E. J. Fisk, of Troy.

Quartz, agate & calcite, amygdaloid, in Triassic diabase. Collected by J. N. Nevius, at Upper Montclair, N. J.

Geology

COLLECTED BY HEINRICH RIES.

Sand from cut south of Spring Hill Grove, S. I.

Cross bedded sand, north of Hastings, S. I.

Hudson River sandstone, from drift on west shore of Great Neck, L. I.

Fossils in concretion, west shore of Great Neck, L. I.

Yonkers Gneiss (2), Westchester county

Sand from cut on Elm Point, Great Neck, L. I., showing faulting and crumpling.

Impare Siderite, (Cretaceous) Elm Point, Great Neck, L. I.

COLLECTED BY J. N. NEVIUS.

River sand, from Hudson River, Albany

River silt, from Hudson River, Albany

Anthracitic slate, Rayville, Columbia co., N. Y.

Siliceous limestone, South Wallingford, Vt.

Newark sandstone, Upper Montclair, N. J.

Hudson River shale, Normansville, Albany co., N. Y.

Shells in mud, Hudson River, Albany

Leaves in mud, Hudson River, Albany

Diabase concretion, Upper Montclair, N. J.

Hudson River shale (decomposing), and soil formed from its disintegration, Watervliet, N. Y.

Alluvium, Hudson River, Castleton, N. Y.

Residual soil formed by disintegration of a quartz magnetite rock, Charlemont, Mass.

Marble, South Wallingford, Vt. (A fresh specimen, one undergoing disintegration, and one of the soil resulting from its decomposition.)

DONATED BY F. W. WESTERMAN.

Clay (4), from Elm Point, Great Neck, L. I.

Lignite & Pyrite, from Far Rockaway, L. I., 409 feet below the surface.

BY PURCHASE FROM J. A. SINGLEY.

The following set of duplicates of a collection of Upper Miocene fossils from the Galveston Deep Well, Galveston, Texas. *These are unique as being the only marine Miocene fossils known from the Gulf slope west of Mississippi.

* See Am. Jour. Sci III Vol 46 pp 39–42. 4th Ann. Rept. Geol Survey of Texas pp 87–95.

No.	No. Specs.	NAME	Authority
112	4 valves..	Eriphyla galvestonensis	Harris
10	6 valves..	Cardium galvestonense	Harris
103	3 valves..	Strigilla galvestonensis	Harris
104	3 valves..	Rangia quadricentennialis	Harris
107	5 valves..	Rangia cuneata, var. galvestonensis	Harris
108	10 valves..	Mactra quadricentennialis	Harris
109	14 valves..	Arca transversa, var. busana	Harris
110	1 spec....	Cylichnella bidentata, var. galvestonensis	Harris
114	1 spec....	Scala galvestonensis	Harris
115	10 specs...	Pyramidella galvestonensis	Harris
127	4 spec....	Phos galvestonensis	Harris
128	8 spec....	Nassa trivigalvesta	Harris
129	9 spec....	Nassa galvestonensis	Harris
130	8 spec....	Terebra galvestonensis	Harris
132	5 spec....	Strombina gibberula, var. galvestonensis	Harris
133	1 spec....	Drillia quadricentennialis	Harris
116	1 spec....	Olivella subtexana	Harris
124	10 spec....	Olivella galvestonensis	Harris
134	2 spec....	Cithara galvestonensis	Harris
135	6 spec....	Bittium galvestonense	Harris
139	3 spec....	Cerithium galvestonense	Harris
143	4 spec....	Cerithium galvestonense, sp. "A"	Harris
145	3 spec....	Cerithium galvestonense, sp. "B"	Harris
146	4 spec....	Cerithium galvestonense, sp. "Y"	Harris
147	2 spec....	Terebra langdoni	Dall.
154	3 spec....	Pleurotoma albida	Perry
155	8 spec....	Natica canrena	Lam.
156	3 spec....	Natica eminuloides	Gabb.
157	9 spec....	Natica duplicata	Say
158	1 spec....	Cancellaria reticulata	Linn.
160	14 spec....	Dentalium quadrangulare	Sby.
161	15 spec....	Dentalium tetragonum	Sby.
162	9 spec....	Crucibulum auriculum (?)	Gmel.
163	3 valves..	Gemma purpurea	Lea
164	4 valves..	Leda concentrica, var. (?)	Say
166	3 valves..	Dreissensia sp. (?)	
167	20 valves..	Lucina crenulata	Con.
168	4 valves..	Lucina dentata	Wood
169	5 valves..	Corbula swiftiana (?)	Sby.
170	12 valves..	Corbula sp. (?)	
171	4 valves..	Arca incongrua	Say
174	14 valves..	Mactra lateralis	Say
175	6 specs...	Conus punticulatus, var. (?)	Hwass
181	10 specs...	Terebra dislocata	Say
183	15 specs...	Oliva reticularis	Lam.
195	12 specs...	Coenangia bella	Con.
196	20 valves..	Balanus sp (?)	

Number of species 47. Species new to science 25. Identified by Gilbert D. Harris.

Exhibit of New York State Petroleum

Part of the State Mineral Exhibit at the World's Fair

LOCALITY OF WELL	Owner	Lot
Alma, Allegany county	McDonald	28
" " "	Davis & Torrey	55
" " "	R. Allen	123
" " "		123
Bolivar, " "		13
" " "		13
" " "		14
" " "	Allen & Sternberg	15
" " "		16
" " "		23
" " "		64
Church Farm, Allegany county		
Clarksville, " "		25
" " "		20
Genesee, " "		18
" " "		29
Scio, " "		5
" " "	J. Mills	8
" " "	" "	8
" " "	Norton	52
" " "	"	52
State Line, Cattaraugus county		
Four Mile, " "	Sims	3
Allegany, " "	Union Oil Co	3
" " "		3
" " "	Laubenthal	10
Carrollton Town, Cattaraugus county		
Greenwood, Steuben county	W. J. Penny	6
" " "	" "	30

Very respectfully submitted,

F. J. H. MERRILL,

Director.

APPENDIX A

THE GEOLOGY OF THE CRYSTALLINE ROCKS OF SOUTHEASTERN NEW YORK.

This paper contains a synopsis of the results of an investigation begun in 1883 and carried on at personal expense till 1890, from which time till 1893, small sums were afforded from the funds of the New York State Museum for continuing the field work. In 1895, there being no museum funds available for this purpose, the Director of the United States Geological Survey contributed $200 for completing the Precambrian and Palaeozoic geology of the Harlem sheet of the United States topographic atlas, embracing the region about New York city. A copy of this Geologic map and of the descriptive text were furnished to Director Walcott and will be incorporated in the New York Folio which is soon to be published.

The preliminary results of the general investigation were published in the American Journal of Science, series 3, vol. XXXIX, p. 389. The geologic mapping of the whole area east of the Hudson in New York was published in the Economic and Geologic map of New York, by F. J. H. Merrill, and in the Preliminary Geological Map of New York*, compiled and published by W. J. McGee, under the direction of James Hall, State Geologist.

The geology of Westchester county is also shown on a scale of four miles to the inch, in the Geologic Map of a Part of Southeastern New York, by F. J. H. Merrill, published in Bulletin No. 15, of the New York State Museum, which also forms part of the 48th annual report of the New York State Museum. This bulletin also contains the Economic and Geologic Map.

In completing the work for the Harlem sheet of the New York folio the writer had an opportunity to review the ground in com-

*The draft for this publication was prepared at the request of Prof. Hall in 1893 and was not revised before engraving, so that it differs slightly from the map of Southeastern New York which contains the results of additional field work.

pany with Prof. C. R. Van Hise and secure his criticism and approval of the principal points discussed.

With the permission of the Director of the United States Geological Survey, the data obtained under his auspices in the field work of completing the Harlem sheet are herewith incorporated.

THE CRYSTALLINE ROCKS OF SOUTHEASTERN NEW YORK.

The crystalline rocks of southeastern New York lie on the east of the Hudson River, in New York, Westchester, Putnam and Dutchess counties, from whence they extend into Connecticut; and on the west of the river, in Orange and Rockland counties, whence they extend southwesterly into New Jersey. The lowest member is a coarse hornblende granite which forms the central mass of the range of mountains known as the Highlands of the Hudson, and, in their highest peak, Breakneck Mountain, is exposed through a vertical height of nearly 1,200 feet. (Pl. I.) With these greater masses of hornblende granite, are associated other local masses of granite comparatively free from hornblende, which are extensively used for building stone. (Pl. II.) These granites are probably igneous and of great age, and on their flanks are branded gneisses consisting chiefly of quartz and orthoclase with biotite and hornblende, containing numerous beds of magnetic iron-ore. The gneisses on the south side of the Highlands (Pl. III) extend through Westchester county in a series of folds with southwesterly trend, and on the northern slope of the Highlands at several places in Dutchess county, are overlain unconformably by Palaeozoic basal quartzites, which are believed to be of Cambrian age and are bordered by Ordovician limestone and slate or schist. Some of the principal valleys of Putnam county contain belts of limestone associated with quartzite and mica schist, which are probably to be correlated with similar rocks hereafter described as altered palaeozoic strata.

From the relation of the quartzite, limestone and schist of Westchester county to the underlying gneiss, which is precisely similar to that of the Palaeozoic strata in southern Dutchess county and

Putnam county to the subjacent gneiss, and from the nearly complete stratigraphic continuity, it is inferred that the crystalline limestone of Westchester county is equivalent to that of southeastern Dutchess county, the age of which has been satisfactorily established by the work of Dwight, Dana, and others to be Calciferous-Trenton, and the schist and micaceous gneiss overlying the limestone by like analogy is considered to be of Hudson river age.

Besides the older granites just mentioned, there are in Westchester and New York counties many later eruptive rocks of considerable areal importance.

Prominent among them is a red granite consisting chiefly of quartz, orthoclase and biotite which is injected into and through the gneiss at many points, and at Sing Sing, through the overlying limestone. In Yonkers township is a large area of reddish granite quite gneissoid in texture, which is intrusive in the Fordham gneiss.

The mica schist has been specially subject to igneous intrusions. Within its areas occur the Cortland series of diorites and norites described by J. D. Dana* and Geo. H. Williams,† the Harrison diorite described in detail by H. Ries,‡ the serpentines which are altered eruptives and certain gray granites which occur in domes, bosses and lenses in the southernmost part of Westchester county. Near the shores of Long Island Sound the Manhattan schist is everywhere injected with bands, lenses and dykes of pegmatite, granite, amphibolite and pyroxenite.

All the stratified crystalline rocks above described, with the possible exception of the Fordham gneiss, were originally sediments laid down in horizontal strata, the quartzite representing a beach deposit, the limestone, a deposit in water unaffected by wash from the land and probably of warmer temperature, and the schist a deposit of sandy mud in shoaler water. These three rocks form a reliable record of a period of subsidence of the land and transgression of the sea with subsequent recession and emergence.

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*Am. Jour. Sci. III, Vol. xxii 1881 pp. 103–119.
† " " " xxxi 1886 pp. 26–41.
xxxiii 1887 pp. 135–144; 191–199.
‡ Trans. N. Y. Acad. Sci., Vol. xiv., 1895 pp. 80–86.

At a time or at times not accurately determined, but which probably began not later than the Upper Silurian, and may have continued at intervals to the end of the Palaeozoic, these horizontal strata by lateral pressure were thrown into parallel folds throughout a broad belt of country having a general northeasterly trend and with the Palaeozoic beds, the underlying rocks of greater age were also folded. As the cross sections show, the folds are closely compressed and in many cases are overthrown to the eastward and westward, so that frequently the rocks on both sides of the fold dip in the same direction. Associated with the longitudinal folding of these rocks was a transverse folding, the general result of which was elevation at the northward, so that the parallel ridges with their intervening valleys as a rule, pitch or slope very gently to the southwest. There are local variations from this general condition and some of the folds have locally a northward pitch, but the general condition may be noticed in the western ridges of Fordham gneiss which in the town of Yonkers attain a height of 300 feet, and on Manhattan Island pass below the sea level and do not reappear.

As already stated these rocks may be classified in the following manner:

CRYSTALLINE ROCKS.

Ordovician:

1 Manhattan schist, containing garnet fibrolite, kyanite and staurolite.

2 Inwood limestone, crystalline dolomite, containing diopside and tremolite.

Cambrian:

Lowerre quartzite

Precambrian.

- Algonkian? Fordham gneiss
- Archaean
  - Gneisses
  - Granites

For detailed examination of these formations, it has been necessary to depend largely on the exposures along the east shore of the Hudson river and those in southern Westchester county and on New York Island. In central, eastern and northern Westchester county, the quaternary deposits of stratified and unstratified drift are so thick and extensive that the outcrops are few. The localities discussed are therefore chiefly confined to the vicinity of New York city.

The stratified crystalline rocks within the area under consideration which is south of the 41° parallel belong to two principal divisions, the Precambrian and the Paleozoic. Of the Precambrian only one member can be recognized, which has been called the *Fordham gneiss.* Of the Palaeozoic there are two persistent members, the *Inwood limestone* and *Manhattan schist,* and a third of local and slight development, the *Lowerre quartzite,* which underlies the limestone.

PRECAMBRIAN.

Fordham Gneiss.

The Fordham gneiss, named from the former town of that name, within which it is well exposed, is a gray banded gneiss varying much in the composition of its bands or layers, which, as a rule, are quite thin, rarely exceeding two inches in thickness. Some of these are highly quartzose (Pl. IV.), some are largely composed of biotite and some consist of pegmatite or granite which has been injected parallel to the regular banding of the gneiss. Hornblende is an occasional constituent of this rock but, though highly persistent in some bands, does not occur over large areas of country. Garnet is present rarely in but small quantity.

As the schistosity of the Fordham gneiss has usually a very steep dip the exposures of this rock chiefly show cross sections of the banding.

It is difficult to give this rock formation a systematic name which exactly indicates its age. If it is of sedimentary origin it may be called Algonkian, but it can only certainly be said that it is Precambrian.

The Fordham gneiss forms the high anticlinal ridge which borders the New York shore of the Hudson River from Yonkers southward to Spuyten Duyvil and also that on the west side of the Bronx valley. The former ridge terminates on the south at Spuyten Duyvil and does not reappear on Manhattan Island. The latter is bifurcated at the southern end and the western fork interrupted by a cross fold at the Harlem River, ends on Manhattan Island in the low ridge which borders Seventh avenue on the west at One Hundred and Fifty-fifth street, and disappears by pitching below the general surface level about half a mile southward. The eastern fork which, owing to the same cross fold, disappears beneath the limestone in Morrisania, reappears near the Bronx Kills in Mott Haven, where it forms a low anticlinal ridge interrupted by the Kills and represented on Manhattan Island by a few outcrops below high water mark at the foot of East 123rd and 125th streets which are now obliterated. Some narrow anticlinal ridges of Fordham gneiss are seen on the islands in the East River, notably Blackwell's, Ward's, N. Brother's and S. Brother's, and it is the only stratified crystalline rock at present exposed on Long Island, where it may be seen near the court house in Long Island City and at intervals on or near the shore of the East River from Ravenswood to Lawrence's Point.

PALAEOZOIC.

At the base of the metamorphosed Palaeozoic limestone and overlying the Fordham gneiss is a stratum of thinly bedded quartzite. This deposit occurs in southern Westchester county near Lowerre station in Yonkers at the Hastings marble quarry and about one-quarter mile south of Sparta on the shore of the Hudson River. It is well shown north of Peekskill along the east shore of Annsville Cove and in the valley of Peekskill Hollow Creek near Oregon. It does not exceed sixteen feet in thickness at Hastings. From the name of the southern locality this is called the Lowerre quartzite. Its age is probably Cambrian and possibly Georgian.

INWOOD LIMESTONE.

This is one of the most prominent formations of the region mapped and is a coarsely crystalline dolomite, distinctly bedded and containing at many localities the lime-magnesia silicates, diopside and tremolite, and occasionally tourmaline. Of its maximum thickness little is definitely known. At Tuckahoe a thickness of one hundred and fifty feet is shown in section. In the Harlem River a thickness of about seven hundred feet is indicated.

The age of this limestone is probably Calciferous-Trenton. In the absence of fossils, which could not have withstood the extreme metamorphism, the exact age is indeterminate.

The crystalline limestone, though frequently well exposed, must often be traced by its absence as well as its presence. Its solubility in water containing carbonic acid renders it an easy prey to the elements, and its position is almost everywhere emphasized by low ground and usually by deep valleys. Throughout all the principal valleys small outcrops may be found, though usually for considerable distances it is buried in river gravel and alluvium. Where it has undergone the maximum of leaching the granular particles of limestone have disappeared entirely and in its stead we find a mass of aluminous and magnesian material, whitish, green with scales of prochlorite, red with peroxide of iron, and sometimes black with separated carbon. In these conditions it is often mistaken for clay or kaolin, and was thus reported from the railroad cutting at Morrisania, from the Blackwell's Island tunnel and from dredgings in the East River on the Middle Ground, Shell Reef and at the mouth of Newtown Creek. The same material was also found overlying the Fordham Gneiss in a deep boring on Tallman's Island near College Point. On the uplands the presence of limestone is evidenced by coarse yellowish white sand, consisting of partially dissolved cleavage fragments of the dolomite. This may be seen on the plain east of Inwood.

To the presence of the limestone is due the commercial prominence of New York, as all the navigable channels about the city are submerged valleys which owe their origin to the solution of the limestone along the lines of its outcrop and exposure. Without the submergence the limestone valleys would not be navigable channels and without the presence of limestone there would have been no valleys for the submergence to render navigable.

Long Island Sound owes its existence to the same cause.

MANHATTAN SCHIST.

This formation covers a larger area than any other within the limits of the Harlem sheet, and is the uppermost of the crystalline groups. The rock is essentially a mixture of biotite and quartz, frequently containing enough orthoclase to give it the composition of a gneiss. The principal accessory is garnet, which occurs in crystals varying from one-sixteenth to one-quarter of an inch in diameter. Occasionally much larger crystals are found. Fibrolite, kyanite and staurolite are also frequent accessories. The Manhattan schist has a marked schistosity which is frequently nearly parallel to the bedding, though not always.

The aspect of this formation is intimately affected by numerous igneous intrusions and injections of granitic and basic material, which, in some places, are so numerous as to predominate over the schist. The small masses are for the most part parallel to the schistosity, though in part, oblique to it. The larger areas usually have their longer diameters parallel to the strike of the schistosity. They are most abundant near the shores of Long Island Sound.

As the geologic map shows, in southern Westchester county, the Manhattan schist is the prevailing rock east of the limestone valley in which lies the New York and Harlem Railroad. This eastern area is closely folded and its bedding planes are mostly on edge. It terminates at its southern extremity in a closely pressed synclinal fold, pitching northward, which crosses Randall's Island and Ward's Island and ends at Little Mill Rock in Hell Gate. Flood Rock, which was removed in the improvement of Hell Gate channel, was part of this synclinal. On Mill Rock the schist is much injected with amphibolite and pegmatite.

The Manhattan schist is also the prevailing rock on New York Island.

IGNEOUS ROCKS.

Under this head are classified those rocks which are clearly intrusive in the Fordham gneiss, the Inwood limestone and the Manhattan schist.

So far as we know, they belong to one general period of igneous activity, the time of which can not be stated with greater exactness than that it was posterior to the deposition of the Manhattan schists and therefore post-Hudson River, and prior to at least a part of the dynamic disturbance and crumpling of these rocks with which the intrusives have become schistose and even crumpled. The igneous rocks which occur in the pre-Cambrian and Palaeozoic within the region south of the 41st parallel of latitude may be classified as follows:

Yonkers gneiss
Granites, red and grey
Pegmatite dykes, very coarse
Harrison diorite
Amphibolites and pyroxenites
Serpentines, derived from basic intrusives.

YONKERS GNEISS.

In an article on the Metamorphic Strata of Southeastern New York*, the writer called attention to a reddish gneiss which appeared to be the lowest stratum in that terrane. From the microscopic structure of this rock, studied at certain localities, and from its apparent relations to the overlying gray gneiss, the conclusion was formed at that time that it was a metamorphosed sedimentary rock. More extended observations on this formation made during the summer of 1891 showed that it was not uniformly persistent as a basal member in southern Westchester county, and that it was not limited to the axes of the eroded anticlinals. The fact that it was overlain by a varying thickness of the gray gneiss was noticed by the writer at an early date but was attributed to unequal repetition of the gray gneiss by folding. Later investigations showed that a rock of the same composition occurred frequently as an intrusive either in veins and dikes or in bosses like the one at Sparta.

The Yonkers gneiss is technically a gneissoid granite. (Pl. V.) It is a well foliated rock consisting of quartz, reddish orthoclase and biotite with a little plagioclase. It is plainly intrusive in the Fordham gneiss and has become completely schistose.

*Am. Jour. Sci. III, Vol. XXXIX, p. 389.

In the particular area where this rock has its greatest extent it has been subjected to greater dynamic action than elsewhere and has been reduced to a gneissoid condition.

The persistence of reddish orthoclase in this rock suggests that it has sprung from a common source with the numerous dykes of red pegmatite and granite of similar composition which penetrate the schist and limestone in many points in Westchester county.

GRANITES.

Gray and reddish granites in small dykes oblique to the banding of the gneiss and schists are quite abundant, but of more frequent occurrence are lenses and injections of granite and pegmatite parallel to the banding of the schistosity. Bosses of pegmatite frequently occur in the Manhattan schist. A granite area of considerable size occurs near Union Corners and many have been found on New York Island, which are now built over and concealed from view. The small islands and reefs in the upper Bay and most of those in Long Island Sound owe their existence to intrusions of granite and other eruptives in the schist.

PEGMATITE DYKES AND BOSSES.

These are intrusions of coarse granitic material in dykes and bosses from one to ten feet in diameter. They are most abundant in the Manhattan schist.

HARRISON DIORITE.*

This rock is intrusive in the Manhattan schist in the town of Harrison and consists of orthoclase, plagioclase, quartz and hornblende. A smaller area of similar rock occurs at Ravenswood, L. I., where it outcrops in a long narrow ridge of northeasterly trend and is intrusive in the Fordham gneiss.

The mass which forms Milton Point near Rye has been subjected to much dynamic action and is well banded. The same rock is abundant along the shore of Long Island Sound between Portchester and Greenwich.

* H. Ries Trans. N. Y. Acad. Sci. 1895 Vol. xiv pp 80-86.

AMPHIBOLITES AND PYROXENITES.

Intercalated with the Manhattan schist and also with the beds of the Fordham gneiss we find at a great number of localities on New York Island and in Westchester county, hornblendic and augitic bands and lenses of limited thickness, usually only a few feet. In composition, these rocks resemble diorites and diabases, and in structure they are granular, and though they are at present in a foliated condition, their general characters suggest that they were originally eruptive rocks. Locally the magnesian silicates in these rocks are altered into epidote.

SERPENTINES.

A large number of observations have been made on these interesting rocks, the result of which are given in the following paper.

APPENDIX B

THE ORIGIN OF THE SERPENTINES IN THE VICINITY OF NEW YORK.

This paper was written in 1890, as part of a thesis for the degree of Doctor of Philosophy, at Columbia College. It has been withheld from publication a long time, in the hope of making it more complete, but an opportunity for this not having been offered, the paper is published in its original form, leaving to future time the completion of the investigation.

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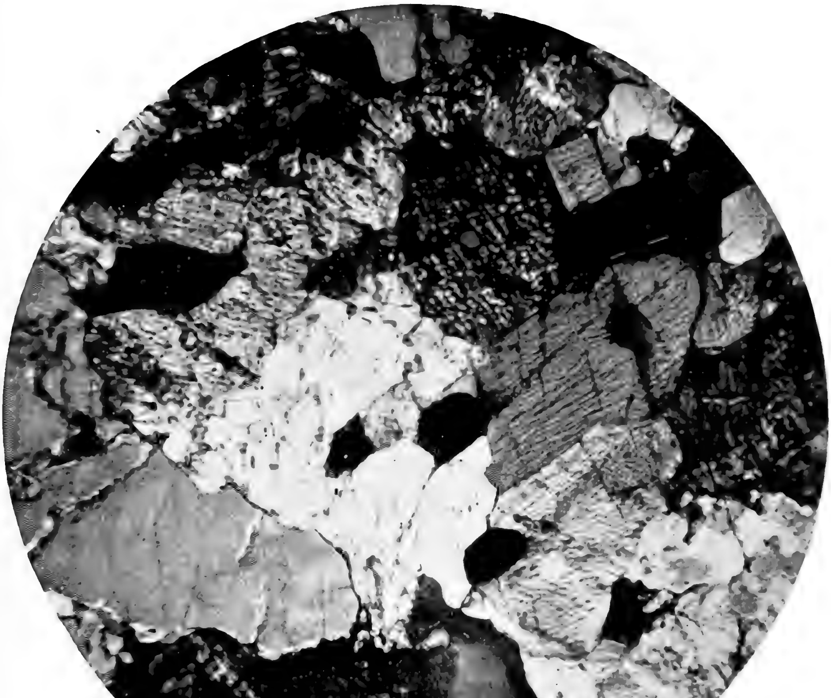
" ...... Proced. Nat. Sci. Ass. Staten Island. May 14, 1887.

PLATE I.



F. J. H. Merrill, Photo.

PRECAMBRIAN GRANITE, BREAKNECK MT., N. Y.

Photomicrograph in polarized light, enlargement 22 diameters.

PLATE II.

F. J. H. Merrill, Photo.

PRECAMBRIAN GRANITE, KING'S QUARRY NEAR GARRISONS, N. Y.

Photomicrograph in polarized light, enlargement 22 diameters.

PLATE III.

F. J. H. Merrill, Photo.

PRECAMBRIAN SHEARED GRANITE, LAKE MAHOPAC, N. Y.

Photomicrograph in polarized light, enlargement 22 diameters.

PLATE IV.

F. J. H. Merrill, Photo.

FORDHAM GNEISS, LEFURGY'S QUARRY, HASTINGS, N. Y.

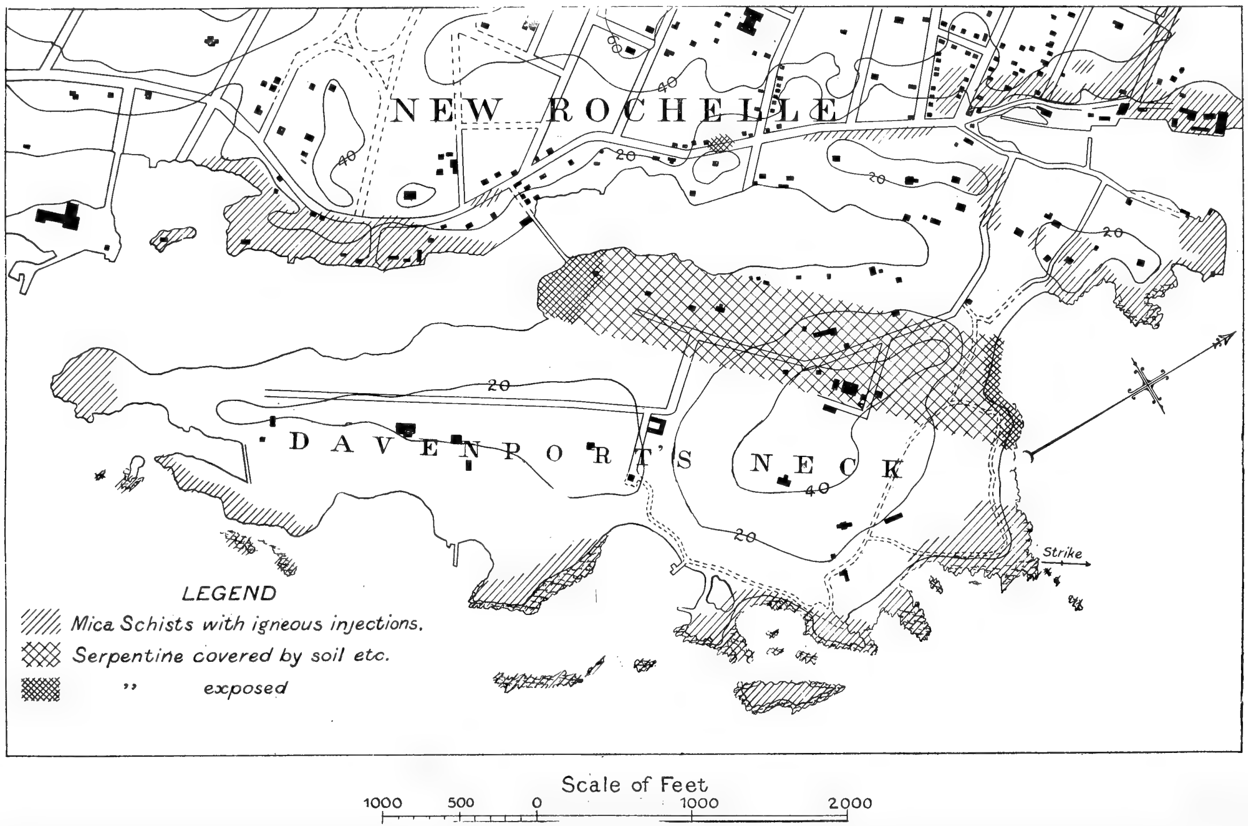
Photomicrograph in polarized light, enlargment 22 diameters.

PLATE V.

F. J. H. Merrill, Photo.

SHEARED GRANITE (YONKERS' GNEISS), HASTINGS, N. Y.
Photomicrograph in polarized light, enlargement 22 diameters.

PLATE VI.



Map of Davenport's Neck, New Rochelle, showing outcrops of serpentine and Ordovician mica schist. Unshaded areas are covered with Quaternary material.

Geology by F. J. H. Merrill.

PLATE VII.

F. J. H. Merrill, Photo.

ALTERATION OF BRONZITE INTO SERPENTINE, DAVENPORT'S NECK, NEW ROCHELLE, N. Y.

Photomicrograph in polarized light, enlargement **22 diameters.**

PLATE VIII.

F. J. H. Merrill, Photo.

ALTERATION OF ACTINOLITE INTO SERPENTINE, DAVENPORT'S NECK, NEW ROCHELLE, N. Y.

Photomicrograph in polarized light, enlargement 22 diameters.

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" .... Chem. and Geol. Essays. pp. 25, 122–3, 296–318 336, 342, 347.
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" .. Proceed. U. S. Nat, Mus., Vol. XI, pp. 105–111.
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" .... Lehrbuch der Mineralogie 2te, Aufl.
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" ...... Final Rept. Geol. Third Dist. N. Y., pp. 108–1.
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WILLIAMS, G. H. Am. Jour. Sci. (III), XXXIV, p. 137–145.
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ZIRKEL .... Zeitsch. Deutsch. Geol. Gesell, Vol. XIX, p. 68.

THE ORIGIN OF SERPENTINE.

The origin of serpentine rocks was for a very long time a matter of controversy among geologists. They have been variously regarded as primary deposits, as plutonic rocks, as alteration products of rocks rich in anhydrous magnesian silicates and as the result of metasomatic change in rocks of any kind whatsoever, by the substitution of a hydrous magnesian silicate for some other silicate or carbonate.

About the middle of the present century Bischof and Gustav Rose expressed the unqualified opinion that all serpentines were of secondary origin, but as they were chemists rather than geologists and did not undertake to discuss the various geognostic problems involved in the study of these rocks, they were unable to account for all the phenomena associated with them, and their views, with which those of many other chemists and mineralogists coincided, were not accepted by geologists as conclusive.

Since most of the minerals from which serpentine was held to be derived, viz.: Olivine, enstatite, hornblende, augite, diallage and chondrodite, were believed to belong pre-eminently to eruptive rocks, it was considered inevitable that if the serpentines were all of secondary origin they must have been derived from igneous rocks, and as this hypothesis, in many cases, did not agree with the apparent stratigraphic conditions, it did not gain general acceptance. For example, many serpentines were found distinctly stratified and intimately associated with stratified crystalline rocks, some of which were limestones and obviously not of igneous origin. Dr. T. Sterry Hunt, who has discussed the origin of serpentines at great length,* while conceding the alteration of olivine and enstatite into serpentine in some cases, considers the association of serpentine with these two minerals to be an evidence of the simultaneous development of hydrous and anhydrous silicates from a magnesian sediment of chemical origin such as he ascribes to all crystalline stratified rocks. He also expresses doubt as to the igneous origin of many of the olivine rocks from which serpentine is held by others to be derived.

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* Trans. Royal Soc. Canada, Vol. I, § iv, 1883.

In this expression of doubt as to the igneous origin of many magnesian silicate rocks, Dr. Hunt voices the sentiment of most field geologists who have made such rock masses a subject of study. All the common anhydrous silicates of magnesia are found to occur as individual rock masses or as constituents of them in the stratified crystalline terranes. In the opinion that anhydrous and hydrous silicates of magnesia are simultaneously developed from a magnesian sediment or magma, Dr. Hunt seems to stand alone and unfortunately for those who would give due weight to this hypothesis, does not advance any conclusive arguments in its behalf, nor does he record any observed facts in connection with serpentine, which make it apparent that this mineral is ever developed simultaneously with olivine or any other anhydrous magnesian silicate. Dr. Hunt alludes to the studies of Scheerer on the association of olivine and serpentine at Snarum, in Norway, which led that eminent scientist to assert his belief that the two silicates, hydrous and anhydrous, were formed simultaneously, because the alleged pseudomorphs were, in many cases, enclosed in masses of chromite.

According to the writer's understanding of Prof. Scheerer's article,* the only ground for rejecting the idea of pseudomorphism was that if the crystals of serpentine were produced by the hydration of pre-existing olivine an increase of bulk would ensue which must rend apart by expansion, the matrix of the altered crystal, many of the pseudomorphs being, as already stated, enclosed in masses of chromite which were unfractured and conformed exactly to the surface of the included crystal, which had the characteristic form of olivine though, in its external portion at least, it had the composition of a serpentine.

If this was Scheerer's reason for rejecting the idea of the pseudomorphism of the olivine into serpentine, his objection can not be accepted until it be proven that the chromite masses enclosing the serpentine were formed before the latter. As chromite masses are almost exclusively confined to serpentine rocks and in them, according to Tschermak, are formed by the segregation of the oxides of iron and chromium which are set free in the decomposition of the

* Pogg. Ann. Vol. LXVIII, p. 319.

anhydrous silicates of magnesia from the alteration of which he holds all serpentines to be derived, it may be that the chromite matrices of the Snarum pseudomorphs were deposited about them after their formation and were subjected to little or no expansive force, since, after the crystals were thus enclosed and protected from external agencies the process of serpentinization would cease.

Tschermak, in his memoir on the formation of serpentine,* quotes the words of Gustav Rose and Volger in their description of the Snarum crystals. Rose writes as follows:

" Of two crystals the surface is dark leek-green, soft and a perfect serpentine. On the freshly broken surface, however, the fact is evident that the serpentine is only from one-half to two lines (1-4mm.) thick and graduates into a very light, yellowish-green mass which traverses the crystal irregularly and encloses white areas with a high lustre, which are so hard that they can not be scratched with a knife. These also appear to have cleavage surfaces, but the whole mass is penetrated with fine fissures, and the small individual parts are brilliant on almost every side so that the true cleavage cracks can not be determined.

" Through another crystal passes a cleft about as thick as a sheet of paper, which is filled with very finely fibrous, highly transparent, leek-green chrysotile. From this spread out to right and left, fissures filled in a similar manner, which are nearly perpendicular to the principal crevice and which turn back upon themselves in ramifications which are sometimes very small and sometimes from one to one and one-half lines (2-3mm.) in thickness.

" Where the margins of these turn back quickly they often touch and intersect themselves and the whole mass between them, even when hard and brilliant, is colored green; where they meet each other at greater distances the included mass is white, of greater toughness than in the first crystal and of subconchoidal fracture.

" It is here evident that the whole mass of the crystal was penetrated by fissures which became filled with serpentine and from which the decomposition has proceeded in all directions."

* Sitz. Wien. Akad. LVI., 1st Abtheil.

Prof. Volger from his examination of this material arrived at a similar conclusion.

Since the development of microscopic methods of research a large number of eminent investigators have studied the structure and optical properties of serpentine, and all, including Tschermak, Rosenbusch, Kalowsky, Websky, Wiik, Des Cloizeaux, Von Drasche and Fischer, are unanimous in considering it an alteration product of anhydrous magnesian silicates. Prof. Rosenbusch in his late work on rock-making minerals.* Epitomizes the latest knowledge of the subject as follows:—

" Serpentine, according to the mineral from which it is derived, has a fibrous or apparently lamellar structure. The apparent lamellæ may, however, only represent parallel bundles of fibres. The arrangement of the fibres is quite varied. They are sometimes parallel and sometimes confusedly felted and the optical characters of the fibres between crossed nicols change with their dimensions and their arrangement. In parallel aggregates, which are not too finely fibrous, one may recognize with certainty that they are biaxial with very large axial angles the negative bisectrix of which is perpendicular to the axis of the fibre which is the axis of least elasticity. These fibres have a weak refractive power (very near that of Canada balsam) and not inconsiderable double refraction. Chrysotile exhibits these properties very clearly. In the finely and confusedly fibrous aggregates very nearly complete compensation occurs so that these often appear to be isotropic.

" The mineral from which serpentine is most frequently derived is olivine. The alteration begins from the surface and from the crevices and leads to a fibrous structure with simultaneous separation of the iron content in the form of Fe_2O_3, $2Fe_2O_3, + 3H_2O$ and Fe_3O_4. The new structures of greenish to yellowish-green color are perpendicular to the crystal boundaries and the cracks. Since the alteration takes place from all the cracks (which cross each other confusedly) and from the sides simultaneously, an olivine in which the alteration into serpentine has begun, appears to have a reticulate structure. The serpentine strings form a network of which the meshes inclose olivine

* Mik. Phys. der Pet. Wicht. Miner. 2te Aufl. pp. 557-559

still unaltered. As the process goes on, new fissures are cleft in consequence of the increase of volume associated with the alteration and thus render possible the constant increase of the new structures until the olivine is completely transformed."

"In the alteration of hornblende and actinolite into serpentine the cleavage planes of amphibole and their oblique separations are very clearly brought out in the arrangement of the serpentine bundles. Between crossed nicols the lines of parallel fibres differentiate themselves in lively colors from the dark ground of the confusedly fibrous field, now running parallel to one another now intersecting one another at an angle of 124° to 125°, or forming rhombic figures with other angles and rectangles. There results in this way a structure which is characteristic in the highest degree and which Wiegand designated as lattice or window structure."

"Other serpentines, which, microscopically, occasionally show a schistose structure, under the microscope appear to consist of foliated masses which cross each other at right angles and so show a netted structure." "These serpentines appear to have resulted from the alteration of monoclinic pyroxenes."

From the alteration of the rhombic pyroxenes is produced both serpentine and bastite.

According to Tschermak the alteration of olivine into serpentine may be expressed as follows:—

Olivine consists of Mg_2SiO_4 and Fe_2SiO_4 combined in varying proportions.

$$2 (Mg_2SiO_4) + CO_2 + 2H_2O = 2H_2O, 3MgO, 2SiO_2 + MgCO_3.$$

$$5 (Fe_2SiO_4) + O + 6H_2O = 2Fe_3O_4 + 2Fe_2O_3, 3H_2O + 5SiO_2.$$

A small portion of the MgO in the serpentine is replaced by FeO.

SERPENTINE LOCALITIES NEAR NEW YORK.

The serpentines in the vicinity of New York City are of two general classes:

A. Serpentine masses of large area.

B. Local developments of serpentine in crystalline magnesian limestones.

Of the first class the most extensive is that of Staten Island, N. Y., next in size are those of Rye and New Rochelle in Westchester County, N. Y., and that of Castle Point, Hoboken, N. J. A fifth area is to be found in New York City, on West 60th Street, between 10th and 11th avenues.*

Of the second class the most prominent examples are at Montville and Mendham in New Jersey and others are found in the continuation of the eastern belt of crystalline limestone through northeastern New Jersey and Orange and Putnam Counties in New York. The most extensive of these, on the east bank of the Hudson River near West Point, was described by Mather under the local name of "cotton rock."† He mentions besides, other localities in Putnam County, notably Huestis, Quarry, 4½ miles northeast of Cold Spring. In Westchester County serpentine occurs in small masses at the Snowflake Marble Quarry at Pleasantville.

A third class might be constituted of the serpentine which is found in some of the iron mines of Putnam County. The serpentine pseudomorphs of the Tilly Foster Mine have been described at length by Prof. J. D. Dana. (Am. Jour. Sci. III. viii. pp. 454, 455.)

THE NEW ROCHELLE SERPENTINE.

The serpentine locality of Davenport's Neck at New Rochelle has long been known to geologists and mineralogists. Its position and stratigraphical relations are shown by the accompanying map. (Pl. VI.)

Prof. J. D. Dana from his observations on this serpentine concludes that it is associated with a limestone bed which is not now visible, having been removed by solution. The writers study of the locality suggests that the serpentine is derived from magnesian silicate rocks intruded in the Manhattan schist. (Am. Jour. Sci. III. xxxix. p. 391.)

The only exposures now visible are at the northeastern and southwestern extremities near the water's edge, and the outcrops have been so long exposed to the weather that the process of serpentiniza-

* This locality is now covered with buildings.

† Cotton rock has been eovered by the railroad embankment.

tion is complete and the serpentine itself is disintegrating. The northeastern outcrops are the most extensive and afford the most information concerning the origin of the deposit. The northernmost outcrop is dark green in color, of very coarse texture and has been derived very largely from bronzite, small quantities of which still remain. Succeeding this to the south is a massive rock consisting of hornblende and garnet covering an area of about one hundred and fifty square feet; followed in turn by more of the coarse serpentine some of which is reddened by the oxidation of its iron content. For one hundred and fifty feet or more, the rock is not visible and then succeeds a fine grained, light green, rather porous serpentine mass which forms a small promontory near the middle of the area. This is overlain with a semblance of stratification which does not harmonise with that of the neighboring gneisses, by a reddish serpentine rock containing actinolite in various stages of alteration. In this portion of the deposit are thick veins of deweylite and chalcedony and a considerable amount of crystalline calcite. In the opinion of the writer the calcite is a by-product of the serpentinization.

Microscopic study of the New Rochelle serpentine suggests that it is chiefly derived from amphibole and bronzite. The occurrence of fibrous amphibole and bronzite or enstatite in connection with the serpentine of this locality has already been recorded by Prof. Dana. In thin sections examined by the writer, crystals of bronzite may be seen in which serpentine has been formed along the transverse crevices. In these bronzite crystals are found also irregular masses of pleonast, the relations of which to the surrounding mass suggest that they are of secondary origin. (Pl. VII.)

Where actinolite has been the source of the serpentine the unaltered mineral verges through a zone of brown, partly decomposed material into the finely fibrous serpentine which contains a very large proportion of minute crystals of magnetite. (Pl. VIII.)

The change from actinolite into serpentine does not seem to be so direct as that from bronzite. The zone of discoloration appears to represent an intermediate stage in which the excess of iron is removed from chemical combination with the silica and set free.

With regard to the genesis of the minerals from which this serpentine is derived but little can be predicted; there seem to be, however, some reasons for not considering them of sedimentary origin. While the writer does not question the formation of amphibole and bronzite from sedimentary deposits, the evidence of such origin in this case is not conclusive. It is impossible at present to predicate with certainty the geological character of the primitive rock. The outcrops are so limited in extent and so far advanced in alteration that the writer has found no clue to guide him in his investigation of this point. It is safe to say however that the primitive rock mass was different from any now known in an unaltered condition in this terrane. A fragment of bronzite rock was found by Mr. J. I. Northrup in the debris removed from one of the shafts of the new Croton Aqueduct near Tarrytown and this may have been a part of such rock mass as that which gave being to the New Rochelle serpentine, but unfortunately nothing can be ascertained concerning its source.

The origin of the deposits from which this serpentine and its congeners have been derived remains the most important question connected with their history, and unfortunately we can only reason upon analogy in discussing it. In all probability the magnesian silicate rocks which by their alteration have yielded these serpentines were similar in their origin to the amphibolites and pyroxenites which abound in Westchester county. In modern sedimentation no evidence has been recorded of an alteration of conditions which would yield in small quantity a deposit having the composition of a magnesian silicate when immediately before and after it the sediment was chiefly composed of silica and aluminous silicates. In *composition* the amphibolite and pyroxenite beds of the Manhattan Group bear the same relation to the strata which enclose them as the intrusive mass of the Palisades bears to the beds of sandstone and arkose between which it is now included. There is nothing but their somewhat foliated condition to suggest that they are of sedimentary origin and this characteristic has been shown to result frequently from dynamo-metamorphism.

The former hypothesis that serpentine is largely derived from the alteration of magnesian limestone or dolomite does not seem to be supported by recent investigations. In the literature to which the writer has access, the only recorded instance of such derivation is that of a pseudomorph collected from the Tilly Foster Mine, the form and structure of which suggested to Prof. J. D. Dana that it had been derived from a crystal of dolomite.* Mr. George P. Merrill has happily suggested, in the case of the Montville serpentine, that the excess of silica set free in the decomposition of the diopside has to some extent combined with the magnesia of the enclosing dolomite and thus formed a serpentine in addition to that formed by the alteration of the pyroxene. It is evident that a dolomitic limestone can only yield serpentine through the action of silicated waters, while the magnesia-iron minerals above mentioned will yield serpentine under the influence of ordinary atmospheric waters.

In the present opinion of the writer the origin of the New Rochelle serpentine has been as follows:

The mica schists were formed by sedimentation and metamorphism. The amphibolites and other magnesian silicate rocks were intruded and by subsequent compression attained their foliated structure. Orographic disturbance subsequently brought the strata into their present attitude and finally erosion removed the covering of mica schist and laid bare the truncated folds. Atmospheric waters then had free access to the magnesian silicates and the process of de-ferrugination and hydration began and resulted in the formation of the serpentine. The excess of silica was carried off and deposited in the form of chalcedony of which large masses and minute veins occur in the deposit, and the excess of iron appears as magnetite and chromite, while according to the combinations into which the magnesia entered, various varieties of serpentine were formed, together with magnesite, talc and deweylite.

The writer is not disposed to attribute any very great geological antiquity to the serpentine. Under favorable conditions it forms quite rapidly. At Stony Point on the Hudson River, the writer has observed a surface of peridotite, which had apparently been swept clean by the ice sheet, covered by a layer of serpentine about one-

*Since the above was written some material has been given to the writer by Dr. Hunt of the Brooklyn institute, which in appearance corroborates Prof. Dana's conclusion.

fourth of an inch thick. As in this case only a small portion of the rock had by its decomposition yielded serpentine, and the layer observed by the writer had been leached out of the rock, it is reasonable to infer that a considerable depth of the rock might since the glacial epoch have been changed into serpentine had all of its minerals yielded that alteration product.

From what is known of the erosion of the region about New York it may be inferred that the rock mass which yielded the New Rochelle serpentine was exposed to the action of atmospheric agencies not earlier than the Mesozoic age.

THE STATEN ISLAND SERPENTINE.

The general characteristics and extent of this deposit have been described by Dr. N. L. Britton, but the question of its origin is not entirely settled. Throughout most of its extent this area has suffered so complete an alteration as to yield no traces of the mineral from which it was derived. Mr. Gratacap records the presence of traces of unaltered hornblende in specimens from Bard avenue and elsewhere. In a well boring made through the serpentine some fibrous amphibole or actinolite was found in a comparatively unaltered condition. (Trans. N. Y. Acad. Sci., Vol. I, p. 58.) Dr. A. A. Julien (loc. cit.) states that he has found traces of unaltered hornblende in Staten Island serpentine.

In none of the material which the writer has examined has he found unaltered particles of the primary mineral, but there is frequently present *a reticulate structure similar to that which Rosenbusch has described and illustrated as characteristic of serpentine derived from olivine.* In a large number of sections examined by the writer the "lattice structure" characteristic of serpentine derived from hornblende was wanting, the angles between the cracks being more nearly those of pyroxene than of hornblende. It is not improbable that more than one magnesian silicate has contributed to its origin.

In the process of alteration limonite and free silica were the chief by-products. The former appears in the once extensive bed of limonite which has been used as an iron ore, and the latter in the groups of quartz crystals which so frequently occur in the former.

If there were any considerable amount of alumina in the primitive minerals it was probably carried off and deposited with the limonite. The manner in which this ore originated accounts for its freedom from sulphur and phosphorus.

THE SERPENTINE OF RYE AND HOBOKEN.

After studying a large amount of material from these two localities the writer is unable to contribute any new facts regarding their origin. The outcrops are so far decomposed as to afford no traces of the primitive mineral. Dr. A. A. Julien (loc. cit.) mentions his discovery of traces of hornblende in serpentine from Hoboken.

SERPENTINES ASSOCIATED WITH LIMESTONES.

The distribution of these serpentines has already been described. The deposits at Montville, N. J., are of much interest. Here the serpentine is derived from segregated masses of diopside enclosed in the magnesian limestone.

Mr. G. P. Merrill's monograph on the subject* shows very clearly the chemical relations of the primitive mineral and its alteration product, and discusses one of the few cases of the formation of serpentines from the magnesia of a dolomitic limestone. At Mendham the serpentine is of similar origin, to that of Montville and pyroxenes easy of decomposition occur throughout this belt of limestone of which the extent has already been mentioned.

In Westchester County, N. Y., at Pleasantville and elsewhere the serpentine is likewise derived from magnesian silicates, chiefly of the pyroxene group but occasionally having the characteristics of an olivine.

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* Proceed. U. S. Nat. Mus., Vol. XI.

APPENDIX C

Preliminary list of Public Geological and Mineralogical collections in the United States and Canada.

United States.

ALABAMA.

University of Alabama, University

Eugene A. Smith, Professor of Mineralogy and Geology (also state geologist). Collections of the State geological survey are included; they comprise 2000 mineral, and 20,000 geological specimens.

Alabama polytechnic institute, Auburn

P. H. Mell, professor of geology and botany. Collection of 1000 specimens.

Southern university, Greensboro

E. L. Brown, professor of chemistry and physics. Collection of 1000 specimens.

Howard college, East Lake

G. W. Macon, professor of botany and zoology. Collection of 500 specimens.

ARIZONA.

University of Arizona, Tucson

Pres. Theodore B. Comstock, instructor in geology. The collections, comprising 3500 specimens, include those of the former territorial geologist and the Arizona collection at the World's Fair.

ARKANSAS.

Arkansas industrial university, Fayetteville

J. F. McNeil, professor of biology.

Hendrix college, Conway

G. H. Burr, professor of natural and physical science. Collection of 800 specimens.

California.

University of California, Berkeley

Joseph LeConte, professor of geology. Collection of 55,000 specimens of minerals and rocks.

Leland Stanford jr. university, Stanford University

John C. Branner, professor of geology. Collection of 23,000 specimens of fossils, minerals, and ores.

Santa Clara college, Santa Clara

A. Cichi, professor of chemistry and physics. Collection of 3500 specimens.

University of Southern California, University

O. P. Philips, professor of natural science.

Golden Gate Park Museum, San Francisco

C. P. Wilcomb, curator. General collection of 2000 specimens.

State Mining bureau, San Francisco

J. J. Crawford, State mineralogist. Mineralogical and economic collections of 15,000 specimens

Colorado.

State school of mines, Golden

Horace B. Patton, professor of geology and mineralogy. Collections consist of rocks, 2000 specimens, minerals 6000, economic products 2000, fossils 2000.

Colorado college and Cutler academy, Colorado Springs

F. W. Cragin, professor of geology and paleontology.

University of Denver, Denver

William C. Strong, professor of natural sciences. Rock specimens 300, minerals 2000.

University of Colorado, Boulder

professorship of geology vacant. Collection of 1300 rocks, 500 rock sections and a small collection of fossils.

State agricultural college, Fort Collins

William P. Headden, professor of geology and chemistry. Collection of 1000 specimens.

Colorado Scientific society, Boston building, Denver

Collections of minerals, rocks and fossils.

State Commissioner of Mines, Denver

Harry A. Lee, commissioner. Collection of minerals and ores from the state.

Colorado fuel and iron company. Boston building, Denver

R. C. Hills. Collection of coals from Colorado, Wyoming and New Mexico. Also a mineral collection and 800 specimens of eruptive rocks from Colorado and New Mexico, the property of Prof. Hills.

Connecticut.

Yale university, New Haven

Geological faculty: H. S. Williams, O. C. Marsh, Geo. J. Brush, A. E. Verrill, E. S. Dana, S. L. Penfield, Chas. E. Beecher and L. V. Pirsson. The Peabody museum contains the best collection of vertebrate fossils in the country. No estimate of the collections given, but they are among the foremost in the country.

Wesleyan university, Middletown

William N. Rice, professor of geology. Collections contain 11,500 specimens, which include 300 mineral species, 4000 Paleozoic, 800 Mesozoic, 2000 Cenozoic fossils.

Trinity college, Hartford

W. H. C. Pynchon, instructor in natural science.

Storrs agricultural college, Storrs

B. F. Koons, president, instructor in geology. Collection of 1000 specimens.

Scientific association of Meriden, Meriden

Robert Bowman, curator. Collection of 1200 specimens.

Delaware.

Society of Natural History of Delaware, Wilmington

Mrs. G. Yeatman Pyle, corresponding secretary. Collection of 1600 specimens, chiefly minerals.

State college for colored students, Dover

No instructor. Small collection.

Delaware college, Newark

T. R. Wolf, professor of chemistry. Collection of 800 specimens.

District of Columbia.

Columbian university, Washington

Dr. George P. Merrill, professor of geology. No estimate of collections.

Howard university, Washington

Richard Foster, professor of natural history. 5000 specimens.

Georgetown university, Washington

A. J. Donlon, S. J., professor. Collection of 6600 specimens.

United States national museum (Smithsonian institution), Washington

Stephen P. Langley, Secretary of the Smithsonian Institution: Keeper Ex-officio.

Chas. D. Walcott, Acting Assistant Secretary of the Smithsonian Institution, in charge of the U. S. National Museum.

Frederick W. True, Executive Curator.

Contains the best and most extensive collections in the United States. The mineral collections are arranged in systematic and comparative exhibition series for the public, and a study series for students: this contains type specimens, etc., and duplicates series from which exchanges, etc., are made. Geological collections include: exhibition, 23,097; study, 28,911; microscopical slides 4700; duplicates 15,541; total, 72,249. Paleontological collections include several hundred thousand specimens, 58,000 type lots, and much material from government geological surveys.

Florida.

Rollins college, Winter Park

Eva J. Root, professor of natural science and French. Collection of 700 specimens.

Georgia.

University of Georgia, Athens

H. C. White, professor of chemistry. Collection of 6000 specimens.

Emory college, Oxford

H. S. Bradley, professor of chemistry and physics. Collection of 10,000 specimens

Mercer university, Macon

J. F. Sellers, professor of physics and chemistry. Collection of 5000 specimens

Bowdon college, Bowdon

C. O. Stubbs, professor of chemistry, astronomy and philosophy. Collection of 700 specimens

IDAHO.

University of Idaho, Moscow

C. P. Fox, professor of mineralogy. Collection of 500 specimens

ILLINOIS.

University of Chicago, Chicago

T. C. Chamberlin, head professor of geology. Collections, estimated between 200,000 and 300,000 specimens, include Dr. Washburn collection, rich in Niagara forms; Dr. James collection, rich in Cincinnati types; ores and economic specimens from World's Fair and Field museum; rock series from the west and from Europe

Northwestern university, Evanston

Oliver Marcey, professor of geology. Mineral and rock specimens, 6000; fossils 3000, and much material from World's Fair not yet arranged

Blackburn university, Carlinville

Geo. F. Weida, professor of chemistry and physics. Collection of 33,000 specimens

University of Illinois, Urbana

Chas. W. Rolfe, professor of geology. Minerals and rocks 5000 specimens, fossils 50,000

Austin college, Effingham

W. J. Brinckley, professor of sciences. Collection of 1200 specimens

Knox college, Galesburg

Albert Hurd, professor of chemistry and zoology. Collection of 3400 specimens

Augustana college, Rock Island

J. A. Uddin, professor of natural sciences. Collection of 3000 specimens

Hedding college, Abingdon

A. A. Waters, professor of chemistry, botany and zoology. Collection of 2000 specimens

Wheaton college, Wheaton

J. B. Russell, professor. Collection of 1500 specimens

Illinois Wesleyan university, Bloomington

R. O. Graham, professor of chemistry. Collection of 1000 specimens

Carthage college, Carthage

C. C. O'Harra, professor of natural science. Collection of 1000 specimens

Greer college, Hoopeston

S. W. Dixon, professor of mathematics and mental science. Collection of 672 specimens

Northwestern college, Naperville

L. Umbach, professor of natural science. Collection of 500 specimens

Lincoln university, Lincoln

A. E. Turner, professor of chemistry. Collection of 500 specimens

Chicago academy of sciences, Chicago

Frank C. Baker, curator. Collection of 10,000 specimens include many type specimens from the Niagara and Cincinnati groups

State museum of natural history, Springfield

Wm. F. E. Gurley, state geologist. Collections include 5000 paleontological species and 2500 forms of rocks and minerals

Field Columbian museum, Chicago

F. J. V. Skiff, director. Collections include paleontology 5000 specimens; meteorites, specimens from 180 falls and 60 casts; mineralogy 5000 specimens; building stone 400 polished slabs; lithology 15,000 specimens; also large collections of precious and semi-precious stones and in economic geology

Indiana.

Indiana university, Bloomington

V. F. Marsters, professor. In 1883 fire destroyed a large collection. Collections now contain 225 varieties of minerals, 250 crystal models, and 5000 paleontological specimens

Franklin college, Franklin

D. A. Owen, professor of biology. Collection consists of 35,000 specimens, largely the gift of S. S. Gorby

Purdue university, Lafayette

Stanley Coulter, professor of biology. Collection contains about 20,000 specimens

Taylor university, Upland

S. Collett, professor of natural science. Collection of 1500 specimens

Brookville society of natural history, Brookville

A. W. Butler, secretary. (No estimate given) Fair sized local collection

Hanover college, Hanover

Glenn Culbertson, professor. Local paleontological collection of 500 specimens. Hudson river, Clinton, Niagara and Corniferous groups well represented

Wabash college, Crawfordsville

Donaldson Bodine, professor of geology and zoology. Collections include 3000 mineralogical, 3000 paleontological (some types), also economic collection and fossil vertebrates

Indian Territory.

Indian university, Bacone

M. L. Brown, principal. Collections are small

Iowa.

Davenport Academy of Natural Sciences, Davenport
W. H. Barris, curator

State university of Iowa, Iowa City
Samuel Calvin, professor of geology, also State Geologist. Collections include 30,000 specimens, chiefly from state survey. Calvin collection of American and European fossils, 6000 specimens; and Hornaday collection of vertebrate fossils

Cornell college, Mount Vernon
Wm. H. Norton, professor of geology. Collection contains 11,000 specimens

Amity college, College Springs
H. K. Holcomb, professor of biology and chemistry. Collection of 4500 specimens

Upper Iowa university, Fayette
Bruce Fink, professor of botany and zoology. Collection of 2000 specimens

Iowa college, Grinnell
H. W. Norris, professor of biology. Collection of 2000 specimens

Wartburg teachers' seminary and academy, Waverly
Frederick Lutz, president. Collection of 1181 specimens

Western college, Toledo
A. G. Leonard, professor of biology and chemistry. Collection of 600 specimens

Muscatine academy of science, Muscatine
Samuel McNutt, president. A valuable collection was destroyed by fire in 1896. New collections started which now contain about 250 specimens

Kansas.

University of Kansas, Lawrence
Samuel W. Williston and Erasmus Haworth, professors of geology. Geological and mineralogical collections contain about 100,000 specimens

Baker university, Baldwin

C. S. Parmenter, professor of natural history

Museum contains 10,000 geological and 3600 mineralogical specimens

Washburn college, Topeka

G. P. Grimsley, professor of botany and zoology. Collection of 4000 specimens

Kansas state agricultural college, Manhattan

John H. Failger, professor of chemistry. Collection of 4000 specimens

Kansas Wesleyan university, Salina

Alfred W. Jones, professor of biology. Collection of 1200 specimens

Bethany college, Lindsborg

J. E. Welin, professor of natural history. Collection of 550 specimens

Midland college, Atchison

C. B. Knox, professor of chemistry, physics, etc. Collection of 500 specimens

College of Emporia, Emporia

W. H. Maurer, professor of chemistry and physics. Collection of 500 specimens

KENTUCKY.

Kentucky university, Lexington

Alfred Fairhurst, professor of natural science

Center college of Kentucky, Danville

J. C. Fales, professor of biology. Collection of 1670 specimens

Bethel college, Russellville

James L. Lake, professor of chemistry and physics. Collection of 1500 specimens

Central university of Kentucky, Richmond

R. M. Parks, professor of chemistry. Collection of 1000 specimens

Ogden college, Bowling Green

J. C. Lewis, professor of chemistry. Collection of 800 specimens

Polytechnic society of Kentucky, Louisville

E. A. Grant, secretary (No estimate given). Collections include The 'Troost cabinet', 'Octavia Allan Shereve memorial cabinet,' part of the Dr. J. Lawrence Smith collection, etc.

State geological department, Frankfort

C. J. Norwood, mine inspector and curator. State economic collection and a small paleontological collection

Louisiana.

Louisiana state university, Baton Rouge

W. W. Clendenin, professor of botany. Collection of 10,000 specimens

Tulane university, New Orleans

J. W. Caldwell, professor of chemistry. Collection of 5200 specimens

New Orleans university, New Orleans

L. G. Adkinson, professor of mental and moral philosophy. Collection of 500 specimens

Maine.

Colby university, Waterville

William S. Bayley, professor of mineralogy and geology. Collection of 6750 specimens

Bowdoin college, Brunswick

L. A. Lee, professor of biology. Collection of 6000 specimens

Maine state college, Orono

F. L. Harvey, professor of natural history. Collection of 900 specimens

Maryland.

Johns Hopkins university, Baltimore

William B. Clark, professor of geology and state geologist. Extensive collections, but no estimate given

Rock Hill college, Ellicott City

Brother Blandin, professor of physical geography. Collection of 2000 specimens

Western Maryland college, Westminster

S. Simpson, professor of chemistry. Collection of 800 specimens

Maryland geological survey, Baltimore

Wm. B. Clark, State geologist. Collections include building stones, clays, ores, minerals, fossils and rock formations of the state

MASSACHUSETTS.

Leominster Public Museum, Leominster

E. G. Davis, curator. Collection of about 1000 specimens

Smith College, Northampton

Harris G. Wilder, professor of zoology. Small collections

Worcester Natural History Society, Worcester

Dill Ten Eyck, custodian. Collection of about 4000 specimens

Boston Society of Natural History, Boston

Geological collections are in charge of Prof. Alpheus Hyatt and W. O. Crosby. The collections are extensive in all departments of geology

Harvard university, Cambridge

Nathaniel S. Shaler, Professor of geology, William Morris Davis, Assistant Professor. Collections include 2400 geological, 12,000 paleontological, 11,000 petrographical specimens, 5000 thin sections for the microscope and 15,000 mineralogical specimens

Massachusetts institute of technology, Boston

Wm. H. Niles, professor of geology. Collections extensive, but no estimate given

Amherst college, Amherst

B. K. Emerson, professor of geology. Collections estimated at from 40,000 to 50,000 specimens

Williams college, Williamstown

T. Nelson Dale, instructor in geology. Collection of 2875 specimens

College of the Holy Cross, Worcester

F. A. Rousseau, professor of mecnanics and astronomy. Collection of 800 specimens

Peabody academy of science, Salem

J. H. Sears, curator of mineralogy and geology. Collections include 960 mineral, 2000 historical geology, 725 historical geology of Essex County, 350 minerals of the state, 1575 thin sections, photographs, etc. Issues bulletins, etc.

Cape Ann scientific and literary association, Gloucester

Thomas Conant, M. D., president. Collection of 1000 specimens

Natural history, museum, Springfield

William Orr, jr, curator. Collections include 650 geological specimens and 530 mineralogical

Michigan.

University of Michigan, Ann Arbor

Israel C. Russell, professor of geology. Collections, estimated to contain 100,000 specimens include Lederer collections of 2500 European minerals; a rich collection from Michigan; collections of state geological survey; White collection of 6000 specimens; Rominger collection of 25,000 specimens

Hillsdale college, Hillsdale

W. H. Munson, professor of biology and chemistry. Collection of 7853 specimens

Alma college, Alma

Charles A. Davis, professor of biology and chemistry. Collection of 5000 specimens

Albion college, Albion

C. E. Barr, professor of biology. Collection of 4200 specimens.

Michigan mining school, Houghton

M. E. Wadsworth, director and professor of geology. Collections include paleontological 3000, mineralogical 30,000, lithological 13,500, thin sections 700 specimens

State geological survey, Houghton

Lucius L. Hubbard, state geologist. Collection of 18,000 specimens, chiefly rocks and ores from the state

MINNESOTA.

University of Minnesota, Minneapolis

C. W. Hall, professor of geology and mineralogy. Collection of 34,500 specimens including minerals, rocks and fossils of the state

Carleton college, Northfield

L. W. Chaney, jr, professor of biology. Collection of 4000 specimens

Hamline university, St. Paul

H. L. Osborn, professor of biology. Collection of 1500 specimens

Gustavus Adolphus college, St. Peter

J. A. Edguist, professor of zoology. Collection of 1000 specimens

State geological and natural history survey, Minneapolis

N. H. Winchell, state geologist. Collection of rocks, mostly crystalline from the state, 5719 specimens

MISSISSIPPI.

University of Mississippi, University

T. O. Mabry, professor of natural history. Collection of 10,000 specimens

Mississippi agricultural and mechanical college, Agricultural College

George C. Crulman, professor of biology. Collection of 2500 specimens

MISSOURI.

Christian University, Canton

A. J. Youngblood, professor of natural science. Collection of 500 specimens

University of state of Missouri, Columbia

G. C. Broadhead, professor of geology and mineralogy. (Fire in 1892 destroyed a valuable collection) Collection of 1300 specimens

Pritchett school institute, Glasgow

W. N. Holmes, professor of physics and chemistry. Collection of 10,000 specimens

School of Mines and Metallurgy, University of Missouri, Rolla

C. DeKalb, professor of mining and metallurgy. Collection of 4000 specimens

Drury college, Springfield

E. M. Shepard, professor of biology. Collection of 2000 specimens

Westminster college, Fulton

J. W. Lyle, professor of chemistry and zoology. Collection of 2000 specimens

Central college, Fayette

J. W. Kilpatrick, professor of biology. Collection of 1000 specimens

Washington university, St. Louis

G. Hambach, professor of mining and metallurgy. Collections chiefly paleontological, include Shumard and Hambach collections. The latter rich in Blastoidae and Paleozoic Echini

State geological survey, Jefferson City

Charles R. Keyes, state geologist. Collection of 32,000 specimens from the state

Montana.

Montana College of agriculture and mechanic arts, Bozeman

F. W. Traphagen, Ph. D. professor of chemistry, physics and geology. Collection strong in fossils and ores

College of Montana, Deer Lodge

F. N. Guild, professor of chemistry. Collection of 500 specimens from the state, chiefly ores

Nebraska.

University of Nebraska, Lincoln

Erwin H. Barbour, professor of geology and state geologist. No estimate given. Collections large and include those of the State Survey

Creighton university, Omaha

C. Borgmeyer, professor of philosophy and mathematics. Collection of 10,000 specimens

Nebraska Wesleyan university, University Place

C. Fordyce, professor of natural science. Collection of 2000 specimens

Doane college, Crete

J. H. Powers, professor of biology. Collection of 800 specimens

Nevada.

State university, Reno

W. McN. Miller, professor of anatomy and physiology. Collection of 1000 specimens

New Hampshire.

Keene High School, Keene

F. R. Miller, sub-master of the school, is in charge of the collection which numbers about 2100 specimens

Dartmouth college, Hanover

Chas. H. Hitchcock, professor of geology and mineralogy

Mineral collection consists of 2,000 specimens

Geological collection consists of 4,000 specimens

New Hampshire college of agriculture and the mechanic arts, Durham

Clarence M. Weed, professor of zoology and entomology. Collection of rocks of the state and a reference collection of minerals

Keene natural history society, Keene

George A. Wheelock, president. Collection of 1000 specimens

New Jersey.

State Geological Survey, Trenton

John C. Smock, state geologist. Collection illustrating several thousand economic products of the state

University of New Jersey, Princeton

William B. Scott, professor of geology. Collection of 25,000 specimens

Rutgers college, New Brunswick

Albert H. Chester, professor of chemistry and mineralogy. Collection of 11,500 specimens

New Mexico.

New Mexico college of agriculture and mechanic arts, Mesilla Park

E. O. Wooton, professor of botany. Collection of 700 specimens

New York.

Binghamton Academy of Science, Binghamton

N. M. Pierce, president. This society owns several collections but they are not at present arranged for exhibition

Glen Island Museum of Natural History, New Rochelle

Lewis M. McCormick, curator. Collections are small

Ward's Natural Science Establishment, Rochester

Henry A. Ward, president. Collections approximate 340,000 specimens

Canisius College, Buffalo

M. Bischoff, professor of philosophy and astronomy. Collection of 2000 specimens

Cornell university, Ithaca

Ralph S. Tarr, A. C. Gill and Gilbert D. Harris, assistant professors of geology. Collection of 100,000 specimens

Columbia university, New York City

J. F. Kemp, professor of geology. Collection of 75,000 specimens

University of Rochester, Rochester

H. LeR. Fairchild, professor of geology. Collections include: mineralogical 5000; geological 3000; and paleontological 25,000 specimens

Union University, Schenectady

Chas. S. Prosser, professor of geology and paleontology. Collections include: mineralogical 4000; lithological 1010; paleozoic fossils 870; mesozoic 300; cenozoic 200; total 7380 specimens

Hamilton college, Clinton

Chas. H. Smyth, jr, professor of geology and mineralogy. Collections include: mineralogical 10,000; 2500 fossils and rocks illustrating geology of New York, 1750 illustrating geology of United States and 600 silurian fossils from Europe

Vassar college, Poughkeepsie

Wm. B. Dwight, professor of natural history. Collections of 10,000 specimens, include many vertebrate fossils of Tertiary age from Bad Lands, Nebraska

Rensselaer Polytechnic institute, Troy

John M. Clarke, professor of geology. Collection of 18,700 specimens

University of the City of New York, New York

J. J. Stevenson, professor of geology. Collection of 17,000 specimens.

United States Military academy, West Point

S. E. Tillman, professor of chemistry. Collection of 10,000 specimens

Alfred university, Alfred

A. R. Crandall, professor of natural history. Collection of 10,000 specimens

Colgate university, Hamilton

A. P. Brigham, professor of geology and natural history. Collection of 5000 specimens

Manhattan college, New York

Brother Elzear, professor. Collection of 5000 specimens

Polytechnic institute, Brooklyn

David H. Cockran, curator. Collection of 4500 specimens

College of the City of New York, New York

W. Stratford, professor of natural history. Collection of 3070 specimens

St Lawrence university, Canton

Professorship in geology is vacant. Collection of 2000 specimens

Niagara university, Niagara university

P. MacHale, professor. Collection of 2000 specimens

Syracuse university, Syracuse

E. C. Quereau, professor of geology. Collection of 1500 specimens

American museum of natural history, at Central Park, New York city

R. P. Whitfield, curator in geology. (No estimate given.) This museum contains one of the largest and best collections of rocks, fossils, minerals and gems in the world

Brooklyn institute of arts and sciences, Brooklyn

D. S. Martin, dep't of geology. Collections include Braun collection of fossils and rocks; R. P. Stevens collection, Gebhard collection from Schoharie, N. Y. (No estimate given)

Natural science association of Staten Island, New Brighton

Arthur Hollick, secretary. Collection of 500 paleontological and 200 lithological specimens

Buffalo society of natural sciences, Buffalo

Fred K. Mixer, director. Collections include 2165 paleontological and 710 lithological specimens. Good local collections

Hobart college, Geneva

(Professorship in the department of geology is vacant.) Geological and mineralogical collections are extensive but no estimate was given

New York state museum, Albany

F. J. H. Merrill, Ph. D., director. Collections on exhibition are estimated to include: Mineralogical, Kunz, Beck, Gebhard and Emmons collections, total 8200 specimens, 300 species. Paleontological, 13,100 specimens invertebrate fossils from state geological survey, 3600 specimens foreign fossils, an Irish elk, the Cohoes mastodon skeleton and Ward's series of casts of fossils. Lithological, rocks from state survey 2800; Carboniferous, 300; Rosenbusch collection of massive rocks 500, and marbles 51 specimens. Total 28,553 specimens

Economic collection (in construction), 600 specimens

Synoptical collection (in construction), 425 specimens. Large collections stored

Long Island historical society, Brooklyn

M. E. Ingalls, assistant curator. Collections include 600 specimens from glacial drift of Long Island. Rocks of Manhattan Island, 200 specimens, N. Y. State minerals and fossils 900 specimens. Charts and specimens from many well borings

State normal college, Buffalo

I. P. Bishop, professor of natural science. Collections include 300 mineral and 500 fossil species

North Carolina.

State Museum, Raleigh

H. H. Brimley, curator. Extensive collections from the state

University of North Carolina, Chapel Hill

Collier Cobb, professor of geology. Collection of 2860 specimens

Davidson college, Davidson

Henry Louis Smith, professor of geology and mineralogy. Collections contain 10,000 or 11,000 specimens

North Dakota

University of North Dakota, University

E. J. Babcock, professor of chemistry. Collection of 1800 specimens

Red River Valley university, Wahpeton

M. V. B. Knox, professor of biology. Collection of 2000 specimens

North Dakota agricultural college, Fargo

W. H. Whalen, professor of geology. Collection of 530 specimens

Ohio

Ohio state university, Columbus

Edward Orton, professor of geology and state geologist. Collection of 20,000 specimens. Excellent economic collection from the state

Adelbert college, Cleveland

Harry P. Cushing, associate professor of geology. Collection of 12,000 specimens

Antioch college, Yellow Springs

G. H. Hubbell, professor. Collection of 15,000 specimens

Oberlin college, Oberlin

A. A. Wright, professor of geology and natural history. Collection of 7500 specimens

University of Wooster, Wooster

J. Kirkwood, professor of biology and geology. Collection of 3000 specimens

Case school of applied science, Cleveland

F. M. Comstock, professor of geology. Collection of 3000 specimens

Baldwin university, Berea

J. H. Smith, professor of natural science. Collection of 2500 specimens

Urbana university, Urbana

(Vacant.) Collection of 2000 specimens

Hiram college, Hiram

G. H. Colton, professor of natural science. Collection of 1500 specimens

Scio college, Scio

W. G. Compher, professor. Collection of 500 specimens

Otterbein university, Westerville

L. McFadden, professor of chemistry and physics. Collection of 500 specimens

Cincinnati society of natural history, Cincinnati

Joshua Lindahl, museum director. Collections of 2000 specimens include minerals and a very full local collection of fossils, also a general paleontological collection

Heidelberg university, Tiffin

M. E. Kleckner, professor of geology. Collections of fossils and ores of 5000 specimens

OKLAHOMA.

University of Oklahoma, Norman

OREGON.

University of Oregon, Eugene

Thomas Condon, instructor. Collections valued at $10,000

Oregon state agricultural college, Corvallis

G. W. Shaw, professor. Collection of 2000 specimens

Williamette university, Salem

L. Cochran, professor of natural science. Collection of 1200 specimens

Portland university, Portland

J. J. Rippetoe, professor. Collection of 1000 specimens

PENNSYLVANIA.

Swarthmore college, Swarthmore

Spencer Trotter, professor of biology. Collection of 4000 specimens

Philadelphia Academy of Natural Sciences, Philadelphia

Samuel G. Dixon, executive curator. Collection of about 6000 specimens

Washington and Jefferson college, Washington

Ed. Linton, professor of biology. Collection

University of Pennsylvania, Philadelphia

Edward D. Cope, professor of mineralogy and geology. Collections estimated at 20,000 specimens, including 6000 minerals

Lehigh university, South Bethlehem

Edward H. Williams, jr, professor of mining, engineering and geology. Geological collection of 10,000 specimens and valuable lithological, mineralogical and economic collections

Pennsylvania college, Gettysburg

C. S. Breidenbaugh, curator of museum. Collection of 10,000 specimens

Lafayette college, Easton

T. C. Porter, professor of botany and zoology. Collection of 6000 specimens

Allegheny college, Meadville

Jas. H. Montgomery, professor of physics and chemistry. Collection of 20,000 specimens

Westminster college, New Wilmington

S. Thompson, professor of botany, physics and geology. Collection of 6000 specimens

Dickinson college, Carlisle

W. B. Lindsay, professor of chemistry and geology. Collection of 5000 specimens

Bucknell college, Lewisburg

G. G. Groff, professor of natural history. Collection of 4575 specimens

Haverford college, Haverford

H. S. Pratt, professor. Collection of 3000 specimens

Thiel college, Greenville

S. H. Miller, professor. Collection of 1500 specimens

Muhlenberg college, Allentown

Philip Dowell, professor of natural history. Collection of 1000 specimens

Central Pennsylvania college, New Berlin

W. P. Winter, professor of natural sciences and chemistry. Collection of 3600 specimens

Lebanon Valley college, Annville

J. A. Shott, professor of chemistry, etc. Collection of 600 specimens

Geneva college, Beaver Falls

W. McCracken, professor of sciences. Collection of 600 specimens

Boy's central high school, Philadelphia

O. C. S. Carter, professor. Collection of 540 specimens

Pennsylvania Military college, Chester

B. F. Morley, professor of engineering and chemistry. Collection of 500 specimens

Bryn Mawr college, Bryn Mawr

Miss Florence Bascom, professor of geology. Collections contain 679 fossil specimens, 905 mineral specimens, 86 rock specimens and 500 thin sections supplemented by Miss Bascom's private collections of 1440 rock specimens

Wagner free institute of science, Philadelphia

Thomas L. Montgomery, actuary. Collections rich in American Tertiary invertebrates, 1396 trays and 72 type specimens. Also Eocene and Cretaceous from Alabama and Texas, Paleozoic from Kansas and Europe

Pennsylvania State College, State College

Magnus C. Ihlseng, professor of geology. Collections of 7000 geological and 10,000 mineralogical specimens

Philadelphia museums, Philadelphia

W. P. Wilson, director. Extensive geological and mineralogical collections along commercial lines

State geological survey, Philadelphia

J. P. Lesley, State geologist. Extensive state collections, but no estimate given

RHODE ISLAND.

Brown university, Providence

Alpheus S. Packard, professor of zoology and geology. Collections of minerals 10,066; fossils 6850; rocks 2808; total 19,724 specimens

Roger Williams Park museum, Providence

James M. Southwick, curator. Collection of about 2500 specimens

South Carolina.

Wofford college, Spartanburg

D. A. DuPre, professor of chemistry and physics. Collection of 3000 specimens

Claflin university, Orangeburg

J. C. Hartzell, professor of biology and mineralogy. Collection of 1800 specimens

South Carolina military academy, Charleston

C. L. Reese, professor of chemistry and physics. Collection of 1500 specimens

Furman university, Greenville

W. F. Watson, professor of chemistry. Collection of 500 specimens

South Dakota.

Yankton college, Yankton

A. T. Free, professor. Collection of 6000 specimens

State school of mines, Rapid City

F. C. Smith, professor of geology, mining and metallurgy. Collection of 3027 specimens

University of South Dakota, Vermillion

J. E. Todd, professor of geology. Collection of 3500 specimens

State geological survey

James E. Todd, director, Vermillion. Collections include 500 mineral, 1500 fossil, 1000 rock and 300 economic specimens, and are united with those of the state university.

Tennessee.

Vanderbilt university, Nashville

James M. Safford, professor of natural history and geology

Southwestern Presbyterian university, Clarksville

James A. Lyon, professor. Collection of 10,000 specimens

University of Tennessee, Knoxville

C. F. Vanderford, professor. Collection of 3800 specimens

Fisk university, Nashville

F. A. Chase, professor of physical science. Collection of 3000 specimens

Southern normal university, Huntingdon

E. C. McDougle, professor. Collection of 1000 specimens

Carson and Newman college, Mossy Creek

J. C. Welsh, professor. Collection of 1000 specimens

Central Tennessee college, Nashville

William Osburn, professor of natural science. Collection of 1000 specimens

Southwestern Baptist university, Jackson

T. J. Deupur, professor. Collection of 800 specimens

Milligan college, Milligan

Professorship in geology is vacant. Collection of 600 specimens

Maryville college, Maryville

G. S. Fisher, professor. Collection of 500 specimens

Cumberland university, Lebanon

J. I. D. Hinds, dean and professor of chemistry and natural sciences. Collection of 2000 fossils and minerals

Texas.

State Geological Survey

E. T. Dumble, state geologist. Extensive collections from the state

University of Texas, Austin

Fred W. Simonds, professor of geology. Collection of 3300 specimens

Howard Payne college, Brownwood

J. L. Kesler, professor. Collection of 650 specimens

Utah.

University of Utah, Salt Lake City

James E. Talmage, president, and Deseret professor of geology and mineralogy. The museum is that of the Salt Lake literary and scientific association and contains 3000 minerals and rock specimens, 500 vertebrate fossils, 2000 invertebrate fossils, 1000 ethnological specimens. Also 7500 specimens in university museum

Vermont.

University of Vermont, Burlington

G. H. Perkins, professor of natural history. Collection of 3000 specimens

Middlebury college, Middlebury

Edward A. Burt, professor of natural history. Collection of 4000 specimens

Fairbanks museum of natural science, St. Johnsbury

Martha G. Tyler, curator. Collections include fossils of Vermont and students' collections and about 500 varieties of ores, rocks and minerals

Virginia.

University of Virginia, Charlottsville

W. M. Fontaine, professor of geology and natural history. Collection of 12,500 specimens

Roanoke college, Salem

S. C. Wells, professor. Collection of 12,000 specimens

Virginia military institute, Lexington.

N. B. Tucker, professor of mineralogy and geology. Collection of 3347 specimens

Virginia agricultural and mechanical college, Blacksburg

T. L. Watson, professor. Collection of 2250 specimens

Emory and Henry college, Emory

J. L. Yarman, professor. Collection of 500 specimens

Washington.

Terry museum, Tacoma

Meriden S. Hill, secretary. Collection of about 500 specimens

Vashon college, Burton

A. C. Jones, professor. Collection of 500 specimens

Tacoma academy of science, Tacoma

Meriden S. Hill, cor. secretary. Geological collection of 500 specimens

State geological survey, Seattle

Henry Landes, state geologist. Economic collection of 1575 specimens, at State university

West Virginia.

West Virginia university, Morgantown
S. B. Brown, professor. Collection of 5000 specimens

Wisconsin.

University of Wisconsin, Madison
C. R. Van Hise, professor. Collection of 15,000 specimens

Northwestern university, Watertown
C. A. Ernst, professor. Collection of 5000 specimens

Milton college, Milton
L. Kumlien, professor. Collection of 5000 specimens

Lawrence university, Appleton
D. Nicholson, professor of natural history. Collection of 3000 specimens

Ripon college, Ripon
C. D. Marsh, professor of biology. Collection of 2800 specimens

Seminary of St. Francis de Sales, St. Francis
L. E. Drexel, professor. Collection of 1500 specimens

Beloit college, Beloit
Geo. L. Collie, curator. Collection of 1200 specimens

Milwaukee public museum, Milwaukee
Dr. Edwin W. Bartlett, president. Collection of 4695 minerals and 11,270 specimens of fossils

Wisconsin academy of sciences, arts and letters, Madison
Albert S. Flint, secretary. Collections are united with those of the University of Wisconsin, but separately labeled. They include the type fossils from the Silurian described in the geology of Wisconsin.

Wyoming.

University of Wyoming, Laramie
W. C. Knight, professor of mining and metallurgy. Collection of 500 specimens

CANADA.

Communicated by Dr. Geo. W. Dawson, assistant director geological survey of Canada.

Provincial museum, Halifax, Novia Scotia

Kings college, Windsor, Nova Scotia

Dalhousie college, Halifax, Nova Scotia

Acadia college, Wolfville, Nova Scotia

Natural history society of New Brunswick, St. John, New Brunswick

Includes the collections of the Mechanics' institute. These are kept separate, and include the collection of Dr. Gesner (rocks, minerals and fossils), made when he was employed on the Geological Survey of New Brunswick. Some of Hartt's fossil insect types are also possessed by the society.

University of New Brunswick, Fredericton, New Brunswick.

Laval university, Quebec, Que.

The nucleus of this collection was the old Cabinet de Mineralogie of the Quebec seminary. The arrangement of the collections was undertaken by Dr. T. Sterry Hunt. Of special interest is a collection of minerals made by the Abbe Haüy for the Quebec seminary. The Mineralogical Cabinet comprises more than 4000 specimens. Good series of Palaeozoic fossils from Bohemia, presented by Joachim Barrande

McGill University, Montreal, Que. (Peter Redpath museum).

Many fine Canadian and foreign minerals and rocks. Collections of Sir J. W. Dawson, largely Carboniferous and Devonian fossil plants. Microsauria and Post-Pliocene mollusks of Canada. Eozoon: Many types of species. The Holmes and Miller collections are incorporated in the general collection of minerals

Natural history society of Montreal, Montreal, Que.

The museum contains the C. U. Shepard Collection of Minerals, presented by Dr. Holmes, and consisting of about 4000 specimens. The mineralogical collections have not been kept up to date, but contain many good specimens of old finds. General collection of fossils

Montreal college, Montreal, Que.

This institution possesses a collection of minerals made by the Abbe Haüy, similar to that at Laval

Queen's university, Kingston, Ont.

General collection of fossils, including that made by Rev. Andrew Bell

Kingston school of mining and agriculture, Kingston, Ont.

Chiefly economic mineral collection

Museum of Geological Survey of Canada, Ottawa, Ont.

The finest and most complete general collection of Canadian minerals, rocks and fossils. The mineral and lithological collection comprises about 7000 Canadian specimens catalogued and on exhibition. Madoc meteorite. The Paleontological collection comprises over 16,000 Canadian specimens classified and exhibited, representing about 4600 species, of which about 1000 are types described by E. Billings and about 400 types described by J. F. Whiteaves. A number of types of Cretaceous and Tertiary plants described by Sir J. Wm. Dawson. Also types of species established by Prof. E. D. Cope, Dr. S. H. Scudder, Prof. T. Rupert Jones, A. H. Ford, Prof. H. A. Nicholson, E. O. Ulrich, Mr. W. R. Billings and others. Among special suites may be mentioned, fossils characterizing the "Quebec Group," of Logan and Billings. Unique collection of Ordovician Crinoids, etc., from Ottawa and vicinity, Devonian fishes from Bay des Chaleurs, original specimens of *Eozoon Canadense.*

Perth high school, Perth, Ont.

Contains a collection comprising many of Dr. James Wilson's original specimens

University of Toronto, Toronto, Ont.

The Ferrier Cabinet of Minerals, collected by W. F. Ferrier. The largest and most complete general collection in Canada.

School of practical science, Toronto, Ont.

Minerals of economic importance, also fair general collection

Victoria university, Toronto, Ont.

Large meteorite found south of Victoria, N.W.T., 3000 paleontological specimens, 1000 minerals

Hamilton association, Hamilton, Ont.

Includes some interesting local fossils

Ontario agricultural college, Guelph, Ont.

J. Hoyes Panton, professor of geology. Collection of Canadian rocks, minerals and economic minerals

Historical and scientific society of Manitoba, Winnipeg, Man.

Includes a few interesting local fossils

Provincial museum, Victoria, B. C.

Economic minerals, fossils, chiefly Cretaceous

Geological Survey of Newfoundland, St. John's, N. F'l'd

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REPORT

OF THE

STATE BOTANIST.

1896

REPORT.

To the Honorable the Regents of the University of the State of New York:

GENTLEMEN.—I have the honor of submitting to you the following report:

Since the date of my last report, specimens of plants of the State have been collected by the Botanist in the counties of Albany, Essex, Franklin, Greene, Hamilton, Herkimer, Livingston, Onondaga, Rensselaer, Saratoga, Suffolk, Ulster and Wyoming.

Specimens have been contributed that were collected in the counties of Albany, Delaware, Dutchess, Essex, Madison, Monroe, Onondaga, Queens, Rensselaer, Saratoga, St. Lawrence, Warren, Washington and Westchester.

The whole number of species represented by specimens added to the Herbarium is 402, of which the collections of the Botanist represent 367, the contributed specimens 35.

The number of species not before represented in the Herbarium, of which specimens have been added, is 99. Of these, 81 belong to the collections of the Botanist and 18 are represented by the contributed specimens.

Of the species new to the Herbarium, 33 are considered new to science and are described in this report for the first time. Specimens of 27 of these are among the collections of the Botanist, the remaining 6 are represented by contributed specimens.

A list of the names of the species of which specimens have been added to the Herbarium is marked A.

Specimens of plants have been contributed by 43 contributors. Many of their contributions represent species not yet found within the limits of our State. Some of these, though sent for identification merely, have been found to be new or undescribed species and will be carefully preserved as the types of the species represented by them.

A list of the contributors and of their respective contributions is marked B.

A record of species new to our flora, giving locality, time of collecting and other matters of interest concerning them; also in case of new species giving descriptions of them, has been made. A few plants previously reported and regarded as mere varieties of other reported species have now been either raised or restored to the rank of distinct species and included in this record. It is marked C.

According to previous custom, a record of observations upon certain species already reported has been made. This will be found to contain various matters of interest concerning those plants, such as new stations for rare species, an extension of previously known geographical range, unusual habitats, noticeable variations and descriptions of new varieties. It is marked D.

In some of the preceding reports a collation in systematic order has been made of all the known New York species belonging to some particular genus, and full descriptions of the species, generally supplemented by additional remarks on their peculiarities, relations and distinctive features, have been given. This work was begun with the purpose of gradually bringing together material for a descriptive manual of all our agarics. These little monographs have been well received and have been a source of much aid to students of our American mycology. They have been so highly appreciated in some instances that special requests have been received for the reports containing them. Another step has therefore been taken in the present report in pursuance of this plan by the collation of the descriptions of our species of the genus Flammula. This part of the report is marked E.

There is a constantly and rapidly increasing demand for such a descriptive manual as these and the remaining contemplated generic monographs would make if brought together in one volume. Such a volume, especially if each genus could be illustrated by a colored figure of some prominent or type species, would add greatly to the general interest in this branch of mycology and would give to its study a strong forward impulse. The demand for this kind of literature seems to increase more rapidly than its supply. Earnest wishes that such a work might soon be available have repeatedly been made known to me, and I have sometimes been surprised at the indications of a great and widespread interest in this lowly and apparently unattractive class of plants. The fact that these plants exhibit an intelligent design in their structure and are just as capable of systematic arrangement and classification as the higher orders of plants doubtless has much to do in arousing an interest in them, but probably the great promise they give of affording a useful reward for their study in the form of a desirable article of food has also something to do with it. The numerous and earnest applications in advance of its publication for copies of the forthcoming Forty-eighth Report, which contains an illustrated and descriptive account of our edible and poisonous fungi, are indications of this.

The past season has been unusually productive of certain crops. Wild plants have in some instances vied with cultivated ones in showing what large crops of fruit they could produce. The choke cherry shrubs of the Adirondack region have been as heavily loaded in proportion to their size as the apple trees of our orchards. Their branches have been weighed down by their loads of fruit. And this great and unusual productiveness has been seen in some of our agarics. The common mushroom, *Agaricus campester*, was never before known by me to be more plentiful in our State. It began to make its appearance earlier than usual, generous crops being found early in August, and it continued to appear in great abundance until cold weather stopped its growth. Even moderate frost does not stop its development, for sometimes, as during the autumn of 1895, and also of 1896, plentiful gatherings of it were made after the ground had been white with frost. The markets of Albany have recently been supplied with an unusual abundance of them. They have been exposed for sale by dealers on whose stands they have rarely if ever before been seen. They have been peddled about the streets and offered for sale at the low price of fifteen cents a quart. Farmers in the vicinity of our large cities have found in them a volunteer crop of their pastures that has added no insignificant amount to their incomes. A correspondent writing from Utica says that the crop of the common mushroom in Oneida county was of extraordinary abundance and that the mushrooms were sold in Utica by farmers and peddlers at twenty cents a quart and that he never before knew them to be plentiful enough to be sold at retail in this way.

Another correspondent, who resides in an adjoining State, and who is an enthusiastic mycophagist, writes that he has at last had a sufficiency of mushrooms, and that they have been offered for sale at his door in such quantity that he has been obliged to decline to purchase them even at the extremely low price of five cents a quart. A newspaper report affirms that in a village in the western part of the State mushrooms were sold in lots of ten quarts for twenty-five cents, a rate of two and a half cents a quart. This is a good illustration of the effect of a bountiful supply upon the price of an article.

In many places the smooth mushroom, *Lepiota naucinoides*, has been quite as plentiful as the common mushroom. In some respects this is superior to the common mushroom. It is less liable to the attack of insects, it will keep longer in good condition and it presents a more attractive appearance when cooked, as its gills do not turn black with age or under the influence of heat. Its flavor is thought by some to be inferior to that of the common mushroom, but others affirm that even in this respect it is more delicate and desirable. It has a wider range of habitat, growing in lawns, pastures, grassy places by roadsides, in the plowed land of potato and corn fields and even in thin woods. From its clean white color, the people of some localities have given it the local name of "white mushroom." It has sometimes been mistaken for the chalky mushroom, *Agaricus cretaceus*. But if we may trust the writings of the best European authors in this matter, the chalky mushroom has brown spores, but the smooth mushroom has white spores, although agreeing closely with the chalky mushroom in many of its characters. This fungus was so abundant about Albany that one lover of mushrooms brought in about a peck of them one day, and affirmed that where he picked them he could easily have filled a barrel with those left behind. I have recently received more letters of inquiry concerning the name, character and edibility of this mushroom than of any other. Its neat appearance and great abundance have attracted attention and suggested the possibility of its edibility and awakened in its observers a desire for information concerning it. It therefore seems proper to attribute some of the present interest in the subject of mushrooms to the abundant crop of certain species that the favorable conditions of the season have produced.

In the Forty-first Report an index of the genera and species mentioned in reports twenty-two to thirty-eight inclusive, was published. A similar index has been prepared for the ten succeeding reports, thirty-nine to forty-eight, and is herein included. It is marked F.

In the prosecution of my investigations of the edible qualities of our more promising species of mushrooms, a considerable number have been tried and of these, eight species additional to those already reported seem to me worthy of being placed in the list of edible ones. But the room now occupied in part by me is poorly lighted and not a very suitable place in which to do work requiring a good light. It has, therefore, seemed to me best to omit for the present the attempt to make proper illustrations of these and to report on them, hoping that soon better facilities for such work will be available.

By reason of the requirements of the State Engineer, the room previously occupied in the State Hall as an office for the Botanist and a place for the State Herbarium was vacated in January and the Herbarium cases, containing the mounted specimens and a part of the duplicates, were transferred to the fourth floor of the Capitol and placed in one of the corridors near the office of the State Entomologist.

The remaining duplicates, the specimens unsuitable for mounting, that had been arranged in trays and kept in table cases, the greater part of the specimens of fungi belonging to the exhibit of our State at the World's Columbian Exposition and the models of fungi donated to the State Herbarium by the Agricultural Department at Washington, were packed in boxes and are now in storage on the fifth floor of the Capitol.

Desk room and space for a table was given me for temporary occupancy in one of the rooms of the State Entomologist. By this arrangement my work is necessarily hindered and the proper care of the stored specimens is practically placed beyond my control. They are not accessible for inspection, reference, study or comparison, and if kept long in that condition they are liable to suffer injury and possibly irreparable loss.

The specimens in the Herbarium cases are kept under lock and key, but the light glass-paneled doors of the cases do not furnish all the safeguard to the contents that is desirable. It is, therefore, greatly to be hoped that this state of things will not continue longer than is absolutely necessary, and that soon suitable safe and adequate accommodations will be assigned to the Herbarium and the necessary office and working room to the Botanist.

Respectfully submitted,

CHAS. H. PECK.

ALBANY, *November* 30, 1896.

(A.)

PLANTS ADDED TO THE HERBARIUM.

New to the Herbarium.

Geranium molle *L.*
G. dissectum *L.*
Prunus Mahaleb *L.*
P. nigra *Ait.*
Amelanchier spicata *DC.*
A. oligocarpa *Ræm.*
Pimpinella Saxifraga *L.*
Sanicula gregaria *Bick.*
Coreopsis tinctoria *Nutt.*
Senecio obovatus *Muhl.*
S. Balsamitæ *Muhl.*
Azalea lutea *L.*
Lysimachia vulgaris *L.*
Symphytum asperrimum *Sims.*
Monarda punctata *L.*
Fissidens incurvus *Schwægr.*
Diplophyllum taxifolium *Dum.*
Jungermannia autumnalis *DC.*
Amanita magnivelaris *Pk.*
Amanitopsis pusilla *Pk.*
Lepiota subprocera *Saut.*
L. Miamensis *Morg.*
L. rugoso-reticulata *Lorin.*
Tricholoma ionides *Bull.*
Clitocybe virens *Scop.*
Collybia nigrodisca *Pk.*
C. uniformis *Pk.*
Pleurotus mastrucatus *Fr.*
Lactarius serifluus *Fr.*
Russula anomala *Pk.*
R. albella *Pk.*
R. cyanoxantha *Fr.*
R. ochrophylla *Pk.*
R. pusilla *Pk.*
Marasmius impudicus *Fr.*
Entoloma grande *Pk.*
Nolanea picea *Kalchb.*
Pholiota rugosa *Pk.*
P. confragosa *Fr.*
Flammula magna *Pk.*
F. rigida *Pk.*
Inocybe unicolor *Pk.*
Cortinarius nitidus *Fr.*
Paxillus Curtisii *Berk.*
Stropharia siccipes *Karst.*
Hypholoma capnoides *Fr.*
Psathyra umbonata *Pk.*
Psathyrella hirta *Pk.*
Coprinus quadrifidus *Pk.*
Boletus auripes *Pk.*
B. firmus *Frost.*
B. fumosipes *Pk.*
B. illudens *Pk.*
B. rubropunctus *Pk.*
Polyporus umbellatus *Fr.*
Hydnum fennicum *Karst.*
H. spongiosipes *Pk.*
H. vellereum *Pk.*
H. albonigrum *Pk.*
H. mirabile *Fr.*
H. separans *Pk.*
H. serratum *Pk.*
Hydnochæte setigera *Pk.*
Radulum Pini-Canadense *Schw.*
Odontia ramosissima *Pk.*
Coniophora subochracea *Pk.*
Exobasidium Peckii *Halst.*
Phyllosticta Apocyni *Trel.*
P. limitata *Pk.*
Dendrophoma crassicollis *S. & S.*
Diplodina quercina *Pk.*
Pestalozzia breviseta *Sacc.*
Puccinia Prenanthis *Fckl.*
Æcidium Rhamni *Pers.*
Æ. Senecionis *Desm.*
Coleosporium Campanulæ *Wint.*
Septoria Lobeliæ-syphiliticæ *Henn.*
Clavaria platyclada *Pk.*
Oidium erysiphoides *Fr.*
Œdocephalum intermixtum *Pk.*
Sporotrichum entomophilum *Pk.*
Ramularia occidentalis *E. & K.*

Ramularia cylindriopsis *Pk.*
Verticillium enecans *Speg.*
Cladosporium caricicolum *Cd.*
Heterosporium gracile *Sacc.*
Phragmotrichum Chailletii *Kze.*
Macrosporium Iridis *C. & E.*
M. Amaranthi *Pk.*
Septonema toruloideum *C. & E.*
Entyloma Veronicæ *Lager.*
Peronospora calotheca *DeBy.*
Exoascus Cerasi *Sadeb.*
Peziza subumbrina *Boud.*
Spathularia rugosa *Pk.*
Cenangium Abietis *Rehm.*
Xylaria castorea *Berk.*
Diaporthe decipiens *Sacc.*
Phyllachora Junci *Fckl.*

Not New to the Herbarium.

Hepatica triloba *Chaix.*
Aquilegia vulgaris *L.*
Nymphæa reniformis *DC.*
N. odorata *Ait.*
Corydalis glauca *Pursh.*
Cardamine hirsuta *L.*
C. pratensis *L.*
Nasturtium sylvestre *R. Br.*
Alliaria Alliaria *Britton.*
Lepidium campestre *Br.*
Barbarea vulgaris *R. Br.*
Helianthemum Canadense *Mx.*
Lechea minor *L.*
Arenaria Grœnlandica *Spreng.*
Silene antirrhina *L.*
Anychia dichotoma *Mx.*
Claytonia Virginica *L.*
C. Caroliniana *Mx.*
Tilia pubescens *Ait.*
T. heterophylla *Vent.*
Flœrkea proserpinacoides *Willd.*
Xanthoxylum Americanum *Mill.*
Rhamnus alnifolia *L'Her.*
Euonymus atropurpureus *Jacq.*
Rhus copallina *L.*
Polygala verticillata *L.*
Melilotus officinalis *L.*
Robinia viscosa *Vent.*
Desmodium nudiflorum *DC.*
D. Dillenii *Darl.*
Gymnocladus Canadensis *Lam.*
Prunus Americana *Marsh.*
P. serotina *Ehrh.*
Pyrus coronaria *L.*
Rubus triflorus *Rich.*
Fragaria Virginiana *Mill.*
Cratægus coccinea *L.*
C. punctata *Jacq.*
C. Oxyacantha *L.*
Ribes rubrum *L.*
Cicuta bulbifera *L.*
Zizia cordata *DC.*
Sanicula Canadensis *L.*
S. Marylandica *L.*
Cornus paniculata *L'Her.*
Viburnum Opulus *L.*
Symphoricarpos vulgaris *Mx.*
Galium verum *L.*
G. Mollugo *L.*
G. pilosum *Ait.*
G. trifidum *L.*
Valeriana sylvatica *Banks.*
Erigeron Philadelphicus *L.*
Solidago puberula *Nutt.*
Aster sagittifolius *Willd.*
A. corymbosus *Ait.*
A. puniceus *L.*
A. undulatus *L.*
A. lævis *L.*
A. diffusus *Ait.*
Cichorium Intybus *L.*
Rudbeckia hirta *L.*
Artemisia caudata *Mx.*
Tragopogon porrifolius *L.*
Hieracium scabrum *Mx.*
H. aurantiacum *L.*
Lactuca sativa *L.*
Vaccinium vacillans *Soland.*
Pyrola rotundifolia *L.*
P. chlorantha *Sw.*
P. elliptica *Nutt.*
P. uliginosa *T. & G.*

Pyrola secunda *L.*
Chimaphila maculata *Pursh.*
Monotropa Hypopitys *L.*
Ilex monticola *Gr.*
Lysimachia thyrsiflora *L.*
Symphytum officinale *L.*
Fraxinus viridis *Mx.*
F. Americana *L.*
Asclepias tuberosa *L.*
A. incarnata *L.*
A. quadrifolia *L.*
Phlox subulata *L.*
Gentiana Andrewsii *Griseb.*
Solanum Dulcamara *L.*
Linaria vulgaris *Mill.*
Veronica Americana *Schw.*
Gerardia flava *L.*
Plantago major *L.*
Amaranthus hypochondriacus *L.*
Atriplex patulum *L.*
Phytolacca decandra *L.*
Rumex crispus *L.*
R. Britannica *L.*
Fagopyrum esculentum *Mœnch.*
Polygonum incarnatum *Ell.*
P. Pennsylvanicum *L.*
P. Hydropiper *L.*
P. acre *H. B. K.*
Sassafras officinalis *Nees.*
Arceuthobium pusillum *Pk.*
Ulmus fulva *Mx.*
Morus rubra *L.*
Carya tomentosa *Nutt.*
C. porcina *Nutt.*
C. amara *Nutt.*
Betula populifolia *Ait.*
Quercus alba *L.*
Q. macrocarpa *Mx.*
Q. bicolor *Willd.*
Q. tinctoria *Bartr.*
Salix candida *Willd.*
Thuja occidentalis *L.*
Corallorhiza innata *R. Br.*
C. multiflora *Nutt.*
Epipactis Helleborine *Crantz.*
Spiranthes latifolia *Torr.*
Habenaria hyperborea *R. Br.*
Habenaria psycodes *Gr.*
Cypripedium arietinum *R. Br.*
C. spectabile *Sw.*
Smilacina trifolia *Desf.*
Trillium erectum *L.*
Calla palustris *L.*
Lemna trisulca *L.*
Triglochin maritima *L.*
Cyperus esculentus *L.*
Eriophorum lineatum *B. & H.*
E. alpinum *L.*
Carex lupulina *Muhl.*
C. livida *Willd.*
C. lurida *Wahl.*
C. Schweinitzii *Dew.*
C. comosa *Boott.*
C. filiformis *L.*
C. stricta *Lam.*
C. xanthosperma *Wright.*
C. Magellanica *Lam.*
C. limosa *L.*
C. virescens *Muhl.*
C. castanea *Wahl.*
C. laxiflora *Lam.*
C. Albursina *Sheld.*
C. styloflexa *Buckley.*
C. aurea *Nutt.*
C. varia *Muhl.*
C. chordorhiza *Ehrh.*
C. stipata *Muhl.*
C. teretiuscula *Good.*
C. straminea *Willd.*
C. fœnea *Willd.*
C. vulpinoidea *Mx.*
Setaria glauca *Bv.*
S. viridis *Bv.*
Panicum macrocarpon *LeConte.*
Andropogon furcatus *Muhl.*
Glyceria nervata *Trin.*
Agropyron repens *Bv.*
Bromus tectorum *L.*
Festuca duriuscula *L.*
Elymus Virginicus *L.*
E. striatus *Willd.*
Asprella Hystrix *Willd.*
Woodwardia Virginica *Sm.*
Aspidium Boottii *Tuckm.*

Aspidium cristatum *Sw.*
Botrychium ternatum *Sw.*
B. Virginianum *Sw.*
Isoetes echinospora (Durieu).
Amanita cæsarea *Scop.*
A. verna *Bull.*
A. Mappa *Fr.*
A. muscaria *L.*
A. Frostiana *Pk.*
A. rubescens *Fr.*
A. solitaria *Bull.*
Amanitopsis vaginata *Roze.*
A. volvata *Sacc.*
A. farinosa (*Schw.*).
Tricholoma tricolor *Pk.*
T. fumidellum *Pk.*
Clitocybe clavipes *Pers.*
C. illudens *Schw.*
C. truncicola *Pk.*
Omphalia Swartzii *Fr.*
Collybia strictipes *Pk.*
C. conigena *Pers.*
Pleurotus ostreatus *Fr.*
P. lignatilis *Fr.*
Hygrophorus parvulus *Pk.*
H. miniatus *Fr.*
H. virgineus *Fr.*
Lactarius volemus *Fr.*
L. subpurpureus *Pk.*
L. trivialis *Fr.*
L. insulsus *Fr.*
L. subdulcis *Fr.*
L. vellereus *Fr.*
L. deceptivus *Pk.*
Russula nigricans *Fr.*
R. lepida *Fr.*
R. Mariæ *Pk.*
R. virescens *Fr.*
R. flavida *Frost.*
R. variata *Banning.*
R. crustosa *Pk.*
R. decolorans *Fr.*
R. alutacea *Fr.*
Cantharellus cinereus *Fr.*
C. aurantiacus *Fr.*
C. infundibuliformis *Fr.*
Marasmius oreades *Fr.*
Marasmius præacutus *Ellis.*
Lenzites betulina *Fr.*
Pluteus umbrosus *Pers.*
P. longistriatus *Pk.*
Entoloma rhodopolium *Fr.*
Clitopilus Prunulus *Scop.*
Leptonia formosa *Fr.*
Pholiota angustipes *Pk.*
Inocybe infelix *Pk.*
I. rimosa *Bull.*
I. geophylla *Sow.*
Flammula spumosa *Fr.*
F. flavida *Pers.*
Naucoria semiorbicularis *Bull.*
Galera lateritia *Fr.*
Cortinarius collinitus *Fr.*
C. corrugatus *Pk.*
C. violaceus *Fr.*
C. cinnamomeus *Fr.*
C. distans *Pk.*
Paxillus involutus *Batsch.*
P. atrotomentosus *Fr.*
P. panuoides *Fr.*
Agaricus campester *L.*
A. arvensis *Schæff.*
A. silvicola *Vitt.*
Hypholoma fasciculare *Huds.*
Psathyrella disseminata *Pers.*
Poria floccosa *Fr.*
Strobilomyces strobilaceus *Berk.*
Boletus bicolor *Pk.*
B. pallidus *Frost.*
B. subtomentosus *L.*
B. griseus *Frost.*
B. variipes *Pk.*
B. eximius *Pk.*
B. affinis *Pk.*
B. vermiculosus *Pk.*
B. Frostii *Russell.*
B. scaber *Fr.*
B. gracilis *Pk.*
B. indecisus *Pk.*
B. felleus *Bull.*
B. castaneus *Bull.*
B. cyanescens *Bull.*
Hydnum imbricatum *L.*
H. repandum *L.*

Hydnum fruscens *Pers.*
H. albidum *Pk.*
H. aurantiacum *A. & S.*
H. scrobiculatum *Fr.*
H. zonatum *Batsch.*
H. Caput-ursi *Fr.*
H. strigosum *Sw.*
H. ochraceum *Pers.*
H. subfuscum *Pk.*
H. rimulosum *Pk.*
Craterellus Cantharellus *Schw.*
C. cornucopioides *Pers.*
Thelephora laciniata *Pers.*
Stereum spadiceum *Fr.*
S. sericeum *Schw.*
S. versiforme *B. & C.*
S. albobadium *Schw.*
Anthurus borealis *Burt.*
Fuligo varians *Rost.*
Amaurochæte atra (*A. & S.*)
Hemiarcyria rubiformis *R.*
Sphærobolus stellatus *Tode.*
Phyllosticta Podophylli *Wint.*
Glœosporium Apocyni *Pk.*
Puccinia Taraxaci *Plow.*
P. Mariæ-Wilsoni *Clint.*
Ustilago Junci *Schw.*
U. Cesatii *Fisch.*
Uredo Agrimoniæ *Schrœt.*
Cæoma nitidum *Schw.*
Æcidium Iridis *Ger.*
Oidium destruens *Pk.*
Rhopalomyces Cucurbitarum *B. & C.*
Verticillium Lactarii *Pk.*
Botrytis Streptothrix *Sacc.*
Rhinotrichum ramosissimum *B. & C.*
Zygodesmus pannosus *B. & C.*
Z. olivascens *B. & C.*
Spathularia flavida *Pers.*
Pezicula carpinea *Tul.*
Patellaria fusispora *C. & P.*
Daldinea concentrica *C. & D.*
D. vernicosa *C. & D.*

(B.)

CONTRIBUTORS AND THEIR CONTRIBUTIONS.

Mrs. E. C. Anthony, Gouverneur, N. Y.

Viola cucullata *Ait.*
Aralia nudicaulis *L.*
Solidago puberula *Nutt.*
Lysimachia stricta *Ait.*
Cypripedium acaule *L.*
Spiranthes cernua *L.*
Spiranthes Romanzoffiana *Cham.*
Fissidens incurvus *Schwægr.*
Amanitopsis pusilla *Pk.*
Tricholoma ionides *Bull.*
Polyporus umbellatus *Fr.*

Mrs. L. L. Goodrich, Syracuse, N. Y.

Pyrus coronaria *L.*
Galium verum *L.*
Epipactis Helleborine *Crantz.*

Mrs. E. G. Britton, New York, N. Y.

Frullania Eboracensis *Lehm.*
Lejeunia serpyllifolia *Lib.*
Blepharostoma trichophyllum *Dum.*
Cephalozia bicuspidata *Dum.*
Scapania nemorosa *Dum.*
Diplophyllum taxifolium *Dum.*
Chiloscyphus polyanthos *Cd.*
Myla Taylori *Gray.*
Jungermannia attenuata *Lind.*
J. autumnalis *DC.*
Marsupella emarginata *Dum.*
Plagiochila porelloides *Lind.*
Aneura bifrons *Lind.*
Tetraplodon mnioides *L. f.*

Mrs. E. Watrous, Hague, N. Y.

Liparis Lœselii *Rich.*

Mrs. H. C. Davis, Falmouth, Me.

Clavaria platyclada *Pk.*

Miss M. L. Overacker, Syracuse, N. Y.

Buda marina *Dum.*
Poterium Sanguisorba *L.*

Mrs. J. A. Lintner, Albany, N. Y.

A collection of about 70 species of dried plants.

Mrs. M. Fuller, Washington, D. C.

Armillaria robusta *A. & S.*
Hydnum fuligineo-album *Schm.*

Arthur K. Harrison, Lebanon Springs, N. Y.

Viola rostrata *Pursh.*
Hypericum nudicaule *Walt.*
Arenaria serpyllifolia *L.*
Vicia Cracca *L.*
Cratægus coccinea *L.*
Cornus paniculata *L'Her.*
Houstonia purpurea *L.*
Ambrosia artemisiæfolia *L.*
Antennaria plantaginifolia *Hook.*
Epigæa repens *L.*
Cuscuta Gronovii *Willd.*
Utricularia cornuta *Mx.*
Rumex Acetosella *L.*
Juncus articulatus *L.*
Cyperus diandrus *Torr.*
C. filiculmis *Vahl.*
Eleocharis acicularis *R. Br.*
Bromus tectorum *L.*
Onoclea sensibilis *L.*
Botrychium Virginianum *Sw.*
Lycopodium clavatum *L.*

Geo. R. Howell, Albany, N. Y.

Artemisia caudata *Mx.*

Augustus Lathrop, Menands, N. Y.

Rudbeckia hirta *L.*

F. C. Stewart, Jamaica, N. Y.

Exobasidium Peckii *Halst.*
Ramularia cylindriopsis *Pk.*
Phyllosticta limitata *Pk.*
Amaurochæte atra (*A. & S.*).
Oidium destruens *Pk.*
Diplodina quercina *Pk.*
Exoascus Cerasi *Fckl.*

M. S. Baxter, Rochester, N. Y.

Aspidium Boottii *Tuckm.*

J. H. Barnhart, Tarrytown, N. Y.

Alliaria Alliaria *Britt.*
Kneiffia fruticosa (*L.*).
Azalea lutea *L.*

L. M. Underwood, New York, N. Y.

Anthoceros lævis *L.*
A. Hallii *Aust.*
A. fusiformis *Aust.*
A. Carolinianus *Mx.*
Riccia nigrella *DC.*
Aytonia erythrosperma *Und.*
Cyathophora quadrata *Trev.*
Lepidozia sphagnicola *Evans.*
Nardia Macounii *Und.*
Chiloscyphus polyanthos *Cd.*
Plagiochila Virginica *Evans.*
Jungermannia Novæ-Cæsareæ *Evans.*
Cephalozia fluitans *Spruce.*
C. Turneri *Lindb.*
Porella pinnata *L.*
Frullania Selwyniana *Pers.*
Lejeunia Macounii *Spruce*
L. serpyllifolia *Lib.*
Kantia Sprengelii (*Mart.*)
Blepharostoma nematodes (*Aust.*)
Lentinus Underwoodii *Pk.*
L. ventricosus *Pk.*
Pholiota sabulosa *Pk.*
Flammula Underwoodii *Pk.*
Boletus tabacinus *Pk.*
Puccinia argentata *Wint.*
Coleosporium Campanulæ *Wint.*

G. F. Atkinson, Ithaca, N. Y.

Sphagnum teres *Angst.*
S. intermedium *Hoffm.*
S. Girgensohnii *Russ.*
Sphagnum acutifolium *Ehrh.*
S. squarrosum *Pers.*
S. Wulfianum *Girg.*

M. B. Fernald, Cambridge, Mass.

Aster Herveyi *Gr.*

W. D. Jackson, Bridgewater, Mass.

Inocybe radiata *Pk.*

F. B. Southwick, Brooklyn, N. Y.

Anthurus borealis *Burt.*

A. C. Waghorne, Bay of Islands, N'fld.

Amphisphæria inæqualis *E. & E.*
Panus betulinus *Pk.*
Sclerotinia infundibuliformis *Pk.*

J. B. Fuller, Rochester, N. Y.

Lepidium campestre *Br.*
Nasturtium sylvestre *R. Br.*
Geranium molle *L.*
Phlox subulata *L.*
Arceuthobium pusillum *Pk.*
Solanum Dulcamara *L.*
Symphytum asperrimum *Sims.*
Rumex crispus *L.*
Œnothera pumila *L.*
Setaria viridis *Bv.*
Bromus tectorum *L.*

Stewart H. Burnham, Vaughns, N. Y.

Nymphæa reniformis *DC.*
Solidago puberula *Nutt.*
Aster sagittifolius *Willd.*
Pimpinella Saxifraga *L.*
Aspidium Boottii *Tuckm.*
Botrychium ternatum *Sw.*

F. L. Harvey, Orono, Me.

Poria violacea *Fr.*
Hypomyces violaceus *Tul.*
Peziza odorata *Pk.*
Embolus ochreatus *Sacc.*
Heydenia fungicola *Pk.*

E. Bartholomew, Rockport, Kan.

Lepiota Morgani *Pk.*
L. mutata *Pk.*
Psathyrella debilis *Pk.*
P. gracillima *Pk.*
Polyporus Bartholomæi *Pk.*
Tylostoma punctatum *Pk.*
T. obesum *C. & E.*
Lycoperdon lilaceum *B. & M.*
Scleroderma Corium *Grav.*
Stereum albobadium *Schw.*
Corticium argentatum *E. & E.*
Pistillaria Bartholomæi *E. & E.*
Hypoxylon Caries (*Schw.*).
Puccinia tecta *E. &. B.*
P. Triodiæ *E. & B.*
P. Kansensis *E. & B.*
P. clavispora *E. & B.*
P. jubata *E. & B.*
P. vexans *Arth.*
P. Bartholomæi *Diet.*
P. Xanthifoliæ *E. & E.*
Cryptophallus albiceps *Pk.*

A. J. McClatchie, Pasadena, Cal.

Lentinus magnus *Pk.*
Tubaria tenuis *Pk.*
Hypholoma atrifolium *Pk.*
Montagnites Candollei *Fr.*

H. W. Barratt, Poughkeepsie, N. Y.

Tricholoma terreum *Schæff.* var. fragrans *Pk.*

E. C. Howe, Troy, N. Y.

Kœleria cristata *Pers.*
Agropyron violaceum *Lange.*
Polyporus conchifer *Schw.*

F. C. Yeomans, Camas, Wash.

Clitocybe subsocialis *Pk.*
Omphalia luteola *Pk.*
Galera semilanceata *Pk.*
Boletinus appendiculatus *Pk.*

C. G. Lloyd, Cincinnati, Ohio.

Dædalea Kansensis *Ellis.*
Marasmius gregarius *Pk.*

H. Webster, East Milton, Mass.

Lactarius luteolus *Pk.*

F. G. Howland, Saratoga Springs, N. Y.

Clitocybe dealbata *Sow.*

J. Dearness, London, Canada.

Melogramma horridum *E. & E.*

J. A. Lintner, Albany, N. Y.

Sporotrichum entomophilum *Pk.*

B. Jones, New York, N. Y.

Flammula magna *Pk.*

W. Herbst, Trexlertown, Penn.

Russula subdepallens *Pk.*

C. McIlvaine, Haddonfield, N. J.

Cortinarius intrusus *Pk.*
Flammula edulis *Pk.*

G. E. Francis, Worcester, Mass.

Tricholoma acre *Pk.*
T. polyphyllum *DC.*
Tricholoma pallidum *Pk.*

R. K. Macadam, Boston, Mass.

Cortinarius intrusus *Pk.*

Calvin Shaffer, Albany, N. Y.

An ear of corn with all its kernels smutted.

R. F. Dearborn, Lynn, Mass.

Lepiota rhacodes *Vitt.*

W. Frothingham, Albany, N. Y.

Agaricus campester *L.*

W. Hailes, Albany, N. Y.

Agaricus campester *L.*
A. Rodmani *Pk.*
Lepiota naucinoides *Pk.*

H. C. Beardslee, Cleveland, Ohio.

Boletus rubropunctus *Pk.*

(C.)

SPECIES OF PLANTS NOT BEFORE REPORTED.

Geranium molle *L.*

Grassy places. Rochester. June. Collected by *Mary E. Macauley;* communicated by *J. B. Fuller.*

This plant has been introduced into this country from Europe and is occasionally spontaneous.

Geranium dissectum *L.*

Waste places. Vaughns, Washington county. June. *S. H. Burnham.* This also is an introduced species which is sometimes spontaneous. It resembles our indigenous Carolina crane's bill, *G. Carolinianum,* from which it may be separated by its shorter, nearly globular, finely-pitted seeds. It is a rare species.

Prunus Mahaleb *L.*

Rocky bank of the Hudson river above Lansingburg, Rensselaer county. May and June.

This small cherry as well as our other introduced and cultivated species is sometimes spontaneous.

Prunus nigra *Ait.*

Meadowdale, Helderberg mountains, and various places in Essex county. May.

This wild plum has commonly been considered a mere form or variety of our common wild red plum, *Prunus Americana.* But it seems to me that greater accuracy will be attained and the purposes of science will be better subserved if it is kept separate. Both species occur in the vicinity of Albany and present noticeable differences. In *P. nigra* the flowers are rather larger and sometimes, at least, if not always, the petals assume a pink or rosy hue with advancing age. The fruit is larger and its stone is larger and more compressed.

Amelanchier oligocarpa *Rœm.*

Adirondack mountains. Why this plant was ever reduced to the rank of a mere variety of *A. Canadensis* is more than I can clearly understand. It differs from that species in its leaves, flowers and fruit, and so far as my observation goes, in the size it attains, and the habitat it manifestly prefers. Its leaves are thinner and smooth even when young, they are pointed at the base, tapering into a petiole but two to three lines long, its flowers are smaller and fewer in a cluster, its fruit is oval rather than globose and the plant appears to delight in the cool shade of mountain forests and in elevated situations. It flowers in June and ripens its fruit in July and August.

Amelanchier spicata *DC.*

Sandy soil. Karner, Albany county. Thin shaly soil covering rocks. Near Lansingburg, Rensselaer county. Flowering in May, in fruit in June and July.

This plant, as it occurs with us, is well marked and quite distinct in the character of its leaves. These are very unlike those of the preceding species in character and texture. They are thick and firm, densely woolly on the lower surface when young, orbicular or oval and very obtuse at both ends. They are more coarsely serrate than in our other species, and the serratures are mostly limited to the upper half of the leaf. The petiole varies in length from three to six lines. The flowers are small and commonly numerous, giving a spike-like appearance to the racemes. The plants are small, those of the Lansingburg station scarcely exceeding a foot in hight, yet they were found flowering and fruiting.

Pimpinella Saxifraga *L.*

In a meadow near Vaughns. *Burnham.* This is an introduced species rarely found growing spontaneously.

Sanicula gregaria *Bicknell.*

Near Albany. June. This species has recently been separated from *S. Marylandica,* with which it has been confused. The fertile flowers have long styles as in that species, but it is more gregarious in its mode of growth, its petals are yellowish, its stem naked below the branches or at most bearing but one leaf, and its rather numerous radical leaves have only five leaflets each, the basal leaflets not being deeply cleft as in both *S. Marylandica* and *S. Canadensis.*

Coreopsis tinctoria *Nutt.*

In a meadow between Ballston and Round Lake, Saratoga county. August.

This plant is indigenous west of the Mississippi river. It is often cultivated as an ornamental plant and it sometimes escapes from cultivation and becomes sparingly spontaneous.

Azalea lutea *L.*

Tarrytown. May. *J. Hendley Barnhart.* Pennsylvania is given in the Manual as the northern limit of the range of this beautiful flame-colored azalea (*Rhododendron calendulaceum* Torr. in the Manual), but its recent discovery in Westchester county extends this limit northward and adds a pretty flowering shrub to our flora.

Senecio obovatus *Muhl.*

Rather moist soil in thin woods. Southfields, Orange county, and New Baltimore, Greene county. June.

This and the next following species were reported by Dr. Torrey as varieties of *Senecio aureus.* But the present tendency of our leading botanists is to recognize their specific rank. They are, therefore, now reported as valid species. The radical or basal leaves furnish the most available characters for the separation of the four species formerly lumped together under one name. The distinguishing features may be tabulated as follows:

Radical leaves cordate....................	S. aureus.
Radical leaves not cordate................	1
1 Radical leaves round, obovate or spatulate, tapering below into a somewhat flattened or margined and commonly glabrous petiole........	S. obovatus.
1 Radical leaves oblong or oblong-lanceolate, crenately toothed, tapering below into a slender more or less hairy or tomentose petiole........	S. Balsamitæ.
1. Radical leaves oblong or lanceolate, sharply serrate, almost truncate at the base or abruptly narrowed into the glabrous petiole...........	S. Robbinsii.

Senecio Balsamitæ *Muhl.*

Rocky places or thin soil covering rocks. Brownsville, Jefferson county, and Whitehall, Washington county. June.

In the Forty-seventh Report, page 16, this plant was confused with *S. Robbinsii* and subjoined to it as variety *subtomentosa*. It is clearly distinct.

Lysimachia vulgaris *L.*

The common loosestrife was doubtless introduced into this country as an ornamental garden plant, but it sometimes escapes from cultivation and is found growing freely in waste places and by roadsides. Cedarville, Herkimer county. June.

Symphytum asperrimum *Sims.*

Roadsides. Chili, Monroe county. *Mrs. J. H. McGuire.* Communicated by *J. B. Fuller.*

This has been introduced and cultivated as a fodder plant, but like many others it is disposed to run wild.

Fissidens incurvus *Schwægr.*

Rocks in damp places. Trout lake, St. Lawrence county. October. *Mrs. E. C. Anthony.*

Diplophyllum taxifolium *Dumort.*

Wet cliffs. Avalanche Pass, Essex county. August. *Mrs. E. G. Britton.* In the Manual this plant bears the name *Diplophyllum albicans* var. *taxifolium.*

Jungermannia autumnalis *DC.*

Trail to Rock falls, Adirondack mountains. August. *Mrs. Britton.*

Amanita magnivelaris *n. sp.*

Pileus convex or nearly plane, glabrous, slightly viscid when moist, even on the margin, white or yellowish-white; lamellæ close, free, white; stem long, nearly equal, glabrous, white, furnished with a large membranous white annulus, sheathed at the base by the appressed remains of the membranous volva, the bulbous base tapering downwards and radicating; spores broadly elliptical, .0004 in. long, .00024 to .0003 broad.

Pileus 3 to 5 in. broad; stem 5 to 7 in. long, 4 to 6 lines thick.

Solitary in woods. Port Jefferson, Suffolk county. July.

The species resembles *Amanita verna,* from which it is separated by its large persistent annulus, the elongated downwardly tapering bulb of its stem and especially by its elliptical spores.

Amanitopsis pusilla *n. sp.*

Pileus thin, broadly convex or nearly plane, subglabrous, slightly umbonate, even on the margin, pale brown; lamellæ narrow, thin, close, free, becoming brownish; stem short, hollow, bulbous, the bulb margined by the remains of the membranous volva; spores broadly elliptical, .0002 to .00024 in. long, .00016 broad.

Pileus about 1 in. broad; stem 8 to 12 lines long, 1 to 2 lines thick.

Grassy ground. Gouverneur, St. Lawrence county. September. *Mrs. Anthony.*

Lepiota subprocera *Saut.*

Round Lake, Saratoga county. August. This plant differs but little from *L. procera,* the parasol mushroom. Its smaller size and smooth unspotted stem are the chief marks of distinction. The author of the species claims that the scales of its pileus are more persistent, but these are commonly persistent in undoubted *L. procera.*

Lepiota Miamensis *Morg.*

Thin woods and heathy places. Fulton Chain, Herkimer county. August.

Our specimens differ slightly from the typical form in being smaller and in having the pileus sometimes umbonate. This is 6 to 12 lines broad and the stem is 12 to 18 lines long in our specimens.

Lepiota rugoso-reticulata *Lorin.*

Open mossy or heathy places. Sand Lake, Rensselaer county, Saranac Lake, Franklin county, and Karner, Albany county.

This species resembles *L. amianthina* in color, but in size and shape and in the attachment of the lamellæ it approaches *L. granulosa.* Its distinguishing characters are its rugose or rugose-reticulated pileus and its strong odor. This is unpleasant and resembles that of vegetable mold or mossy humus. The surface of the pileus is commonly radiately wrinkled and the rugosity is usually more pronounced in the center of the pileus than toward or on the margin. Specimens sometimes occur that have the surface of the pileus even. The flesh is white when dry and the lamellæ are white. The stem is yellowish within but it has a white pith or is hollow. It is pale ochraceous below the slight or evanescent annulus. The pileus also is of this color and both are granulose. The margin of the pileus is often appendiculate with the remains of the veil.

Tricholoma ionides *Bull*

Grassy ground and lawns. Gouverneur. Sept. *Mrs. Anthony.* The specimens are smaller than the typical form, the pileus being one inch or less in diameter.

Clitocybe virens *Scop.*

Thin woods. Selkirk, Albany county. Aug. This species, like *C. odora,* has an agreeable fragrance, but it may be distinguished from that plant by its thin pileus and thin narrow crowded white lamellæ.

Collybia nigrodisca *n. sp.*

Pileus thin, convex, glabrous, whitish or smoky white with a brown or blackish disk, flesh white; lamellæ rather broad, subdistant, rounded behind, adnexed, whitish inclining to creamy yellow; stem equal, hollow, pruinose, even or but slightly striate, whitish; spores subelliptical, .00024 to .0003 in. long, .00016 broad.

Pileus 1 to 1.5 in. broad; stem 1 to 1.5 in. long, about 2 lines thick.

Sandy soil. Wading River, Suffolk county. July.

In size and in the character of the lamellæ this plant bears some resemblance to *Marasmius oreades*, but in other respects it is far different.

Collybia uniformis *n. sp.*

Pileus thin, hemispherical or convex, glabrous, hygrophanous, grayish-brown when moist, paler when dry, the thin margin even, at first involute or strongly incurved; lamellæ narrow, crowded, rounded behind, nearly free, whitish; stem equal, glabrous or slightly pruinose, hollow, grayish-brown, with a slight white mycelioid tomentum at the base; spores minute, subglobose, .00012 to .00016 in. broad.

Plant cæspitose; pileus 3 to 6 lines broad; stem about 1 in. long, 1 line thick.

Among mosses on much decayed wood. Saranac Lake. Sept.

The species belongs to the tribe Confertipedes and is related to *C. acervata*, *C. Familia*, etc. The plants are quite regular and uniform in size and shape.

Pleurotus mastrucatus *Fr.*

Decaying wood. Bethlehem, Albany county. September. This species is very rare with us, but it is well marked by the gelatinous upper stratum of the pileus.

Lactarius serifluus *Fr.*

Woods. Port Jefferson, Suffolk county. July.

The plants referred to this species in Report 24, p. 74, proved to be distinct and were published in Report 28, p. 50, under the name *Lactarius aquifluus*. The plants now under consideration agree well with the description and figures of *L. serifluus* and are believed to be the true species.

Russula anomala *n. sp.*

Pileus thin, fragile, nearly plane or somewhat centrally depressed, with no viscid or separable pellicle, distinctly striate on the margin, white, flesh white, taste acrid; lamellæ thin, moderately close, adnate, entire or with an occasional short one intervening, white, dusted with the white spores when dry; stem equal, solid or spongy within, white; spores subglobose, .0003 to .00035 in. broad.

Pileus 1 to 1.5 in. broad; stem 1 to 1.5 in. long, 3 to 4 lines thick.

Damp ground under trees. Port Jefferson. July.

This plant has the fragile pileus and striate margin characteristic of the tribe Fragiles, but its pileus is destitute of the viscid separable pellicle which also belongs to species of that tribe. If it had a viscid pileus it would approach *Russula fragilis* so closely that it might be regarded as a white variety of that species. It will probably be better to refer it to the tribe Rigidæ, notwithstanding the fragile character of its pileus and its distinctly striate margin.

Russula pusilla *n. sp.*

Pileus very thin, nearly plane or slightly and umbilicately depressed in the center, glabrous, slightly striate on the margin, red, sometimes a little darker in the center, the thin pellicle separable, flesh white, taste mild; lamellæ broad for the size of the plant, subventricose, subdistant, adnate or slightly rounded behind, white, becoming yellowish-ochraceous in drying; stem short, soft, solid or spongy within, white; spores faintly tinged with yellow, .0003 in. broad.

Pileus scarcely 1 in. broad; stem 6 to 12 lines long, 2 to 3 lines thick.

Bare ground in thin woods. Port Jefferson. July.

The coloring matter of the pileus may be rubbed upon paper and produce on it red stains if the surface is previously moistened with water or dilute alcohol. This is one of the smallest Russulas known to me. The pileus is less than an inch broad and the stem less than an inch long in all the specimens seen by me. The species is closely allied to *R. puellaris*, and especially resembles the variety *intensior* in color. It differs in its smaller size, even or but slightly striate margin, broad lamellæ and in the stem or flesh not becoming yellowish-spotted where touched.

Russula ochrophylla *n. sp.*

Pileus firm, convex becoming expanded and often somewhat centrally depressed, even or rarely very slightly striate on the margin when old, purple or dark purplish-red, flesh white, purplish under the adnate cuticle, taste mild; lamellæ entire, a few of them forked at the base, subdistant, adnate, at first yellowish, at length bright ochraceous-buff, dusted by the spores when dry, the interspaces somewhat venose; stem equal or nearly so, solid or spongy in the center, reddish or rosy tinted, paler than the pileus; spores bright ochraceous-buff, globose, verruculose, .0004 in. broad.

Pileus 2 to 4 in. broad; stem 1.5 to 2.5 in. long, 6 to 10 lines thick.

Grassy ground under oak trees. Menands. July.

Var. albipes n. var. Pileus deep red; stem white; otherwise like the type.

In the size of the plant and the color of the pileus and stem this is almost exactly like *Russula drimeia,* as shown by Cooke's Illustr. pl. 1023. It also agrees in nearly all points with the description of that species, differing only in the color of the lamellæ and spores and in its mild taste. It is therefore with some hesitation that I have separated it as a distinct species. The flavor has been made a character of such prime importance in distinguishing the species of Russula that in Massee's recent work, British Fungus Flora, all the British species are grouped in two Sections, one of which depends upon its species having a mild taste, the other, an acrid one. It scarcely seems right to disregard a character to which so much importance has been given, and therefore I have recognized it. In the figure of *R. drimeia,* to which I have referred, the lamellæ are of a canary yellow, a color which I have not seen in the lamellæ of our plant. In it they are at first pale yellow, but when mature and in the dried state both they and the spores are almost exactly the color called in Ridgway's Nomenclature of Colors, ochraceous-buff. If there is any departure they are a shade brighter.

The mild taste of our plant led me to try its edible qualities. The flavor was not at all disagreeable, but the firmness of the flesh was such that it might be called rather tough, and it would probably exclude this species from the first class of edible mushrooms. If stewed in milk or cream the liquid assumes some of the purplish or pinkish-purple hue of the mushroom. This coloration would probably be avoided if the mushrooms were peeled before stewing.

According to Cooke, the flavor of *R. drimeia* is " so intensely peppery that after tasting a small fragment, the tongue tingled for more than half an hour. "

Russula cyanoxantha *Fr.*

Grassy ground. Menands. August.

Russula albella *n. sp.*

Pileus thin, fragile, dry, plane or slightly depressed in the center, even or obscurely striate on the margin, commonly white, sometimes tinged with pink or rosy red, especially on the margin, flesh white, taste mild; lamellæ entire, white, becoming dusted by the spores; stem equal, solid or spongy within, white; spores white, globose; .0003 in. broad.

Pileus 2 to 3 in. broad; stem 1 to 2 in. long, 3 to 4 lines thick.

Dry soil of frondose woods. Port Jefferson. July.

Closely allied to *R. lactea*, but differing in its fragile texture, entire lamellæ, more slender stem and in the pileus not cracking into areolæ.

Marasmius impudicus *Fr.*

Under pine trees and sweet fern bushes. Delmar. September.

Entoloma grande *n. sp.*

Pileus fleshy, thin toward the margin, glabrous, nearly plane when mature, commonly broadly umbonate and rugosely wrinkled about the umbo, moist in wet weather, dingy yellowish-white verging to brownish or grayish-brown, flesh white, odor and flavor farinaceous; lamellæ broad, subdistant, slightly adnexed, becoming free or nearly so, often wavy or uneven on the edge, whitish becoming flesh-colored with maturity; stem equal or nearly so, solid, somewhat fibrous externally, mealy at the top, white; spores angular, .0003 to .0004 in. long and broad.

Pileus 4 to 6 in. broad; stem 4 to 6 in. long, 8 to 12 lines thick.

Thin mixed woods. Menands. August.

The flavor of this mushroom is not at first disagreeable, but an unpleasant burning sensation is left in the mouth for a considerable time after tasting. It is therefore to be regarded with suspicion.

Nolanea picea *Kalchb.*

Pileus thin, varying from broadly conical to convex or nearly plane, often irregular from its crowded or cæspitose mode of growth, even, covered with a grayish pruinosity, hygrophanous, blackish when moist, grayish-brown when dry, the thin even margin at first incurved and slightly tinged with red, extending beyond the lamellæ; lamellæ moderately close, rounded behind and slightly adnexed, often becoming ventricose with the expansion of the pileus, more or less serrate on the margin, whitish then flesh-colored; stem equal, often flexuose, stuffed or hollow, reddish-brown or blackish; spores narrowly elliptical, .0003 to .0004 in. long, .0002 broad.

Pileus 8 to 24 lines broad; stem 1 to 1.5 in. long, 1 to 2 lines thick.

Among chips. Adirondack mountains. September.

This fungus has the fishy odor of such species as *Nolanea nigripes* and *N. pisciodora,* to which it is closely related, but from which it differs in its glabrous or merely pruinose pileus and in its coloration. We have referred it to *N. picea,* although it differs in some minor particulars from the description of that species. On this account we have recorded the description of our plant as made at the time of the collection of the specimens. It will be seen that there is no papilla on the pileus in our plant, yet this is given as one of the characters of the European species. Still the figures of it as given by Kalchbrenner himself and also by Gillet show no papilla, and for this reason especially we have the more confidently considered our plant as specifically the same.

Pholiota rugosa *n. sp.*

Pileus thin, broadly conical or campanulate becoming expanded and often umbonate, hygrophanous, yellowish-red or ferruginous and striatulate on the margin when moist, pale yellow or buff and commonly rugose when dry; lamellæ close, adnexed, yellowish-white or cream-colored becoming ferruginous or brownish-ferruginous with age, white and minutely denticulate on the edge; stem flexuose, equal or slightly thickened toward the base, hollow, fibrillose or sometimes squamulose below the annulus, pruinose or mealy above, pallid, the annulus membranous, white or whitish, radiately striate on the upper surface; spores narrowly elliptical, .0004 to .0005 in. long, .00024 to .00028 broad.

Pileus 6 to 12 lines broad; stem 1 to 2 in. long, 1 to 2 lines thick.

Ground among decaying chips. Adirondack mountains. September.

The fibrils of the lower part of the stem have a tawny hue. The species is closely related to *P. togularis*, from which it is separated because of the hygrophanous pileus and the adnexed lamellæ. From *P. blattaria* the different color adnexed lamellæ and larger spores separate it. The peculiar upper surface of the annulus is similar to that indicated in the figure of *P. togularis* var. *filaris*, as given by Fries.

Pholiota confragosa *Fr.*

Decaying wood in woods. Adirondack mountains. September.

This is apparently a variable species. Our specimens resemble more closely the long-stemmed form figured by Fries, but this form also sometimes has the slight but evanescent hairy flocs or scales when young, although the figures do not show them. European authors do not agree in the characters ascribed to the spores of this species; one describing them as " elliptic-oblong, ferruginous 8x4," another as " subellipsoid or sphaeroid-ellipsoid, yellowish, 5-6x3-5 or 12x5." These can not all be correct, and it is probable that two or three species have been confused. In our plant the spores are really naviculoid or boat shaped. They are about .0003 in. long, and .00016 or .0002 broad, according to the position they are in, being more narrow when viewed edgewise than when viewed flatwise. In color they are pale ferruginous or yellowish-ferruginous. *P. unicolor*, according to the description, has broader lamellæ and longer spores.

Flammula magna *n. sp.*

Pileus fleshy, broadly convex, soft, dry, fibrillose and somewhat virgate, pale yellow or buff, the margin commonly becoming revolute with age, flesh whitish or yellowish; lamellæ close, adnate or slightly decurrent, often crisped or wavy toward the stem, about three lines wide, ochraceous; stem equal or thickened toward the base, fleshy-fibrous, solid, elastic, fibrillose, colored like the pileus, brighter yellow within; spores subelliptical, ochraceous, .0004 in. long, .00024 broad.

Cæspitose; pileus 4 to 6 in. broad; stem 3 to 4 in. long, 8 to 12 lines thick.

About the base of trees. Westchester county. October. *Basset Jones.*

This is a large and showy species. The stems are sometimes united at the base into a solid mass. The young lamellæ are probably yellow, but I have seen only mature specimens.

Flammula rigida *n. sp.*

Pileus thin, rather firm and rigid, convex becoming nearly plane or centrally depressed, sometimes wavy on the margin, glabrous, hygrophanous, rusty-tawny or subferruginous when moist, buff or grayish-buff when dry, flesh concolorous; lamellæ moderately close, adnate, creamy white, becoming rusty tan color or subferruginous; stem equal or nearly so, tough, slightly striate, colored like the pileus, with a compact white tomentum on the lower part or at the base; spores broadly elliptical, .0003 to .00035 in. long, .00016 to .0002 broad.

Pileus 1 to 1.5 in. broad; stem 1 to 2 in. long, 1.5 to 3 lines thick.

Chip dirt about an old lumber camp. Adirondack mountains. September.

The plants are gregarious and by their mycelium they adhere closely to chips and fragments of wood from which they grow and which are usually pulled up with them when they are gathered.

Inocybe unicolor *n. sp.*

Pileus at first conical or very convex, becoming expanded or broadly convex, firm, tomentose-squamulose, pale-ochraceous or grayish-ochraceous, flesh white; lamellæ broad, subdistant, somewhat ventricose, pale-ochraceous when young, tawny-brown when old; stem slender, equal, firm, flexuose, solid, squamulose, colored like the pileus; spores tawny-brown, elliptical, even, .0004 to .0005 in. long, .0002 to .00025 broad.

Pileus 8 to 12 lines broad; stem 1 to 1.5 in. long, 1 to 2 lines thick.

Clay soil. Menands. July. This plant resembles *Inocybe ochracea*, from which it may be separated by its more highly colored squamulose stem and its larger spores. It belongs to the tribe Squarrosæ.

Cortinarius nitidus *Fr.*

Swampy woods. Gansevoort. August.

Paxillus Curtisii *Berk.*

Decaying pine wood and stumps. Mechanicville and Round Lake. September and October. The description of this species appears to have been omitted from Saccardo's Sylloge Fungorum. It resembles *Paxillus panuoides* in size and general habit, but it differs from that species very decidedly in its orange-colored narrow lamellæ, which are more wavy or crisped and more branched and connected. Sometimes they anastomose throughout their whole length, sometimes they are forked near the margin of the pileus and abundantly crisped and connected toward the base. The spores are minute, .00016 in. long, .00008 broad. The color of the pileus in the typical form is said to be sulphur-yellow and the substance tawny. In our specimens the pileus is commonly tawny and the flesh yellow, just the reverse of the characters ascribed in the type. The pileus is apt to become blackish in drying, either wholly or in part, and the plant emits a peculiar strong odor, which it retains for a long time even in the dried state.

Stropharia siccipes *Karst.*

On dung in pasture. Jordanville, Herkiner county. June.

This dung-inhabiting mushroom is related to *Stropharia stercoraria* and *S. semiglobata*, but it differs from both in its dry flocculose and minutely fibrillose stem. The veil is white and often adheres in fragments to the margin of the pileus, thereby making an approach to the genus Hypholoma. In such cases the annulus is very slight or wholly wanting. The stem is stuffed with a white cottony pith, but it sometimes becomes hollow with age. The pileus is viscid when moist and quite variable in color.

Hypholoma capnoides *Fr.*

On and about spruce stumps and decaying wood of spruce. Adirondack mountains. September.

Psathyra umbonata *n. sp.*

Pileus submembranous, campanulate, umbonate, hygrophanous, purplish-brown and striatulate when moist, grayish-white when dry, even or slightly rugulose, atomate, the umbo commonly paler than the rest; lamellæ rather broad, moderately close, ventricose, subadnate, brownish-red, becoming purplish-brown and finally almost black; stem slender, flexuose, hollow, white, commonly hairy-tomentose at the base and slightly mealy at the top; spores blackish-brown or almost black, .0005 to .0006 in. long, .0003 broad.

Chip dirt. Lake Pleasant. July.

The species is apparently related to *Psathyra corrugis*, but differs in the color of the pileus and of the young lamellæ and in the flexuose stem. The umbo is very prominent and when the pileus begins to lose its moisture the umbo becomes very conspicuous, for it first loses color and becomes much paler than the rest, appearing like a whitish knob in the midst of a dark background. The margin of the young pileus is straight and sometimes shows vestiges of a slight grayish fibrillose veil. In dried specimens the pileus is apt to become sulcate-striate or radiately sulcate.

Coprinus quadrifidus *n. sp.*

Pileus thin, at first oval, then campanulate, finally more or less expanded with the margin revolute, when young adorned with a superficial floccose-tomentose veil, which soon separates into evanescent flakes or scales and reveals the finely striate surface of the pileus, whitish becoming grayish or grayish-brown with age, the margin often wavy or irregular; lamellæ broad, thin, crowded, free, at first whitish, then dark purplish-brown, finally black; stem equal or slightly tapering upward, hollow, floccose-squamulose, white, sometimes with a slight evanescent floccose ring near the base; spores .0003 to .0004 in. long, .00016 to .0002 broad.

Plant gregarious or cæspitose; pileus 2 to 3 in. broad; stem 3 to 4 in. long, 3 to 4 lines thick.

Damp vegetable mold or much decayed wood under basswood trees. Portage. June.

When mature the pileus becomes perforated in the center and soon splits into three to five, commonly four, segments, the divisions extending a short distance down the stem, allowing the parts of the pileus to droop on the recurved upper parts of the stem. This remarkable feature of the species has suggested the specific name. The plant is referable to the tribe Tomentosi, but the pileus soon becomes glabrous. The veil is whitish or slightly yellowish. The spores appear at first to be brownish-black, but they become black after a short exposure.

Psathyrella hirta *n. sp.*

Pileus thin, hemispherical or convex, adorned when young with erect or spreading tufts of white, easily detersible and quickly evanescent hairs, hygrophanous, brown or reddish-brown and slightly striatulate when moist, pale grayish-brown or dingy whitish when dry, flesh subconcolorous; lamellæ broad, moderately close, adnate and often furnished with a decurrent tooth, at first pallid, becoming blackish-brown or black; stem flexuose, squamose, hollow, shining, white; spores elliptical, black, .0005 to .00055 in. long, .00025 to .0003 broad.

Subcæspitose; pileus 4 to 6 lines broad; stem 1 to 2 in. long 1 to 1.5 lines thick.

Dung or dungy ground in shaded places. Adirondack mountains. July.

The species has some points of similarity to *Psathyra gossypina* and *P. pennata*, but its adnate lamellæ and black spores distinguish it from both. The hairs of the pileus are coarse and vanish so easily that they are preserved with difficulty in the dried specimens.

Boletus auripes *n. sp.*

Pileus convex, subglabrous, yellowish-brown, sometimes cracking in areas when old, flesh yellow, fading to whitish with age; tubes nearly plane, their mouths small, subrotund, at first stuffed, yellow; stem nearly equal, solid, even or slightly reticulated at the top, bright yellow, a little paler within; spores ochraceous-brown tinged with green, .0005 in. long, .0002 broad.

Pileus 3 to 6 in. broad; stem 3 to 5 in. long, 8 to 12 lines thick.

Under mountain laurel, *Kalmia latifolia*. Port Jefferson. July.

The whole plant, except the upper surface of the pileus, is of a beautiful yellow color. The stem is sometimes more highly colored than the tubes. The species is referable to the tribe Edules.

Boletus firmus *Frost.*

Thin woods. Ballston lake. August. The spores in our plant are broader than the dimension given in the description. They are .0005 in. long and .00024 broad. In other respects the agreement with the description is very close.

Boletus fumosipes *n. sp.*

Pileus convex or nearly plane, minutely tomentose, sometimes minutely rivulose, dark olive-brown, flesh whitish; tubes at first nearly plane, becoming convex with age, their mouths whitish when young, becoming yellowish-brown, changing to bluish-black where bruised; stem equal, solid, smoky-brown, minutely scurfy under a lens; spores purplish-brown, .0005 to .0006 in. long, .0002 to .00025 broad.

Pileus 1 to 2 in. broad; stem 1 to 2 in. long, 3 to 4 lines thick.

Woods. Port Jefferson. July.

This species resembles small dark colored forms of *B. chrysenteron*, and this resemblance is still more noticeable in those specimens in which the pileus cracks in areas, for in these the chinks become red as in that species. The different color of the stem and tubes will at once separate these species.

Boletus illudens *n. sp.*

Pileus convex, dry, subglabrous, yellowish-brown or grayish-brown, sometimes tinged with red, especially in the center, flesh pallid or yellowish; tubes bright yellow, plane or somewhat convex when old, adnate, their mouths angular or subrotund, often larger near the stem; stem nearly equal, sometimes abruptly pointed at the base, glabrous, pallid or yellowish, coarsely reticulated either wholly or at the top only; spores oblong or subfusiform, yellowish-brown tinged with green, .00045 to .0005 in. long, .00016 to .0002 broad.

Pileus 1.5 to 3 in. broad; stem 1.5 to 2.5 in. long, 3 to 5 lines thick.

Woods and copses. Port Jefferson. July.

This species bears a strong resemblance to *B. subtomentosus*, with which it doubtless has been confused. The strong point of distinction is in the reticulated stem, which should place it among the Calopodes. In large specimens these coarse reticulations extend to the base of the stem, in smaller ones they are often limited to the upper part. The spores when first dropped on white paper are dark green or olive green, but they fade to a yellowish-brown, barely tinted with green.

Boletus rubropunctus *n. sp.*

Pileus convex, glabrous, reddish-brown, flesh yellowish, unchangeable; tubes nearly plane, depressed about the stem, their mouths small, round, bright golden yellow, not changing color where bruised; stem firm, solid, tapering upward, yellow, punctate with reddish dots or squamules; spores olive-green, .0005 in. long, .00016 to .0002 broad.

Pileus 1 to 2 in. broad; stem 1 to 2 in. long, 3 to 6 lines thick.

Woods. Port Jefferson. July. Cold Spring Harbor. *H. C. Beardslee.*

This is a pretty boletus, well marked by the red dots of the stem. It is apparently a very rare species. *B. radicans* is said to have the stem sprinkled with red particles, but that is a larger plant with the margin of the pileus persistently involute or incurved and with a radicating stem, characters which are not shown by our fungus.

Polyporus umbellatus *Fr.*

Gouverneur, St. Lawrence county. *Mrs. E. C. Anthony.*

Hydnum fennicum *Karst.*

Woods, on naked soil or among fallen leaves. Port Jefferson. July.

Our plant differs in some respects from the description of the European species, but its general correspondence is so close that it can scarcely be specifically distinct. The European fungus is said to have an acerb taste, approaching, in this respect, *H. acre.* But this species is described as having a bitterish peppery taste. In our fungus the taste is bitter, resembling that of *Boletus felleus*. It has a farinaceous odor and a slight farinaceous flavor with the first taste, but this is soon overcome by the very bitter flavor.

Hydnum albonigrum *n. sp.*

Pileus convex or nearly plane, broadly obconical, tough but soft and densely tomentose on the upper surface, buff-brown or smoky brown, often wholly covered with a whitish downy tomentum, sometimes on the margin only, substance within soft tomentose and buff-brown in the upper stratum, the lower half hard and black; aculei short, at first white, then whitish or grayish; stem short, often irregular compressed or confluent, blackish when moist, buff-brown when dry, covered with a thick dense tomentum, which is frequently more abundant toward the base, hard and black within; spores white, globose, .00016 to .0002 in. broad.

Pileus 1 to 3 in. broad, sometimes two or three confluent; stem 1 to 2 in. long.

Ground in mixed woods. Gansevoort. August.

This species is apparently near *H. nigrum*, but it is well marked by the peculiar structure of the pileus which is similar to *H. mirabile* in having the upper half densely tomentose and soft, the lower half hard and black and continuous with the stem. Like that species also the tomentum of the pileus and stem imbibes much moisture in wet weather, which may be pressed out in drops. It is also near *H. velutipes*, but according to the description, that species is fuscous murine in color, paler within and its spores are smaller, and no mention is made of the difference in texture of the upper and lower part of the pileus.

Hydnum vellereum *n. sp.*

Pileus nearly plane, tough, subcoriaceous, sometimes centrally uneven or colliculose, downy-tomentose, whitish or cinereous from the overspreading tomentum, or somewhat brownish-ferruginous and whitish on the margin, within fibrous, ferruginous-brown; aculei short, about one line long, white or whitish inclining to brownish-ferruginous; stem short, colored like the pileus and often covered with a whitish tomentum; spores white, globose, minutely echinulate, .00016 in. broad.

Pileus 6 to 18 lines broad; stem 6 to 10 lines long, about 2 lines thick.

Gregarious among fallen leaves in woods. Port Jefferson. July.

This species appears to be very much like the preceding one, from which it is separated by its smaller size and the paler brownish or ferruginous-brown substance of the pileus and stem.

Hydnum spongiosipes *n. sp.*

Pileus convex, soft, spongy-tomentose, but tough in texture, ferruginous-brown, the lower stratum more firm and fibrous, but concolorous; aculei slender, 1 to 2 lines long, ferruginous-brown, becoming darker with age; stem hard and corky within, externally spongy-tomentose, colored like the pileus, the central substance often transversely zoned, especially near the top; spores subglobose, nodulose, purplish-brown, .00016 to .00024 in. broad.

Pileus 1.5 to 4 in. broad; stem 1.5 to 3 in. long, 4 to 8 lines thick.

Woods. Rensselaer and Saratoga counties. August.

This plant was formerly referred to *Hydnum ferrugineum* Fr., to which it is closely related and of which it may perhaps be a variety. But having observed it for several years I find it constantly differing from the Friesian plant as figured and described in Icones Hymenomycetum, in having the pileus convex and the stem covered with a dense spongy tomentum, colored like the pileus and quite distinct in texture from the hard central part. The figure of *H. ferrugineum* shows a depressed pileus and a stem paler in color and of a uniform texture that is without any external tomentose coating. Nor does the description ascribe such a character to the stem of the European plant.

Hydnum mirabile *Fr.*

A plant answering fairly well to the description and figure of this species was found in the sandy soil of woods near Port Jefferson. Its structure is of that peculiar character ascribed by Fries to his species, and which apparently suggested the specific name, *mirabile*. Its odor when the flesh is cut or broken, is farinaceous and its taste is also farinaceous at first, but quickly becomes hot or peppery like the taste of acrid species of Lactarius and Russula. It is to be regretted that Fries neglected to note the flavor of species of Hydnum, for it is of value in their identification.

The substance of the stem and pileus, except the superior stratum of the latter, is brittle when fresh, but compact and slightly or lineately zoned within, a character not ascribed by Fries to his plant. It becomes hard and woody when dry. It might be called compactly fleshy when fresh and moist, and then it has some points of agreement with *H. acre* Quel. But Quelet fails to notice any difference in texture in the upper and lower strata of the pileus in his plant, a feature well shown by our specimens and strongly emphasized by Fries in the description of *H. mirabile*. For this reason we have referred our plant to *H. mirabile*, although otherwise agreeing quite well with the description of *H. acre*. The description of *H. mirabile* attributes an alutaceous color to the pileus, but the figure indicates a pale yellow color. In our plant the color varies from grayish-buff to brownish-buff. Possibly our plant may prove to be a species distinct from both.

Hydnum separans *n. sp.*

Resupinate, white; subiculum membranous, at first pure white, becoming yellowish or cream color with age; aculei subulate, glabrous, crowded, 2 to 3 lines long, fragile, easily separating from the subiculum and leaving in it alveolar impressions; spores globose, colorless, .00016 in. broad.

Much decayed wood of deciduous trees. Adirondack mountains. July.

After the teeth have been separated from the subiculum it resembles somewhat a shallow-pored species of Poria. By this character, the thinner subiculum and the smaller spores the species may be separated from *H. mucidum*, to whch it is allied.

Hydnum serratum *n. sp.*

Resupinate, white; the subiculum thin, somewhat gelatinous, livid white or bluish-tinted; aculei crowded, short, somewhat confluent in small fasciculate compact clusters, compressed, serrate on the sides and at the apex, white, sometimes slightly tinged with straw color.

Decorticated wood of spruce, *Picea Mariana*. Adirondack mountains. September.

This fungus forms patches several inches in extent. In external appearance it is suggestive of *H. Artocreas*, but it is much thinner, with shorter, more compressed and serrate teeth. This last character will also separate the species from *H. fasciculare*.

Hydnochæte *n. gen.*

Subiculum effused, submembranous, floccose-tomentose, setigerous; aculei subulate, setigerous.

A hydnoid genus of which the typical species is like a resupinate Hydnum or more nearly like *Caldesiella ferruginosa*, but it differs in having its hymenium furnished with small smooth colored setæ, which gives to the Hydnei a genus corresponding to Hymenochæte among the Thelephorei and to Mucronoporus among the Polyporei.

Hydnochæte setigera *n. sp.*

Subiculum thin, at first grayish-tawny or pale tawny, tomentulose, setigerous, the margin even and concolorous or sometimes somewhat fimbriate and whitish or grayish-white; aculei at first short, subconical, blunt, pale tawny, becoming subulate with age, about one line long, villosely setigerous, persisting through the winter and becoming ferruginous or dark ferruginous, the plant becoming stratose by the development of a new subiculum and new aculei over the old ones each year, the setæ simple or branched, .0016 to .0024 in. long, slender, sharp pointed; spores pale, subglobose or broadly elliptical, .0002 to .0003 in. long.

Decaying wood of pine, spruce and hemlock. Adirondack mountains. July to September. I have also received specimens of the first year's growth of this fungus from Professor Underwood, who collected them on the White mountains.

Although forming strata, this species must be very distinct from the plant described by Rev. M. J. Berkeley under the name *Hydnum stratosum*. In its first year it is so similar in general appearance to *Caldesiella ferruginosa* Sacc., (*Hydnum ferruginosum* Fr.) that by a careless observer it might easily be mistaken for it, but its paler color and the presence of setæ will at once separate it.

The setæ of the aculei are mostly simple and project at right angles from them, but those of the subiculum are generally longer and are often stellately or radiately branched from a common base. Rarely one or two short branches project horizontally from near the base. The plants form patches varying from several inches to several feet in extent. They begin to develop in June or July and apparently do not always become mature before September.

Radulum Pini-Canadensis *Schw.*

Bark of hemlock, *Tsuga Canadensis.* Gansevoort. August.

Odontia rimosissima *n. sp.*

Effused, very thin, determinate, crustose, adnate, abundantly rimose, at first whitish, then pallid or somewhat grayish-ochraceous; granules very minute, scarcely visible to the naked eye, subconical, distant or crowded, bearing one or several setæ at the apex; spores broadly elliptical, commonly uninucleate, .0002 to .00024 in. long, .00014 to .00016 broad.

Wood and bark of alder, *Alnus incana.* Sand Lake. November.

Coniophora subochracea *n. sp.*

Effused, membranous, the subiculum composed of whitish webby filaments; hymenium greenish-ochraceous, even or minutely papillose, finally cracking and revealing the thin subiculum and the matrix; spores numerous, broadly elliptical, colored, .00024 in. long, .00016 broad.

Decaying wood and bark in dark damp places. Menands. October.

Clavaria platyclada *Pk.*

Woods and swamps. Adirondack mountains. September.

Near *C. fusiformis*, but separated because of its flattened obtuse clubs tapering below into a whitish base.

Exobasidium Peckii *Halstd.*

Living leaves and flowers of stagger bush, *Andromeda Mariana.* Long Island. June. *F. C. Stewart.*

Phyllosticta limitata *n. sp.*

Spots orbicular, small, commonly 1 to 3 lines broad, sometimes confluent, brown or reddish-brown, sometimes becoming gray or having a grayish center, often sterile, definitely limited and surrounded by a narrow slightly elevated brown or blackish-brown margin; perithecia epiphyllous, minute, few, punctiform, black; spores elliptical, .0003 in. long, .00016 broad.

Living leaves of apple, *Pyrus Malus*. Westbury, Queens county. June. *Stewart.*

Phyllosticta Apocyni *Trel.*

Living leaves of *Apocynum androsæmifolium*. Mechanicville. July.

Dendrophoma crassicollis *S. & S.*

Dead bark of ash, *Fraxinus Americana*. Meadowdale. May.

Diplodina quercina *n. sp.*

Perithecia small, .0014 to .0016 in. broad, numerous, erumpent, black; spores narrow, subfusiform, obscurely uniseptate, .0004 to .0006 in. long, .00016 broad, usually containing 2 to 4 nuclei.

Dead twigs of oak. Jamaica. April. *Stewart.*

Pestalozzia breviseta *Sacc.*

Living leaves of apple. Port Jefferson. July.

Puccinia Prenanthis *Fckl.*

Living leaves of rattlesnake root, *Prenanthes alba*. Cedarville, Herkimer county. June. The æcidial state is *Æcidium Prenanthis.*

Æcidium Rhamni *Pers.*

Living leaves of the alder-leaved buckthorn, *Rhamnus alnifolia.* Jordanville, Herkimer county. June. The peridia in our specimens are shorter than in the type.

Æcidium Senecionis *Desm.*

Living leaves of golden ragwort, *Senecio aureus*. Cedarville. June. This is the æcidial state of *Puccinia conglomerata.*

Coleosporium Campanulæ *Wint.*

Living leaves of *Campanula rapunculoides.* Earlville, Madison county. August. *L. M. Underwood.*

Septoria Lobeliæ-syphiliticæ *Henn.*

Living leaves of *Lobelia syphilitica.* Mechanicville, Saratoga county. September. The spores in this species are larger than those of *S. Lobeliæ.*

Oidium erysiphoides *Fr.*

Living leaves of *Potentilla Norvegica.* Karner, Albany county. July. The affected plant has a very unthrifty, deformed appearance.

Œdocephalum intermixtum *n. sp.*

Fertile hyphæ erect, simple, continuous or with one or two obscure septa near the base, white, about .0003 in. thick, terminating above in a slightly inflated verrucose vesicle; spores elliptical or obovate, even, hyaline, .0005 to .001 in. long, .0004 to .0006 broad.

Dead stems of *Iris Germanica,* growing among and intermingled with *Macrosporium Iridis.*

Sporotrichum entomophilum *n. sp.*

Hyphæ very slender, .0001 in. thick, branched, forming a thin white tomentose stratum over the matrix; spores subelliptical, .00016 to .0002 in. long.

Larvæ of elm leaf beetle, *Galerucella luteola.* Albany. September. *J. A. Lintner.*

Ramularia occidentalis *E. & K.*

Living or languishing leaves of great water dock, *Rumex Britannica.* Mechanicville. September.

Ramularia cylindriopsis *n. sp.*

Hyphæ very short or but little diverse from the spores; spores very variable, elliptical oblong or cylindrical, catenulate, continuous, .0003 to .001 in. long, .00016 to .0002 broad.

Living leaves of stagger bush, *Andromeda Mariana.* Westbury, Queens county. June. *Stewart.*

The fungus occupies the whole lower surface of the leaves and it overspreads them with a white flocculent stratum of its spores. It is similar in habit to *R. effusum*, which attacks the leaves of the common huckleberry, *Gaylussacia resinosa*. It sometimes kills both leaves and twigs. It differs from *R. Andromedæ* in its shorter hyphæ, broader spores and different habit.

Verticillium enecans *Speg.*

On some unrecognized species of Marasmius. Voorheesville, Albany county. August.

The parasite completely overspreads the host plant with a thin white felty covering of its hyphæ and soon kills it.

Cladosporium caricicolum *Cd.*

Living leaves of carices. Jordanville. June.

The leaves in our specimens were attacked near the middle and so weakened by the fungus that the apical half had drooped and withered.

Heterosporium gracile *Sacc.*

Dead and languishing leaves of flower-de-luce, *Iris Germanica.* Menands. September.

Phragmotrichum Chailletii *Kze.*

Cone scales of white spruce, *Picea Canadensis.* Minerva, Essex county. July. I am not aware that this interesting and peculiar fungus has before been detected in this country.

Macrosporium Iridis *C. & E.*

Dead flower stems of flower-de-luce, *Iris Germanica.* Menands. September.

Macrosporium Amaranthi *Pk.*

Living leaves of goose-foot, *Chenopodium album.* Mechanicville, Saratoga county. October. (Bull. Torr. Bot. Club, Vol. 22, p. 493, 1895.)

Septonema toruloideum *C. & E.*

Decaying pine wood. Menands. October.

Entyloma Veronicæ (*Halst.*) *Lager.*

Living leaves of American speedwell, *Veronica Americana.* Jordanville. June.

Peronospora calotheca *De By.*

Living leaves of *Galium triflorum.* Cedarville, Herkimer county. June.

The leaves of badly infested plants have a starved appearance and do not attain their usual size, and the plant itself is small and discolored.

Exoascus Cerasi (*Fckl.*) *Sadeb.*

Living leaves of sweet cherry, *Prunus Avium.* Westbury, Cutchogue, Queens, Floral Park and Flatbush, Long Island. May. *Stewart.*

Peziza subumbrina *Boud.*

Black muck soil in woods. Mechanicville. July. The spores in our specimens are binucleate. They are at first smooth, but they become verrucose with age.

Spathularia rugosa *n. sp.*

Club compressed, rugose, oblong, obovate or spatulate, sometimes irregular or long decurrent, pale yellowish; stem subequal, subterete, often minutely pruinose-tomentose or subvelvety, especially toward the base, whitish or pallid; asci clavate, gradually tapering below into the very short stem, .003 to .004 in. long, .0004 to .0005 broad; spores filiform, .0016 to .0024 in. long, about .00008 broad; paraphyses filiform very slightly thickened at the top and more or less curved.

Growing in circles under or near coniferous trees. Old Forge, Herkimer county. August.

In size and color this fungus is very much like *S. flavida* Pers., to which it was referred as variety *rugosa* in Report 39, p. 58.

It differs from that species in its very rugose club, its rather shorter spores, its habit of growing in circles and in the less glabrous stem. Possibly it may not be distinct from *S. crispata* Fckl., which was erroneously referred to *S. crispata* Fr., according to Sylloge. The description of Fuckel's plant is too brief to be satisfactory.

Admitting the specific value of this plant and of *S. velutipes* and substituting for *S. flavida* the earlier name *S. clavata* Schæff., which is adopted in Sylloge, we have three New York species. In the annexed table their differentiation is indicated.

	Stem whitish or pallid	1
	Stem bay or bay-brown	S. velutipes.
1	Club even or wavy	S. clavata.
1	Club rugose	S. rugosa.

Cenangium Abietis (*Pers.*) *Rehm.*

Dead bark of white pine, *Pinus Strobus*. Delmar, Albany county. August.

Diaporthe decipiens *Sacc.*

Dead branches of water beech, *Carpinus Caroliniana*. New Baltimore, Greene county. June.

Phyllachora Junci (*Fr.*) *Fckl.*

Dead stems of slender rush, *Juncus tenuis*. Cedarville, Herkimer county. June.

Xylaria castorea *Berk.*

Prostrate trunks of beech, *Fagus Americana*. Adirondack mountains. September.

(D.)

REMARKS AND OBSERVATIONS.

Nymphæa reniformis *DC.*

Great South Bay, near the head of Lake Champlain. *S. H. Burnham.* This station extends the known range of the species northeastward.

Corydalis glauca *Pursh.*

A white-flowered form was found growing with the common form on the summit of Altar or Cobble mountain, near Lake Placid.

Nasturtium sylvestre *R. Br.*

Banks of the Genesee river near the southern and also near the northern boundary of the city of Rochester. Collected by *Mrs. J. H.*

McGuire; communicated by *Mr. J. B. Fuller*. The yellow cress is an introduced and sparingly naturalized plant. Specimens were collected several years ago near Flushing, Long Island.

Lepidium campestre *Br.*

The field pepper grass is an introduced species, which is gradually spreading through the State, and is attracting some attention as a pernicious weed. Mr. Fuller sends specimens with the following note: "It is frequent in grain fields in the western part of Monroe county, where it is locally known as 'long John.' It is rarely observed in the eastern part of the county."

Arenaria Grœnlandica *Spreng.*

Unusually large specimens of this plant were collected near Lake Mohonk, Ulster county. They were still flowering early in October.

Silene antirrhina divaricata *Robinson.*

Dry rocky woods. Lansingburg. July. The branches in our specimens are widely spreading and the flowers apetalous.

Tilia pubescens *Ait.*

Near Riverhead, Suffolk county. July. Our specimens are from the same source as those mentioned in Sargent's Trees of North America, as coming from this locality. The station was discovered by *Mr. E. S. Miller.*

Tilia heterophylla *Vent.*

Camillus and Marcellus Station, Onondaga county. June. This indicates a more northern range for the species than has hitherto been attributed to it. The flower buds had not yet opened when the specimens were collected.

Flœrkea proserpinacoides *Willd.*

The false mermaid is rare in the eastern part of our State and in the New York Flora it is credited to the western part only. There is, however, a station in a low piece of woods near Meadowdale, Albany county, in which it grows in considerable abundance.

Euonymus atropurpureus *Jacq.*

Banks of the Genesee river at Glen Iris, Wyoming county. June.

Fragaria Virginiana *Mill.*

The wild strawberry is a variable plant and indicates in the fields its tendency to run into numerous varieties. Near Meadowdale a form was found bearing flowers scarcely more than half the usual size. These small flowers are followed by very small fruit. The breadth of the receptacle of the flower indicates in some degree the size of the resulting fruit. From a broad receptacle we would expect a large fruit, from a narrow one, a small fruit. Possibly some of the forms referred to this species will yet be shown to be distinct species.

Zizia cordata *DC.*

A form with the radical or basal leaves trifoliate was found growing with the ordinary form in the borders of woods near New Baltimore, Greene county. In one or two instances both entire and trifoliate basal leaves were found on the same plant.

Viburnum lantanoides *Mx.*

The hobble bush is one of the prevailing shrubs of the Adirondack forests. Wherever we go in this mountainous region we find it extending its long horizontal branches as if to welcome us to its forest home with outstretched arms, but really to impede our steps, for the interlocking of the branches of neighboring plants or the rooting at the tip of an occasional deflexed branch makes traveling difficult and sometimes causes a trip and a fall.

This shrub is generally three or four feet high and bears a few horizontally spreading branches which are nearly as long as the parent stem. But plants were noticed the past summer in the southern part of Essex county between the Boreas and Hudson rivers that were ten feet high. These tall individuals generally had shorter and more numerous branches than their more lowly neighbors, and these were ascending in direction, diverging from the stem at a smaller angle than usual. In searching for the cause of this excessive and peculiar growth it was found that these tall specimens generally grew in clumps or clusters of several individuals or else were closely crowded by other shrubs or small trees. In either case the tendency would be to stimulate an upright growth in the effort of the plant to get into more and better light, and to retard or hinder the horizontal growth of the branches. The result is seen when trees grow close to each other in groves or forests. They grow taller and have more slender elongated trunks than when they grow singly or widely scattered in open fields. A fertile soil and a constant supply of the necessary moisture are doubtless contributing conditions. This plant evidently delights in the shade of trees and therefore in a constantly though perhaps a moderately moist soil, for it quickly disappears when the trees are cut away and it is exposed to the full rays of the sun.

Symphoricarpos vulgaris *Mx.*

The Indian currant or coral berry is not common in our State. There is a station for it near Newtonville, the only one known to me in Albany county. Possibly the plants have been introduced there from some western locality.

Aster sagittifolius *Willd.*

The arrow-leaved aster is credited in the New York Flora to Yates county. It is now quite plentiful in the northern part of the Hudson river valley. It is found about Mechanicville and extends northward to Bemus Heights. It has also been collected by Mr. Burnham near Sandy Hill, Washington county, and probably occurs in intermediate localities.

Solidago puberula *Nutt.*

"Sandy soil, Maine to Virginia and southward, mostly near the coast," is given in the Manual as the habitat and range of this species. In our State it frequently occurs in gravelly soil and in rocky places in the mountains remote from the seacoast. It has been found on the Shawangunk mountains in Ulster county, among the Catskill mountains and in the Adirondack mountains. It has been sent from rocky places in St. Lawrence county by Mrs. Anthony and from rocky hills near Fort Ann, Washington county, by Mr. Burnham. In these plants the hoary puberulence of the typical form is scarcely noticeable and the achenes have a few scattered hairs on the upper part, otherwise I see no distinct variation from the typical form.

Pyrola uliginosa *T. & G.*

In the Manual this plant is considered as a mere variety of *P. rotundifolia.* But having seen living specimens in the Mud lake locality in the southern part of Herkimer county, where it was discovered by Mr. Paine many years ago, I am disposed to consider it a distinct species and would restore it to the place assigned it by Dr. Torrey in the New York Flora. Its habitat is peculiar and its flowers are beautiful.

Pyrola secunda pumila *Gr.*

The peaty bog at the east end of Mud lake is still a station for this very small or dwarfish pyrola. It was found here by Mr. Paine more than thirty years ago. The same variety occurs in the Adirondack mountains, where it passes into the typical form.

Ilex monticola *Gr.*

Lake Mohonk, Ulster county. Few localities in the State are richer in botanical novelties and rare species of plants than this. It seems to be common ground where mountain loving species from the north and from the south meet and intermingle.

Symphytum officinale *L.*

Roadsides. Pike, Wyoming county. June. The purplish-flowered form.

Myosotis palustris *With.*

This introduced plant is abundant along Ilion creek between Ilion and Cedarville.

Phlox subulata *L.*

This early flowering, highly ornamental and sometimes cultivated plant was formerly abundant on the west bank of the Genesee river three and a half miles from its mouth. It is still found on the east bank. It occurs also at Caledonia, Livingston county. *Fuller.*

Gerardia flava *L.*

A singular form of this plant was collected near Port Jefferson. It has three leaves at each node of the stem.

Rumex crispus *L.*

Mr. Fuller sends specimens of a Rumex collected near Rochester, in a field locally known as the Riley lot. According to his notes and the characters exhibited by the specimens, the plants are from four to six feet high, which is nearly twice the hight of the ordinary *R. crispus* growing in the same field. Its leaves are smoother and more fleshy, paler, less veiny and less crisped on the margin than those of the yellow dock which they otherwise resemble. Its panicles are paler and the fruit valves are larger and more rounded with commonly only one of them grain-bearing. They are entire or but slightly toothed on the margin. The plants begin to blossom four or five weeks earlier than *R. crispus,* but they ripen few or no seeds, nearly all the flowers being abortive and falling about the first week in July. This indicates that the plants are hybrids. A hybrid of *R. crispus* and *R. obtusifolius* is known and was reported by Professor Dudley in his Catalogue of Plants of Cayuga Valley, but the specimens from Rochester do not agree with the description given of that hybrid, and the tall growing plants and the broad rounded valves without conspicuous teeth on the margin and commonly only one grain-bearing indicate rather a hybrid between *R. crispus* and *R. Patientia.*

Arceuthobium pusillum *Pk.*

This parasite on the spruce has been found by M. A. Baxter as far west as Rochester.

Hicoria alba (*L.*) *Britton.*

The mocker nut, (*Carya tomentosa* Nutt.) is common enough on Long Island and in the southern part of the State, but in other parts it is either wholly absent or occasional in its occurrence. The local catalogues of plants do not record it in the western part of the State. It is credited to Oneida county on the authority of Knieskern and is mentioned as "scarce" in the Catalogue of Plants of Schenectady county. It occurs near Cedar Hill, Albany county, which is the most northern station in which I have seen it.

Quercus macrocarpa *Mx.*

The form of this oak recognized by Michaux as a distinct species, and to which he gave the name *Quercus olivæformis,* is now generally regarded by botanists as a mere form or at most a mere variety. It was admitted into the New York Flora by Dr. Torrey on the authority of Michaux. He gave as its locality, "banks of the Hudson above Albany and in the western part of the State." Since that time it has been reported from Glenville, Schenectady county, by Professor Pierson and from Dexter, Jefferson county, by Dr. Vasey. In August a single tree of it was discovered by myself near Mechanicville, Saratoga county. This discovery is more interesting because of the proximity of this tree to one of the localities mentioned by Michaux, and because of the possibility that this very tree may be a lineal descendant of one of the trees observed by him. Recently a specimen of the same variety has been sent to us by Dr. Vandenburg, who collected it near Fort Edward.

Picea Canadensis (Mill) *B. S. P.*

The white spruce (*Picea alba* Lk. of the Manual) occurs in Minerva, Essex county. This is the most southern station in which I have seen it. Some of the old cones still remained on the tree in July, but the ground under the tree was well strewed with fallen cones and the attachment of those remaining on the tree was very slight and easily broken. The bark of this tree contains blisters or resin reservoirs similar to those of the balsam, *Abies balsamea,* but they are less prominent and less numerous. The resin in them is scarcely distinguishable in color, consistency or flavor from that of the balsam.

Besides the white spruce and the black spruce we have in the State a third form, which may be a variety of the black spruce. I have observed it in the swamps and on the mountains of the Adirondack region and elsewhere. It has the slender twigs, glabrate sterigmata and small cones ascribed to *Picea rubra,* but I hesitate to report it as that species, because the cones have the persistency ascribed to those of the black spruce. The foliage generally has the silvery green hue of the foliage of the balsam. The leaves are generally shorter than those of the black spruce and are not more acute. The tree is of very slow growth and very flexible. The question in my mind is whether it should be considered a variety of the black spruce or a distinct species.

Habenaria hyperborea *R. Br.*

The great variability of this species is recognized in the New York Flora, but no effort seems to have been made to classify the varieties. In the marshes and cedar swamps about Jordanville, three well marked forms occur.

In one the plants are two or three feet high, with a stem six to ten lines thick, with broad leaves and a dense spike of spreading flowers. This is the largest and stoutest form.

In another the plants are generally about a foot high, with a rather slender stem and narrow leaves, but with a dense spike of spreading flowers.

In the third form the plants are eight to twelve inches high, the stem slender, the leaves narrow and the spike loose and slender, with erect or appressed flowers.

Corallorhiza multiflora *Nutt.*

A variety of this species has occurred in woods at Menands, Albany county, in which nearly the whole plant has a pale yellow color, the lip of the flower being white and unspotted. This is such a wide departure from the ordinary form that I have labeled our specimens *Corallorhiza multiflora flavida.*

Cyperus esculentus *L.*

The yellow nut grass sometimes penetrates the tubers of the potato by its sharp pointed rootstocks and develops its tubers in the tubers of the host. Specimens of this kind were brought to me by Mr. Van DeLoo, of the State Museum. One of the invading tubers was planted and it developed into a fine specimen of *Cyperus esculentus.*

Carex castanea *Wahl.*

This rare and interesting sedge still lingers in small quantity under the hemlocks on the eastern shore of Cedar lake, in the southern part of Herkimer county. Its first discovery in this country was made here by Professor Gray more than sixty years ago. At the time of my visit to this place men were busy cutting the hemlock trees and peeling the bark from their trunks, and I fear very much that the changed conditions thus induced will soon cause the disappearance of these rare plants from this historic locality.

Carex Schweinitzii *Dew.*

More than thirty years ago Rev. J. A. Paine detected this rare sedge in the swamp near Cedarville. It still exists there, growing in the edge of the swamp in a springy place at the foot of a hill. It was found by myself in a similar locality near Pike, Wyoming county, in June.

Carex livida *Willd.*

In the Catalogue of Oneida county plants this sedge is reported as abundant on the State marsh in Litchfield, Herkimer county. A recent visit to this locality failed to reveal more than a few poorly developed specimens. The indications are that this rare species will soon disappear entirely from this locality.

Carex filiformis *L.*

This sedge sometimes assumes a sort of diœcious character. On one of the marshes in Litchfield, Herkimer county, some plants bore only staminate spikes; others bore only a single pistillate spike. But in the same locality other plants bore both staminate and pistillate spikes as usual.

Carex teretiuscula prairea *Britton.*

This is the prevailing form of the species in all the cold "cedar swamps" in the towns of Litchfield and Warren in the southern part of Herkimer county. The typical form of the species occurs in more open and less boggy places. Specimens collected in Albany county many years ago have the spikes on still longer branches, and thus appearing more conspicuously panicled. This is *Carex prairea* Dew. and *C. teretiuscula ramosa* Boott.

Festuca duriuscula *L.*

Wet, dripping cliffs along the Genesee river at Portage. The specimens were collected near the high bridge of the N. Y. & L. E. Railroad, on the west side of the river. The culms are rather slender, often geniculate at the base and about two feet tall. The lower sheaths are hairy or downy, and the upper surface of the cauline leaves are minutely hairy along the veins. The basal leaves are involute and eight to ten inches long. The habitat is so peculiar that I suspect the plants are indigenous in this locality. They certainly seem to me to be specifically distinct from *Festuca ovina,* to which, in the Manual, this species is added as a variety. The plants have no running rootstocks.

Elymus striatus *Willd.*

Dry rocky woods. Menands and Cedar Hill, Albany county. July. Our plants belong to the variety *villosus* Gray, *Elymus villosus* Muhl. of the New York Flora.

Tricholoma terreum fragrans *Pk.*

Poughkeepsie. October. *H. W. Barratt.* Mr. Barratt writes that many hundred specimens of this mushroom grew in a patch about twenty feet square, yet not as many as in the fall of 1894. There were none in 1895. He regards it as a valuable mushroom on account of its late appearing, its freedom from insect attack, its durability and fine flavor. It is especially good roasted and eaten on dry buttered toast or on milk toast. In his opinion many mushrooms are better roasted than cooked in other ways.

Clitocybe vilescens *Pk.*

A pale form of this species grows on sandy soil, in which the pileus is smoky white, but it becomes grayish-brown in drying. The mycelium binds together a mass of sand, so that when the plant is taken up carefully a little ball of sandy soil adheres to the base of the stem. The stem is sometimes pruinose. The flavor is mild and agreeable.

Clitocybe amethystina *Bolt.*

This fungus has commonly been united with *C. laccata* as a variety, though sometimes the remark is added that perhaps it is a distinct species. So far as I have observed it, its colors constitute the chief difference between the two, but these are very constant. I have seen no connecting forms. *C. laccata* has been made the type of a new genus Laccaria by Berkeley and Broome, with the following characters: Pileus convex then umbilicate or depressed, flesh thin; lamellæ broadly adnate, sometimes with a decurrent tooth, becoming mealy with the copious subglobose minutely warted white spores; stem central, externally fibrous; veil not evident.

If this genus is accepted, *Clitocybe ochropurpurea* Berk. and *C. tortilis* Bolt. should be referred to it. *C. trullisatus* Ellis is closely allied to these in general characters and appearance, but must be excluded because its spores are oblong and smooth.

Then admitting the specific validity of *C. amethystina*, we have four species that should be included in it. The species may be recognized by the characters indicated in the subjoined table.

Stem more than 4 lines thick	L. ochropurpurea.
Stem less than 4 lines thick	1
1 Moist pileus obscurely violaceous or watery brown, lamellæ amethystine	L. amethystina.
1 Moist pileus rufescent tinged with yellow or flesh color, lamellae flesh color	2
2 Stem commonly longer than the width of the pileus, 1 to 4 in. long	L. laccata.
2 Stem commonly shorter than the width of the pileus, 4 to 10 lines long	L. tortilis.

Pholiota unicolor *Vahl.*

Specimens of this species were found near Jordanville as early as June. They were growing on moss-covered decaying wood. The resemblance between this species and some forms of *Clitocybe laccata* is quite strong. The color of its spores and the presence of a membranous annulus will at once preclude any confusion of the two species. The stem sometimes has a very evident white mycelioid tomentum at its base.

Pholiota angustipes *Pk.*

This plant is of rare occurrence. It was discovered in 1876. The past season it was found in Albany county. The pileus varies in color from brown to gray or grayish-brown. It is slightly viscid when moist. The veil is slight and often its fragments adhere entirely to the margin of the pileus, leaving the stem without an annulus. Were it not for the rusty tint to the spores such specimens might easily be referred to the genus Hypholoma.

Lactarius aquifluus *Pk.*

This plant is sometimes cæspitose. The pileus when dry is tawny-gray and squamulose or rimulose-squamulose. The margin may be even or coarsely sulcate-striate. The flesh is grayish or reddish-gray. The color of the lamellæ varies from creamy-white to tawny-yellow. The stem often has a conspicuous white mycelioid tomentum at its base. I have never found this plant with a white or milky juice, and therefore I am disposed to regard it not as a variety of *L. helvus,* but as a distinct species. Its mild taste and agreeable odor suggested a trial of its edible qualities. It is harmless, but the lack of flavor induces me to omit it from the list of edible species.

Galera tenera *Schæff.*

A notable form of this species was found growing in an old stable of an abandoned lumber camp. The plants were large, the pileus in some being more than an inch broad, the stems were three to six inches long and the color was ferruginous as in *G. ovalis,* to which the plants might be referred but for the large spores. Essex county. July. I have labeled the specimens variety *obscurior.*

Cortinarius violaceus *Fr.*

Minerva, Essex county. A form of this species occurs here, having the pileus merely downy or punctate-hairy under a lens, no squamules being distinguishable by the naked eye. July.

Panæolus retirugis elongatus *n. var.*

Pileus grayish-brown, 1 to 1.5 in. broad; stem straight, 5 to 7 in. long.

Growing with *Galera tenera obscurior* in an old stable of an abandoned lumber camp, near Minerva, Essex county. July.

The stems were often coated toward the base with a grayish-white tomentum.

Coprinus plicatilis *Fr.*

Chip dirt, about an old lumber camp, Township 24, Franklin county. September.

The lamellæ sometimes show a whitish edge and whitish dots on the sides. These are due to projecting cells of cystida. There is a sterile form in which the pileus is paler than in the fertile form, and the lamellæ are persistently whitish. The lamellæ are free and sometimes the free space about the stem ruptures in such a way as to give them the appearance of being attached to a free collar. The spores are broadly ovate and compressed, so that the transverse diameter is greater when the spore lies flat than when it lies on its edge. They are .00045 to .0005 in. long, .0003 to .0004 broad.

Cantharellus aurantiacus pallidus *Pk.*

Specimens of this variety were found growing from the dead trunk of a standing pine tree. The stem in some instances was eccentric. The yellowish pileus sometimes has the margin almost white. The lamellæ are frequently crisped or wavy.

Cantharellus cinereus bicolor *n. var.*

Pileus and stem pale cinereous or grayish; hymenium yellowish, its folds very narrow. Menands. August.

Lenzites betulina rufozonata *n. var.*

Pileus brown, grayish-brown or tawny-brown, with one or more reddish subglabrous zones. Ulster and Saratoga counties. September and October.

Russula Mariæ *Pk.*

This fungus appeared in considerable abundance the past summer near Albany and at Port Jefferson. It is well marked by the pruinose appearance of its pileus and the minute reddish or purplish granules which when wet cause a stain upon any white surface or paper which may lie in contact with the pileus. The margin is even, but sometimes becomes slightly striate in old age. The flesh is white, but is often slightly red or pinkish under the cuticle, which is separable, at least on the margin. The lamellæ are entire and the interspaces venose. The stem is sometimes white, but generally it is colored like the pileus or a little paler. There are several species which have the pileus similarly colored, among which are *R. purpurea* Gill., *R. Queletii* Gill., *R. expallens* Gill. and *R. drimeia* Cke., but from all these, which are acrid, it is distinct by its mild taste. Sometimes the margin of the pileus fades with age and then the appearance is very similar to that of *R. depallens* Fr. as shown by the figures in Illust. of British Fungi, plate 1021. But that species has a viscid pileus and the stem varies from white to cinereous. It has not the red or purplish hues of the stem of our plant.

Hydnum albidum *Pk.*

Port Jefferson. July. This fungus has been tested and found to be edible.

Hydnum Caput-ursi *Fr.*

This species is not rare in the Adirondack forests. It grows on old trunks of deciduous trees either prostrate or standing and sometimes attains a large size, being six or eight inches high and nearly as broad, with aculei an inch long. Small forms have shorter teeth and might easily be mistaken for *H. coralloides* if not carefully observed. I have eaten of it and find it very good, but scarcely as well-flavored as *H. coralloides.*

Thelephora laciniata *Pers.*

A form of this species in which the margin of the pileus is entire is not rare. To distinguish it from the typical form it might be called variety *integra.*

Stereum spadiceum plicatum *n. var.*

Pileus narrow, laterally confluent, much crisped or folded. Prostrate trunks of oak, *Quercus alba.* Menands. August.

Anthurus borealis *Burt.*

In an asparagus bed. Sherruck, Delaware county. August. *F. B. Southwick.*

This is the second time and the second locality in our State in which this very rare and interesting phalloid fungus has been found. Successive crops of it appeared in this place during an interval of several weeks.

Xylaria digitata (*L.*) *Grev.*

Prostrate trunks of maple, *Acer saccharinum*. Adirondack mountains. September.

This species is quite variable. Specimens growing in the same group and under the same conditions had the stroma terete or compressed, simple or divided above into two or more branches, or two or more would be united at the base only as if growing from a single starting point. Occasionally two clubs are confluent or grown together throughout their entire length. The apex may be either rather bluntly acute or acuminate and sterile, but sometimes it is obtuse. The stem may be either short or long and wholly glabrous or at the very base involved in mucedinous tomentum. The clubs in our specimens were very fragile when fresh.

Var. *tenuis* n. var. Clubs slender, 1 to 1.5 lines thick, with the sterile apex commonly more conspicuous; perithecia less crowded and more prominent; stem elongated, commonly flexuous.

This variety was found growing on the same trunk with the ordinary form but lower down on the sides and partly beneath, and probably depends chiefly on its place of growth for its peculiar development. The spores both in it and in the typical form are .0007 to .0009 in. long.

Var. *Americana* differs chiefly in its shorter spores, which are about .0005 in. long. This is our most common form and the dimensions of its spores are given in the work on North American Pyrenomycetes as representing the spores of the species in this country. It may be a question whether this fungus would better be considered a variety of *X. digitata* or a distinct species.

(E.)

NEW YORK SPECIES OF FLAMMULA.

Flammula *Fr.*

Pileus fleshy, its margin at first involute; lamellæ decurrent or adnate without a sinus; stem fleshy-fibrous, not mealy on the upper part; veil fibrillose or none.

The genus Flammula is not represented in our territory by a large number of species. It is, nevertheless, not very sharply distinct from the allied genera, Pholiota, Hebeloma and Naucoria. From Pholiota it is especially separated by the slight development of the veil which is merely fibrillose or entirely wanting. It never forms a persistent membranous collar on the stem. From Hebeloma it may be distinguished by the absence of a sinus at or near the inner extremity of the lamellæ, by the absence of white particles or mealiness from the upper part of the stem and by the brighter or more distinctly ferruginous or ochraceous color of the spores. From Naucoria the fleshy or fibrously fleshy stem affords the most available distinguishing character. The genus belongs to the Ochrosporæ or ochraceous spored Series, but the spores of its species vary in color from ochraceous or tawny-ochraceous to ferruginous or fuscous-ferruginous. The three things to be especially kept in mind in order to recognize the species are the color of the spores, the adnate or decurrent but not clearly sinuate lamellæ and the fleshy or fibrously fleshy stem without a membranous annulus.

Our species are mostly of medium size, none being very small and one only meriting the appellation large. They appear chiefly in late summer or in autumn and grow in woods or in wooded regions either on the ground or more often on decaying wood. Many are gregarious or cæspitose in their mode of growth. Some have a bitterish or unpleasant flavor and none of our species has yet been classed as edible. Fries arranged the species in five groups, of which the names and more prominent characters are here given:

Gymnotæ. Pileus dry, often squamulose; veil none; spores ferruginous.

Lubricæ. Pileus viscose, glabrous, the pellicle subseparable; veil fibrillose; spores ferruginous or fuscous-ferruginous.

Udæ. Pileus moist or slightly viscid in rainy weather, glabrous, the cuticle not separable; veil evident, appendiculate.

Sapineæ. Pileus not viscose; lamellæ at first yellow or yellowish; veil almost none or fibrillose, not appendiculate; spores tawny or ochraceous.

Sericellæ. Pileus dry or at first viscid, slightly silky.

At present, no representatives of the first and the last tribes are known to belong to our State. The three remaining tribes are represented by twelve species, but three of these are so closely allied respectively to three others that they might easily be regarded as mere varieties rather than as distinct species. An analytical table is here given to facilitate the tracing of the species to their respective names:

	Pileus viscose, the cuticle separable	1
	Pileus moist, glabrous, cuticle not separable	6
	Pileus dry	9
1	Pileus commonly obscurely spotted, stem solid	2
1	Pileus not spotted; stem stuffed or hollow	3
2	Pileus paler on the margin, flesh white	lubrica.
2	Pileus uniformly colored, flesh grayish-white	subfulva.
3	Stem fibrillose	4
3	Stem squamulose or floccose-squamulose	5
4	Pileus paler on the margin, flesh yellowish	spumosa.
4	Pileus uniformly colored, flesh whitish	squalida.
5	Pileus 1 inch or more broad, flesh yellow	carbonaria.
5	Pileus 1 inch or less broad, flesh whitish	Highlandensis.
6	Pileus not hygrophanous	7
6	Pileus hygrophanous	8
7	Pileus yellow, slightly silky on the margin	alnicola.
7	Pileus pale yellow, margin naked	flavida
8	Stem reddish-brown	Halliana.
8	Stem not reddish-brown	rigida.
9	Pileus buff, fibrillose-virgate	magna.
9	Pileus golden-tawny, flocculose-squamulose	sapinea.

Lubricæ.

Pileus covered with a viscose glabrous wholly or partly separable cuticle; veil fibrillose; spores ferruginous or fuscous-ferruginous.

Flammula lubrica *Fr.*

SLIMY FLAMMULA.

Hym. Europ. p. 246. Syl. Fung. Vol. V. p. 815.

Pileus fleshy, somewhat tough, convex becoming plane or sometimes slightly depressed, even, viscose, often adorned with a few inconspicuous appressed spot-like scales, yellowish-red or tawny with a paler or yellowish margin, flesh white; lamellæ close, adnate or slightly decurrent, at first pallid or dingy clay color becoming subferruginous; stem equal or slightly tapering upward, solid, fibrillose or somewhat flocculose-squamulose below, often striate at the top, whitish with a white mycelioid tomentum at the base; spores dark ferruginous, .00024 in. long, .00016 broad.

Pileus 1.5 to 3 in. broad; stem 1.5 to 4 in. long, 2 to 5 lines thick.

Decaying wood and ground among fallen leaves. Catskill and Adirondack mountains.

Sometimes the pileus is slightly umbonate and its margin appendiculate with the remains of the white floccose-fibrillose veil. The spots are due to the presence of more highly colored innate fibrils. The stem is often flexuous. It sometimes becomes a little brownish or ferruginous toward the base when old. The Adirondack specimens were found growing on decaying spruce wood.

Flammula subfulva *Pk.*

DINGY-TAWNY FLAMMULA.

Mus. Rep. 41, p. 68.

Pileus convex, viscid, innately fibrillose, spotted toward the margin with darker colored appressed scales, sordid-tawny, flesh grayish-white; lamellæ close, adnate, becoming ferruginous; stem equal or slightly tapering upward, fibrillose, solid, whitish; spores brownish-ferruginous, elliptical, uninucleate, .00024 to .0003 in. long, .00016 broad.

Pileus 1.5 to 2.5 in. broad; stem 2 to 3 in. long, 2 to 4 lines thick.

About the base of trees. Catskill mountains. September.

The plant is more or less cæspitose in its mode of growth. It has been found but once. It is so closely allied to the preceding species that it might easily be regarded as a mere variety of it. The differences are found chiefly in the uniformly colored pileus and its grayish-white flesh.

Flammula spumosa *Fr.*

FROTHY FLAMMULA.

Hym. Europ. p. 247. Syl. Fung. Vol. v. p. 817.

Pileus fleshy, thin, convex or nearly plane, obtuse or umbonate, glabrous, viscose, pale yellow, tinged with reddish tawny or brownish hues in the center, flesh pale yellow or greenish-yellow; lamellæ thin, close, adnate, pale yellow when young, becoming ferruginous;

stem rather slender, equal or tapering at the base, fibrillose, hollow, yellowish, generally becoming brownish or ferruginous toward the base; spores elliptical, dark ferruginous, .0003 in. long, .00016 to .0002 broad.

Pileus 1 to 2 in. broad; stem 1.5 to 3 in. long, about 2 lines thick.

Gregarious or cæspitose; growing on the ground or on decaying wood. August and September.

This is our most common species of Flammula. It is found especially in hilly or mountainous districts, either in woods or open places. The pileus varies in the color of its center or disk from reddish to brownish. The umbo is sometimes present and very distinct, but it is often wholly absent. Occasionally the pileus becomes depressed in the center and then its margin is apt to be irregular, repand or wavy. It is a beautiful fungus when clean and well developed. Specimens, which in Report 23, p. 91, were referred to *Agaricus polychrous*, are probably only a form of this species. Satisfactory specimens of *Ag. polychrous* have not yet been found in our State.

Flammula squalida *Pk.*

SQUALID FLAMMULA.

Mus. Rep. 44, p. 19, auct. ed.

Pileus fleshy, convex or plane, firm, viscose, glabrous, dingy-yellowish or rufescent, flesh whitish but colored similar to the pileus under the separable cuticle; lamellæ rather broad, adnate, pallid, becoming dark ferruginous; stem slender, generally flexuose, hollow, fibrillose, pallid or brownish, pale yellow at the top when young; spores brownish-ferruginous, .0003 in. long, .00016 broad.

Pileus 1 to 1.5 in. broad; stem 1.5 to 3 in. long, 1 to 2 lines thick.

In bushy and swampy places. Cattaraugus and Rensselaer counties. September.

This species is closely related to *F. spumosa*, of which, perhaps, some may prefer to consider it a variety. But having observed it several times in different localities and always finding it constant in its characters and readily distinguishable, it has seemed best to recognize it as a distinct species. Its dingy appearance, slender habit, more uniform and darker color of the pileus and darker color of the mature lamellæ and spores are its peculiar features. It is often very cæspitose and is found especially among alder bushes in swamps.

Flammula carbonaria *Fr.*

BURNT GROUND FLAMMULA.

Hym. Europ. p. 247. Syl. Fung. Vol. v. p. 817.

Pileus fleshy, thin, convex or nearly plane, even, glabrous, viscid, subtawny, flesh yellow; lamellæ broad, adnate, crowded, brownish-clay color; stem equal or tapering downward, slender, rigid, narrowly fistulose, fibrillose-squamulose, pallid; spores brownish-ferruginous, .0003 to .0004 in. long, .00016 to .0002 broad.

Pileus 1 to 2 in. broad; stem 1 to 2 in. long, 2 to 3 lines thick.

Burnt ground and charcoal beds. Rensselaer county. June. Rare.

European authors do not agree as to the dimensions of the spores of this species. In Sylloge they are given as 10 to 11 x 5 to 6. In British Fungus Flora, as 7 x 3.5. Fries describes the pileus as one inch or a little more in width, but Cooke represents it as much broader, sometimes reaching three inches in diameter. The only specimens we have ever seen that agree tolerably well with the description of the European plant were found growing on ground where wood had been burned into charcoal a short time before.

Flammula Highlandensis *Pk.*

HIGHLAND FLAMMULA,

Agaricus Highlandensis, Mus. Rep. 24, p. 67.

Pileus fleshy, thin, hemispherical or convex, becoming nearly plane, glabrous, viscose, yellowish-red, commonly paler or yellowish on the inflexed margin, flesh white or whitish, sometimes tinged with yellow under the tough separable cuticle; lamellæ close, rounded behind or adnate, sometimes with a decurrent tooth, pallid or yellowish when young, becoming ferruginous; stem equal, stuffed or hollow, fibrillose and minutely floccose-squamulose, yellowish; spores elliptical, .00024 to .0003 in. long, .00016 broad.

Pileus 6 to 12 lines broad; stem 1 to 1.5 in. long, 1 to 2 lines thick.

Burnt ground or damp earth. Highlands of Orange county, Catskill mountains and Adirondack mountains. June to September.

From *F. carbonaria*, of which it may perhaps be a mere variety, this is separated by its smaller size, whitish flesh and differently colored lamellæ. The margin of the pileus is often paler than the central part. The surface is usually more or less defiled by dirt or other adhering substances that have been carried up in the growth of the plant. The mycelium commonly binds together a little ball of earth which clings to the bottom of the stem when the plant is pulled from the ground. *Agaricus Ascophorus* is merely a form of this species with the squamules of the stem wanting or inconspicuous.

Udæ.

Pileus moist or slightly viscid in rainy weather, glabrous, the cuticle not separable; veil evident, appendiculate.

Flammula alnicola *Fr.*

ALDER FLAMMULA.

Hym. Europ. p. 248. Syl. Fung. Vol. v. p. 820.

Pileus fleshy, at first broadly conical or convex, then broadly convex or nearly plane, glabrous or sometimes slightly silky-fibrillose on the margin, clear lemon yellow, rarely tinged with ferruginous in the center, moist, flesh yellowish, taste bitter; lamellæ close, adnate or sometimes slightly rounded behind, pallid or yellowish becoming ferruginous; stem rather long, often curved or flexuose, fibrillose, hollow, yellowish becoming ferruginous or brownish-ferruginous especially toward the base; spores ferruginous, .0003 to .0004 in. long, .0002 to .00024 broad.

Gregarious or cæspitose; pileus 1 to 2.5 in. broad; stem 2 to 3 in. long, 2 to 4 lines thick.

Ground or decaying wood of deciduous trees. Albany and Rensselaer counties, Catskill and Adirondack mountains. September and October.

The Alder flammula is a beautiful fungus. The color of the pileus is generally a uniform bright lemon yellow but sometimes it assumes deeper hues and may be tinged with ferruginous in the center. The margin is generally adorned with pale yellow or whitish webby fibrils which are sometimes slightly interwoven. Usually they are appendiculate to the margin of the expanded pileus, but occasionally they adhere in part to the stem and form a kind of evanescent annulus. The lamellæ vary at their inner extremity, being either rounded behind, adnate or slightly decurrent. The plants do not inhabit alders alone as might be inferred from the specific name, but they also occur on birch and wood of other deciduous trees and on the ground.

Flammula flavida *Pers.*

PALE YELLOW FLAMMULA.

Hym. Europ. 248. Syl. Fung. Vol. v. p. 820.

Pileus fleshy, thin, broadly convex or nearly plane, glabrous, moist, pale yellow, flesh whitish or pale yellow, taste bitter; lamellæ moderately close, adnate, pale or yellowish becoming ferruginous; stem equal, often more or less curved, hollow, fibrillose, whitish or pale yellow, with a white mycelium at the base; spores .0003 in. long, .0002 broad.

Pileus 1 to 2 in. broad; stem 1 to 3 in. long, 1 to 3 lines thick.

Decaying wood of various trees. Commonly in wooded or mountainous districts. Summer and autumn.

Our specimens were found on wood of both coniferous and deciduous trees. The plants are sometimes cæspitose. The pileus becomes more highly colored in drying. The spores are pale ferruginous approaching ochraceous. In Sylloge the spores of this species are described as pale yellowish.

Flammula Halliana *Pk.*

HALL'S FLAMMULA.

Mus. Rep. 23, p. 90.

Pileus thin, hemispherical or convex, glabrous, hygrophanous, subferruginous with the margin obscurely striatulate when moist, dull yellow when dry; lamellæ close, subarcuate, slightly decurrent, tapering to a point at the outer extremity and ceasing before reaching the margin, ferruginous; stem equal, slightly fibrillose, hollow, reddish-brown; spores ferruginous, .0003 to .0004 in. long, .0002 to .00024 broad.

Pileus 1 to 2 in. broad; stem 2 to 3 in. long, 2 to 3 lines thick.

Pastures. Albany county. November.

This plant was found more than twenty-five years ago and has not since been detected. Its flavor is bitterish. The fibrils of the veil form a slight fibrillose annulus on the stem which forms a lodging-place for the spores and becomes stained by them.

Flammula rigida *Pk.*

RIGID FLAMMULA.

Mus. Rep. 50, p. 104.

Pileus thin, rather firm and rigid, convex becoming nearly plane or centrally depressed, sometimes wavy on the margin, glabrous, hygrophanous, rusty-tawny or subferruginous when moist, buff or grayish-buff when dry, flesh concolorous; lamellæ moderately close, adnate, creamy-white becoming rusty tan color or subferruginous; stem equal or nearly so, tough, slightly striate, colored like the pileus, with a compact white tomentum on the lower part or at the base; spores broadly elliptical, .0003 to .00035 in. long, .00016 to .0002 broad.

Pileus 1 to 1.5 in. broad; stem 1 to 2 in. long, 1.5 to 3 lines thick.

Chip dirt. Adirondack mountains. September.

The plants are gregarious and by the mycelium they adhere closely to chips and fragments of wood from which they grow and which are usually pulled up with them when they are gathered. This is a smaller plant than the preceding one and has the dry pileus and shorter stem paler in color.

Sapineæ.

Pileus not viscose; lamellæ at first yellow or yellowish; veil almost none or fibrillose, not appendiculate; spores tawny or ochraceous.

The species of this tribe grow especially on decaying wood of pine and other coniferous trees or on the ground about or under them.

Flammula sapinea *Fr.*

PINE TREE FLAMMULA.

Hym. Europ. p. 251. Syl. Fung. Vol. v. p. 824.

Pileus fleshy, compact, hemispherical or convex, becoming expanded, sometimes irregular, obtuse, dry, slightly flocculose-squamulose when young, often becoming rimose and paler with age, golden-tawny, paler and shining on the margin, flesh yellowish, odor strong; lamellæ broad, close, adnate, yellow becoming tawny-cinnamon; stem commonly short, often unequal or irregular, compressed and sulcate, sometimes radicating, stuffed or hollow, yellowish or pallid; spores ochraceous, .0003 in. long, .0002 broad.

Pileus 1 to 3 in. broad; stem 1 to 2 in. long, 3 to 5 lines thick.

Decaying wood of pine. Onondaga county. September.

This is a rare species in our State. The plants are sometimes cæspitose.

Flammula magna *Pk.*

LARGE FLAMMULA.

Mus. Rep. 50, p. 103.

Pileus fleshy, broadly convex, soft, dry, fibrillose and somewhat virgate, pale yellow or buff, the margin commonly becoming revolute with age, flesh whitish or yellowish; lamellæ close, adnate or slightly decurrent, often crisped or wavy toward the stem, about three lines wide, ochraceous; stem equal or thickened toward the base, fleshy-fibrous, solid, elastic, fibrillose, colored like the pileus, brighter yellow within; spores subelliptical, ochraceous, .0004 in. long, .00024 broad.

Cæspitose; pileus 4 to 6 in. broad; stem 3 to 4 in. long, 8 to 12 lines thick.

About the base of trees. Westchester county. October.

This is a large and showy species. The stems are sometimes united at the base into a solid mass. The young lamellæ are probably yellow, but I have seen only mature specimens.

(F.)

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REPORT

OF THE

STATE ENTOMOLOGIST

1896.

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REPORT.

OFFICE OF THE STATE ENTOMOLOGIST,
ALBANY, *December* 14, 1896.

To the Regents of the University of the State of New York:

GENTLEMEN.— I have the honor of presenting to your Board my Twelfth Report on the Injurious and Other Insects of the State of New York.

The work of the department has been diligently and successfully prosecuted during the year. A large number of insects have been studied, most of which are of economic importance to the farmer, the fruit-grower, or to the general public. Among these special attention was given to the army-worm in consideration of its distribution and destructiveness throughout the larger portion of the State of New York to an extent not previously recorded. In the pages devoted to the elm-leaf beetle will be found interesting observations upon the long continuance, in successive broods, of the insect in this vicinity — quite at variance with what has hitherto been ascribed to it. Instead of the beetle going into retreat for hibernation in the month of August, the insect has remained with us from its first appearance in May until into November as active larvæ and transforming in its subsequent stages. Quite a number of the insect attacks that have come under observation, have been noticed briefly in "Notes on Some of the Insects of the Year in the State of New York," and others, more fully, in their proper place in the body of the report.

Work upon the classification, arrangement, and labeling of the Collection has been continued. Some progress has been made in the preparation of a biological collection in the limited time that could be spared for the purpose: A well-arranged collection of this character, exhibiting at a glance the entire life-history, habits, transformations, enemies, etc., of each species, would prove both interesting and instructive to those who apply in person at our rooms for information regarding some special insect pest. The material for such an exhibit has been accumulating during past years, and is only awaiting time for its arrangement.

The additions made to the State Collection have not been as large as those of the preceding year, from the general paucity of insect life, as noticed in a following page. Their number (in part estimated) aggregates about 2,000. Contributions have been received from forty-two persons aggregating about eight hundred examples.

The Tenth Report of the State Entomologist was issued in the early part of July, and forms a part of the Forty-eighth Report of the State Museum. An edition was also printed as separates, for convenience of distribution among agriculturists and entomologists. The report contains 300 pages, 4 plates and 24 figures. Its preparation required an unusual amount of office labor from the extended index given to the ten reports of the Entomologist (1883-1895), occupying 93 pages, and embracing (as estimated) 20,600 references.

The Eleventh Report of the State Entomologist for the year 1895, is now being printed, and will, it is hoped, be ready for distribution before the close of the present year. It will contain nearly 250 pages and 16 plates.

The usual list of miscellaneous publications by the Entomologist during the current year will be found in the Appendix. Forty-one titles are cited with time and place of publication, with a brief summary of each. The aggregate number of such publications listed and abstracts given, in the several volumes of this series of reports, including the present, is 909.

The correspondence of the office during the year has been as follows: Letters received and filed, 1119; letters sent, so far as recorded, 1215.

Arrangement has been made for an amount of additional shelving required by the increase in the collections and library. These additions will permit a better classification of material, and add greatly to convenience in the frequent reference to both specimens and publications.

In conclusion, I desire to express my appreciation of the aid and encouragement extended by your board during the year past, especially in the recent arrangement through which my department has been brought in closer and more satisfactory relations with your Honorable Board.

Respectfully submitted,

J. A. LINTNER.

INJURIOUS INSECTS.

"Camponotus Pennsylvanicus" and "Formica rufa."

Carpenter Ant and Mound-building Ant.

(Ord. HYMENOPTERA: Fam. FORMICIDÆ.)

In the preceding Report of this series (Eleventh), one of the large ants, *Camponotus herculaneus* var. *Pennsylvanicus*, is represented as sometimes entering dwellings from nests built outside near the house. In one instance mentioned by Dr. Riley, a fine old homestead was so overrun with it that it was on the point of being sold, when the source of the infestation was discovered in a large nest of several feet in diameter in the back yard.

In all probability the above infestation as cited by Dr. Riley was erroneously referred to *C. herculaneus*. Rev. Dr. H. C. McCook, of Philadelphia, who has made special study of the habits of our N. American ants, has modestly questioned the statement in a recent letter received from him:—

"I think that I may venture to question the statement respecting *Camponotus Pennsylvanicus* on page 113. I am reasonably familiar with the habits of this species, and have never known an example of a nest made in the earth, as implied in your statement. It is a carpenter ant exclusively, and lives in trees and timber. I suspect, therefore, that a mistake must have been made in the species. I have occasionally seen the Pennsylvania carpenter ant in houses, but as a rule, it is not inclined to such resorts, and I very much doubt if it could have proved a household pest.

"I make the above statement with some degree of confidence, even though you quote Dr. Riley for your authority. However, if Mr. Theodore Pergande endorses the species, I suppose I should waive my objection, as he is well acquainted with the species of our American Ants."

Dr. McCook has also indicated another error made by me, on page 115 of the Report cited, where *Formica rufa* is given as the "not improbable" annoying occupant of the soil of a lawn on the south side of Long Island, which "during the summer is alive with ants," and also the artificers of large mounds seen by me in the Catskills and in the Shawangunk range at Lake Mohonk. He writes as follows:

"You refer to our American mound-making ants as *Formica rufa*. That is a blunder which I made when I first published an account of the habits of these species in the Transactions of the American Entomological

Society, of 1877. I was misled by Mr. Smith, of the British Museum. Dr. August Forel, however, subsequently corrected my error and described this species as a new one, viz., *Formica exsectoides*. We have *F. rufa* in this country. I have observed and studied it in Colorado, and know that it is found in the Dakotas, but I have no knowledge of its being found in the New England States or in Eastern New York."

In consideration of Dr. McCook's expressed deference to Mr. Pergande's views, his letter was submitted to Dr. Howard, chief of the Entomological Bureau at Washington, who returned the following comments by Mr. Pergande:

"Regarding our mound-making ants I will say that the genuine *Formica rufa* has so far not been found in this country, but that there are numerous forms more or less nearly related to it which occur in different sections of the United States. One of these forms, *F. exsectoides* Forel, appears to be an exclusively eastern species and has so far been found only in Virginia, Pennsylvania, New Jersey and New York, whereas the most common form, occurring in Colorado, Utah, Montana, Wyoming, the Dakotas and Nebraska, is not *F. exsectoides*, as stated by Dr. McCook, but *F. obscuripes* Forel, which up to the present time has not been observed east of the Missouri and Mississippi. As to *Camponotus Pennsylvanicus*, I have never observed it to build extensive nests in the ground, either near dwellings or in the woods, although occasionally I have found small nests under stones near the base of large oak trees which were probably connected with breeding chambers in the large and partly decayed roots of the trees. Most commonly I found them in dead trunks or stumps, generally oak, which had been perforated in all directions by wood-boring larvæ. Whether the ants which Professor Riley observed as having built a large nest in the ground of a back-yard in this city really were *C. Pennsylvanicus* or not, I am unable to say. I incline, however, to the belief that they were *Formica subsericea* Say, which has the habit of building large and rather flat nests in the ground."

In the recent "Comstock's Manual for the Study of Insects," *Formica exsectoides* is briefly referred to as being the builder of our largest ant-hills; these are often five or six feet across, and sometimes more than twice that in diameter. The head and thorax of this ant are rust-red, while the legs and abdomen are blackish brown. This species has been supposed to be the same as the European wood ant, *Formica rufa*, and is referred to in many books under that name.

Ecpantheria scribonia (Stoll).

The Great White Leopard-Moth.

(Ord. LEPIDOPTERA: Fam. ARCTIIDÆ.)

STOLL: Sup. to Cramer's Pap. Ex., 1787, fig. 177, pl. 41, fig. 3 (as *Phalæna*).

ABBOTT-SMITH: Lepidopt. Ins. Georgia, 1797, p. 137, pl. 69 (as *Phalæna oculatissima*).

CLEMENS: in Proc. Acad. Nat. Sci. Phila., xii, 1860, p. 523 (description, distribution).

MORRIS: Cat. Lepidopt. North Amer., 1860, p. 25; Synop. Lepidopt. North Amer. 1862, p. 347 (synonymy, adult and larva described).

HARRIS: Ins. Inj. Veg., 1862, p. 349 (moth and larva described).

SAUNDERS: in Proc. Entomolog. Soc. Phila., ii, 1863, pp. 28–29 (larva described); the same in Canad. Journ., New Ser., viii, 1863, p. 370; Synop. Canad. Arctiidæ, 1863, p. 22; in Canad. Entomol., xiv, 1882, pp. 113–115, figs. 12, 13 (brief general account); in 13th Rept. Entomolog. Soc. Ont. for 1882, 1883, pp. 14–15, figs. 4, 5 (brief general account).

PACKARD: in Proc. Entomolog. Soc. Phila., iii, 1864, p. 127 (bibliography, synonymy, distribution).

RILEY: in Amer. Entomol.-Bot., ii, 1870, p. 179 (larva briefly described), p. 182 (known as "fever worm"); 4th Rept. Ins. Mo., 1872, pp. 141–143, figs. 63, 64 (life-history, description of larva); in Amer. Entomol., iii, 1880, pp. 133–134 (notes on life-history, parasites); Bull. 31 Divis. Entomol., U. S. Dept. Agricul., 1893, p. 49 (eating leaves of cotton plant).

STRETCH: Zyg. and Bomb., 1873, p. 174, pl. 7, figs. 20, 21.

SIEWERS: in Canad. Entomol., ix, 1877, p. 128 (feeds on poke berry, will eat cabbage).

FRENCH: in 7th Rept. Ins. Ill., 1878, p. 184 (brief account).

MARTEN: in 10th Rept. Ins. Ill., 1881, p. 116 (brief mention).

SLOSSON: in Entomolog. Amer., iii, 1887, pp. 185, 212 (variety *denudata* in Florida).

EDWARDS, H.: Bull. U. S. Nat. Mus., No. 35, 1889, p. 61 (references)

HARRINGTON: in 20th Rept. Entomolog. Soc. Ont., for 1889, 1890, p. 48, fig. 23 (brief mention).

RILEY-HOWARD: in Insect Life, iii, 1890, p. 155 (*Ophion arctiæ* Ashm. parasitic on).

SMITH: Cat. Ins. N. J., 1890, p. 294 (not rare); in Canad. Entomol., xxii, 1890. p. 179 (bibliography, synonymy); List Lepidopt. Bor. Amer., 1891, p. 27, no. 1122 (listed, synonymy).

DYAR: in Psyche, vi, 1891, p. 127 (at Poughkeepsie, N. Y.); in Canad. Entomol., xxiii, 1891, pp. 106–108 (description of stages).

HOWARD: in Bull. 33 Office Expt. Stat., U. S. Dept. Agricul., 1896, p. 345 (feeding on cotton leaves); the same in Farm. Bull. 47, U. S. Dept. Agricul., 1897, p. 26.

Although this handsome insect is native to the State of New York, the moth is rarely seen. The thickly-haired caterpillars of this and allied species are frequently seen in the autumn crawling rapidly, as though in haste to find suitable shelter for the winter before the setting in of cold weather. This particular species can not be considered injurious in this latitude, as it is comparatively rare, but in some of the southern States it is quite abundant, though not destructive.

The Egg.

Eggs of a moth sent me October 6, 1884, by Mrs. J. P. Ballard, of eastern Pennsylvania, and received by her from Orlando, Florida, proved to be of this insect. They were small, 0.025 inch ($\frac{1}{40}$) in diameter, round, irregularly punctate, changing before hatching from whitish to reddish and finally purplish (Mr. Dyar gives the color as yellowish pearly gray). The duration of this stage was about five days. Less than one-half of the shell was eaten by the larva upon its escape.

While many of the Arctians are known to be quite prolific, this one is markedly so, for Mr. Dyar records an instance in which he obtained 2274 eggs from one individual.

Notes on the Larval Stages.

October 7th. Larva after hatching 0.05 inch long, yellowish, with brown dorsal tubercles on segments 4 and 5 (apodal), 8, 9, 10 and 12, appearing, from above as if two-banded; head reddish, with a conspicuous black spot on each side over the ocelli; hair nearly as long as the body; legs long. Larva feeds readily on plantain.

October 15th. First molting commenced; on the 16th, 10 had molted, and the last on the 20th. Appearance much as before, except that the subdorsal spots on segments 4, 5, 8, 9 and 10 are dark reddish-brown, extending around and below the tubercles — those on segments 4 and 5 also embracing the lateral tubercles, making almost a band upon these segments, except as separated by a pale dorsal line. Terminal segment without brown. Head brownest at the slightly lobed apex. Hairs fuscous, longer than the diameter of the body.

October 19th. Second molt commenced; on 20th, 12 had molted. Length, 0.2 in. Hairs black, about the diameter of body in length. Head pale reddish, a blackish crescent over the ocelli. Body honey yellow. Segment 3 with four brown tubercles dorsally; segments 4 and 5 brown dorsally and laterally; segments 8 to 10, brown dorsally only (over the two subdorsal rows of tubercles). The molting was completed on the

25th, when the earliest had taken the position for the 3d molt, having a length of 0.35 in. The preparation for the molt is made by leaving the plant and selecting a place on the top of the jar containing the larvæ, where each spins a web of three times the area of its body, in which it may securely fasten its prolegs — such attachment being apparently necessary for its successful escape from the cast skin.

October 27th. Third molt commenced. Ended on the 30th. Color dull red. The brown has become black and its area is extending, as segment 3 is also black, in addition to 4, 5, 8 to 10. On the terminal segment (12) the two subdorsal tubercles are shining-black. On the evening of the 31st, the first two took position for the 4th molt — length 0.45 in. With very few exceptions (the result perhaps of disturbance) the larvæ after their molting reverse their position and entirely consume their exuvia.

November 1st. Fourth molt commenced—1 molted; on 2d, 10 molted; on 3d all of previous molt had ceased feeding, and were in position on the lid and sides of the glass jar, for their approaching molt—a few only remained upon the leaves. The molting was completed on the morning of the 5th. Portions of about 20 per cent. of the exuviæ were uneaten. In several instances the larvæ were seen to commence feeding upon the spines, biting them off in small pieces, before attacking the skin. The withdrawal from the old skin occupied about a minute. The spines, first appressed to the body beneath the old skin, appear as wet places, but at once begin to expand and dry. Their final adjustment is apparently hastened by the contortions in which the larva throws itself, by resting on three pairs of prolegs, and with the two extremities raised and curved over the back, almost touching one another, frequently twisting, at short intervals, from side to side. In about an hour after emerging, the meal upon the exuviæ is commenced.

With its longer spines, the caterpillar is now nearly twice as broad as before, but not much increased in length, averaging but 0.5 in. The central and terminal segments are still red, but diminished in extent and less conspicuous than before—the red of the extremities being nearly concealed beneath the long black spines radiating from the tubercles. The legs, prolegs, and ventral surface are red, the plantæ of the prolegs being quite pale—almost a flesh color. The spines on segments 6 and 7 are dusky, interspersed with a few black ones; length of spines equal to the diameter of the body. The head is red with black ocelli, the mandibles black-tipped, and with a few perpendicular black lines on the clypeus. On the 5th the more advanced larvæ show the red ring on the incisures characteristic of the adult form. On the 6th a larva took position for its molt, on the 7th two others, and ten on the 8th. At this time they measure 0.9 inch in length.

November 8th. Fifth molt commenced—one larva molted; ten more were found to have molted on the morning of the 10th; the last molted on the 15th—the molting of this stage extending over seven days. At the end of this stage they average in length 1.6 in. at rest and 2 in. when in motion. All the spines are black, except some lateral ones in a few individuals, which are brownish; they are minutely barbed to the naked eye and distinctly so under a magnifier (Pl. iv, fig. 1). The segments are black dorsally, except the thoracic and the last two which are a reddish-brown, as are the sides below the spiracles. The red incisural bands commence behind the 4th segment and continue until after the 10th, being seven in number; the central ones being about one-third as long as the black portion of the segment.

November 17. Sixth molt commenced—all the larvæ remaining upon the leaves. The molting terminated on the 23d—continuing six days. In every instance in this molt, the head-case remained attached to the skin. The exuvia shows distinctly a central lateral patch of dusky scales. Fewer of the exuviæ were eaten (26 per cent only), owing doubtless to the stronger and more rigid spines. All the spines are black and all the segments are black dorsally.*

November 25. Seventh molt commenced—terminated on December 4th,—continuing nine days. Length 2.4 inches, at rest; when extended in feeding, 3 inches.

December 1. A caterpillar commenced spinning its cocoon on the side of its feeding cage and the glass cover; for convenience it was transferred to another box. On the 3d inst. a second one had commenced.

December 13. The first pupa was observed, from the caterpillar that had commenced to spin up December 1st. Two more molted on December 14th. On the 30th, the last larva was transferred to a box for pupation.

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* If the preceding notes are compared with Dr. Dyar's description of the early stages of this insect (see *Canadian Entomologist*, xxiii, 1891, pp. 106–107), some differences will be detected. Most of these can undoubtedly be accounted for by the natural variations of the species under differing conditions.

TABLE OF LAST TRANSFORMATIONS.

SPUN UP.	Pupated.	Emerged.	Sex.	Pupal period.
December 1	December 13	January 15	....	33 days.
" 3.......	" 18	" 16	♀	29 "
" 10.......	" 20	" 18	♀	29 "
" 12.......	" 21	" 18	♀	28 "
" 12.......	" 22	" 19	♀	28 "
" 12.......	" 21	" 19	♀	29 "
" 12.......	" 22	" 21	♀	30 "
" 12......	" 22	" 22	♂	31 "
" 15.......	" 22	" 20	♀	29 "
" 16.......	" 24	February 1	....	39 "
" 16.......	" 25	January 30	....	36 "
" 17.......	" 25	" 20	♀	26 "
" ?.......	" 25	" 26	....	32 "
" ?.......	" 25	February 1	....	38 "
" ?.......	" 25	" 6	....	43 "
" 17.......	" 26	" 5	....	41 "
" 19.......	" 28	January 31	....	34 "
" 19.......	" 28	February 6	....	40 "
" 19.......	" 28	" 5	....	39 "
" 20.......	" 28	January 22	♂	25 "
" 21.......	" 28	February 2	....	36 "
" 21.......	" 28	" 6	....	40 "
" 22.......	" 28	" 11	....	45 "
" 22.......	" 28	" 14	....	48 "
" 22.......	" 28	January 26	....	29 "
" 22.......	" 29	February 13	....	46 "
" 22.......	" 30	" 5	....	37 "
" 25.......	" 30	" 7	....	39 "
" 25.......	" 28	" 1	....	35 "
" 25.......	" 31	" 10	....	41 "
" 25.......	January 3	" 20	....	48 "
" 27.......	" 3	" 17	....	45 "
" 27.......	" 3	March 4	....	60 "
" 30.......	" 4	February 20	....	47 "
January 3	" 7	" 25	....	49 "
" 3.......	" 7	March 1	....	53 "
" 3.......	" 8	February 17	♀	40 "
" 5.......	" 12	Crippled	....	....
" 6.......	" 12	February 12	♀	31 "
" 10.......	" 15	" 12	♀	28 "

In the above table is given in detail the time occupied in the last two transformations of forty individuals of this interesting insect within cases which had been kept upon my office table at the State Museum

It will be seen by consulting it, that the shortest period between the spinning up of the larva and pupation was but three days,—the longest fifteen, and the average a little over seven days and one-half. The shortest period of pupation was twenty-five days, and the longest sixty — the average being nearly thirty-eight days.

The Pupa.

The larva spins a thin netting of yellowish silk with little amber beads at the joining of the threads just before pupating. No description of the pupa was made, but it has been described by Dr. Dyar as follows:

"Robust, of normal shape; on the abdominal segments, dorsally and subventrally are ten rows of large tufts of short spiny hairs, the tufts smaller ventrally and less numerous posteriorly; cremaster, two tufts of reddish spines from elevated bases. Color black, reddish in the abdominal incisures; the body is smooth and dull, the wing cases more shiny, creased. Spiracles linear, reddish. Length 35 mm., width 13 mm."

The Imago.

This beautiful insect with a wing-spread of from two and three-quarter inches in the male to three and a half in the female is a desirable addition to the cabinet of a collector. Its lustrous blue abdomen marked with orange down the middle and on the sides, and the sharp black markings of the thorax and wings on a white background, give the insect a striking appearance. There is considerable variation in the markings in different individuals as will be seen on plate 1, and particularly so when the sexes are compared. The irregular black rings that adorn the thorax and wings of the female, tend to become black spots in the male, as seen in figure 2 of plate 1. More often, however, the costal and some of the smaller discal rings on the wings and those of the thorax are replaced by spots (see figures). It will also be noticed that the posterior thoracic spots of the male are frequently blue, while in the female the corresponding marking are a much darker blue or a black.

A variety of this species, *denudata* Slosson, in which the tips of the primaries are invariably denuded, has been described from Florida.

Life-History.

So far as known there appears to be but a single annual generation. The nearly full-grown larvæ are commonly observed in the autumn, and in this stage usually hibernate. The caterpillars can successfully withstand a great degree of cold. They may even be revived after having been frozen stiff and partially encased in ice. In Kentucky the insect spins up about the first of June and the moths emerge about the 15th. Under exceptional conditions the insect pupates in the autumn and the imago is disclosed before winter sets in.

The only recorded parasite of this species appears to be *Ophion arctiæ* Ashm., which was reared from it at Columbia, S. C.

Food-plants.

The insect is a very general feeder in its travels over the ground as it approaches maturity, and eats from almost any plant that it chances to meet with except the coarser ones. It will also climb low trees and feed on the foliage. Among its favorite food plants are some of the Compositæ, the wild sun-flower (*Helianthus*) being one commonly eaten by the larva. It has also been recorded as feeding on the willow, poke berry, and black locust in nature. In confinement it has been reared successfully on cabbage, the plantain, castor bean (*Ricinus communis*), and the spurge (*Euphorbia cyathophora*).

Distribution.

This insect has a wide distribution, being comparatively abundant throughout most of the northern United States and in many parts of Canada. In some of the southern swamps it is quite common, and in those regions it has been known as "Fever-worm" among the negroes from a mistaken impression that this caterpillar is the cause of the ague.

An Innoxious Insect.

The injuries resulting from this insect are seldom, if ever, serious, as it is nowhere known as a common pest, and it rarely causes any damage worthy of notice. This would naturally result from their restlessness. which does not allow them to remain long in one place, and from their food consisting largely of comparatively valueless plants.

Leucania unipuncta (Haworth).

The Army-Worm.

(Ord. LEPIDOPTERA: Fam. NOCTUIDÆ.)

COMSTOCK: Rept. upon Cotton Insects, 1876, p. 11 (mention), pp. 101, 106 (mistaken for *Aletia*), pp. 202, 203 (*Nemoræa leucaniæ* and *Exorista flavicauda* valuable parasites of *Heliophila unipuncta*).

SMITH: in Rept. upon Cotton Insects, 1879, p. 259 (*Leucania unipuncta* attracted to sweets); Cat. Ins. N. J., 1890, p. 316 (common all over the State); List Lepidopt. Bor. Amer., 1891, p. 46, no. 2280; in Rept. N. J. Agricul. Expt. Stat. for 1890, 1891, pp. 514–515, figs. 27, 28 (remedies); in Entomolog. News, vii, 1896, p. 204 (brief notice of ravages in 1896); Economic Entomol., 1896, pp. 294–296, figs. 332, 333 (brief general account); in Rept. N. J. Agricul. Expt. Stat. for 1896, 1897, pp. 433, 434, 449–457, figs. 1–5 (recent injuries in N. J.; general account).

HICKS: in Amer. Entomol., iii, 1880, p. 227 (ravages in Queens Co., N. Y. in 1880).

LINTNER: in Country Gentleman, for July 1, 1880, xlv, p. 424 (eggs identified); in id., for June 2, 1881, xlvi, p. 359 (reference); 1st Rept. Ins. N. Y., 1883, pp. 33, 53 (remedies), pp. 100, 127, 128, 132, 134–135, 146, 147, 226, 312–313, 314 (references); 2nd do., 1885, pp. 43–44 (injuries in N. Y.); 4th do., 1888, pp. 139, 163 (references); 6th do., 1890, pp. 176, 179–180 (references); 7th do., 1891, pp. 373, 376 (references); in Country Gentleman, for October 6, 1892, lvii, p. 750 (remedies); 8th Rept. Ins. N. Y., 1893, pp. 265, 293 (references); 9th do., 1893, p. 443 (reference); in Country Gentleman, for June 29, 1893, lviii, p. 508 (reference); 10th Rept. Ins. N. Y., 1895, pp. 482, 490, 519 (references); in The Argus [Albany, N. Y.], for July 8, 1896, p. 8 (ravages in N. Y., remedies); the same, in part, in the New York Recorder, for July 15, 1896; in Country Gentleman, for July 16, 1896, lxi, p. 552; in Rome Sentinel, for July 10 and 17, 1896; in Circular of the Department of Agriculture of the State of New York; in New York Daily Tribune, for July 18, 1896 (injuries in Eastern N. Y., remedies); in Country Gentleman, for July 23, 1896, lxi, p. 574 (extent of injuries, remedies); in id., for August 6, 1896, lxi, p. 606 (ravages at Orchard Home, N. Y., remedies); in Bull. 6 New Ser., Divis. Entomol., U. S. Dept. Agricul., 1896, pp. 55–56 (ravages in New York).

MANN: in Psyche, iii, 1880, pp. 91, 93, 115, 118 (references to ravages of army-worm in Mass. and vicinity), 1881, p. 226 (reference); in do., iv, 1884, p. 210 (reference).

DIMMOCK: in Psyche, iii, 1881, pp. 212, 282 (numerous references to ravages in New England and Nova Scotia), pp. 287, 345 (references); in do., iv, 1885, p. 295 (reference); in do., v, 1888, p. 141 (reference).

SAUNDERS: in Canad. Entomol., xiii, 1881, pp. 198-199 (in Ontario and Western States); the same in Ann. Rept. Entomolog. Soc. Ont. for 1881, 1882, p. 6.

THOMAS: 10th Rept. Ins. Ill., 1881, pp. 5-43, figs. 1-5 (extended account).

COQUILLETT: in 11th Rept. Ins. Ill., 1882, pp. 8, 49-64 (habits and life-history).

GODING: in Trans. Iowa State Agricul. Soc. for 1882, 1883, separate, p. 9 (brief account).

COOKE: Inj. Insects Orch.-Vineyard, 1883, pp. 282-283, figs. 269-271 (brief general account).

FORBES: in Trans. Miss. Valley Horticul. Soc., 1883, separate, p. 7 (strawberries stripped of leaves by army-worms); 12th Rept. Ins. Ill., 1883, p. 102, fig. 22 (ravages in Ill.); 13th do., 1884, pp. 9, 40, 61, 84, pl. VI, figs. 1, 2 (notes on habits, remedies); 14th do., 1885, p. 5 (mention); 15th do., 1889, pp. 2-3 (mention, as *Heliophila unipuncta*); 16th do., 1890, p. ix (mention); Append. to 17th do., 1891, pp. 25, 35 (references to Le Baron); 18th do., 1894, pp. x, 14 (mention); 19th do., 1896, p. 76 (experiment on larvæ).

REED: in 13th Ann. Rept. Entomolog. Soc. Ont., 1883, p. 52 (*Nemoræa leucaniæ* a parasite).

RILEY: in 3d Rept. U. S. Entomolog. Comm., 1883, pp. 89-156, pls. I, II (an extended account); in Canad. Entomol., xv, 1883, p. 173 (duration of transformations); the same in 14th Ann. Rept. Entomolog. Soc. Ont., 1884, p. 19; 4th Rept. U. S. Entomolog. Comm., 1885, p. 19 (mistaken for *Aletia*), pp. 350-351, pl. V (brief account), Append., p. [102] (note on appearance); in Insect Life, iii, 1890, pp. 183-184 (mention); Bull. 31 Divis. Entomol., U. S. Dept. Agricul., 1893, pp. 41, 54, 57 (exhibit of at World's Columbian Exposition); in Insect Life vi, 1894, p. 222 (living examples in Mexican cereals at World's Fair).

FERNALD: in Kingsley's Stand. Nat. Hist., ii, Crust. and Ins., 1884, p. 451, figs. 568, 569 (brief notice, both as *Heliophila* and *Leucania unipuncta*); in 34th Ann. Rept. Mass. Agricul. Coll., 1897, p. 186 (mention).

HUBBARD: in 4th Rept. U. S. Entomolog. Comm., 1885, Append., p. [6] (not in Florida).

VAN DUZEE: in Canad. Entomol., xvii, 1885, p. 80 (*Aphis mali* attracting *L. unipuncta* moths).

WEBSTER: in Ind. Agricul. Rept. for 1885, 1886, separate, p. 18, pl. 4, figs. 2, 3 (injuring corn); in Insect Life, iii, 1890, pp. 112-113 (in Indiana, ovipositing in corn); in Bull. 22 Divis. Entomol., U. S. Dept. Agricul., 1890, pp. 45-46 (damages in Ind., parasites); in Insect Life, vi, 1893, p. 150 (but one brood injurious in Ohio); the same in 24th Ann. Rept. Entomolog. Soc. Ont., 1894, p. 89; Bull. 51 Ohio Agricul. Expt. Stat., 1894, p. 125 (distribution), p. 133 (reference); in Bull. 6 New Ser., Divis. Entomol., U. S. Dept. Agricul., 1896, p. 66 (injuries in Ohio).

COOK: in Entomolog. Amer., i, 1886, p. 209 (ravages); Bull. 76 Mich. Agricul. Expt. Stat., 1891, p. 14 (reference).

BETHUNE: in 17th Ann. Rept. Entomolog. Soc. Ont., 1887, p. 59, figs. 33, 34 (brief mention); in 27th do. for 1896, 1897, pp. 55–56 (damage in Ontario).

BRUNER: in Insect Life, i, 1888, p. 66 (in S. Dak., Nebr. and Wyoming); in Bull. 22 Divis. Entomol., U. S. Dept. Agricul., 1890, p. 98 (damage in Nebr., parasites); in Bull. 23 do., 1891, p. 14 (injuring beets); in Ann. Rept. Nebr. State Bd. Agricul., 1893, pp. 390–394, figs. 35–41 (brief general account); in Bull. 32 Divis. Entomol., U. S. Dept. Agricul., 1894, pp. 14–15 (injuries in Nebr. in '93).

FLETCHER: Ann. Rept. for 1887, 1888, pp. 11–12, figs. 1, 2 (life-history, ravages in Canada, remedies); in 19th Ann. Rept. Entomolog. Soc. Ont., 1889, p. 9 (brief mention); Ann. Rept. for 1894, 1895, pp. 192–194, figs. 2, 3 (life-history, ravages in '94 in Canada, remedies); in 27th Ann. Rept. Entomolog. Soc. Ont. for 1896, 1897, pp. 59–60 (injuries in Ontario); in Rept. Canad. Experimental Farms for 1896, 1897, pp. 231–234, figs. 3, 4 (general account of, in Canada).

HULST: Bull. xlvi N. J. Agricul. Expt. Stat., 1888, pp. 6–7 (remedies, brief); in Entomolog. Amer., v, 1889, p. 58 (contagious disease of army-worm).

BURNETT: in Insect Life, i, 1889, p. 287 (in Orleans Co., N. Y. in 1888).

DYAR: in Insect Life, i, 1889, p. 285 (moth attracted to electric light).

DANSBY: in Insect Life, i, 1889, p. 375 (injuries in Florida).

MILLER: in Insect Life, ii, 1889, pp. 76–77 (ravages in Indiana).

RILEY–HOWARD: in Insect Life, i, 1889, p. 356 (reference); in do., ii, 1889, p. 56 (ravages in Ind.), 1890, p. 258 (mention), p. 351 *Rhogas terminalis* Cr. reared); in do., iii, 1891, pp. 15, 17, 153, 154, 156, 157, 460 (reared parasites), p. 478 (mention); in do., iv, 1891, p. 157 (in the island of Jamaica); in do., vi, 1893, p. 41 (ravages in N. Mex. and Va.), 1894, p. 348 (mention), p. 374 (injuries reported in various localities); in do., vii, 1894, p. 269 (ravages in Va. from May to Sept.), p. 279 (abundance of moths at electric light).

TOWNSEND: in Insect Life, ii, 1889, p. 42 (destructive in Mich. in '81); in Psyche, vi, 1893, pp. 466, 467, 468 (flies bred from *Leucania unipuncta*).

ASHMEAD: in Insect Life, iii, 1890, pp. 53–57 (ravages in Md. in 1880).

HOWARD: in Insect Life, ii, 1890, p. 222 (irrigation for controlling); Circular 4 2d Ser., Divis. Entomol., U. S. Dept. Agricul., 1894, pp. 1–5, figs. 1–3 (brief general account); in Proc. Entomolog. Soc. Wash., iii, 1895, p. 225 (of distribution); Bull. 5 Technical Ser., Divis. Entomol., U. S. Dept. Agricul., 1897, pp. 33, 50 (mention), p. 51 (*Winthemia 4-pustulata* a common parasite).

OSBORN: in Bull. 22 Divis. Entomol., U. S. Dept. Agricul., 1890, pp. 20–21 (mention); in Insect Life, v, 1892, p. 112 (mention); in Bull. 30 Divis. Entomol., U. S. Dept. Agricul., 1893, p. 44 (injuries in Iowa in '92); in Bull. 33 Io. Agricul. Coll. Expt. Stat., 1896, pp. 600–603, figs. 3–5 (injuries in Iowa, brief general account); in Bull. 6 New Ser., Divis. Entomol., U. S. Dept. Agricul., 1896, p. 78 (injuries in Iowa).

HARRINGTON: in 21st Ann. Rept. Entomolog. Soc. Ont., 1891, p. 67 (*Ophion purgatum* a parasite).

KOEBELE: in Bull. 23 Divis. Entomol., U. S. Dept. Agricul., 1891, p. 44 (mention).

MOFFAT: in 21st Ann. Rept. Entomolog. Soc. Ont., 1891, pp. 51–54, figs. 21, 22 (ravages in Maritime Provinces and Eastern States); in 27th do. for 1896, 1897, pp. 77–78 (injuries in Ontario, etc.).

COCKERELL: Bull. 10 N. Mex. Agricul. Expt. Stat., 1893, pp. 10–14 (food-plants and remedies); in Insect Life, vii, 1894, p. 210 (mention).

GILLETTE: in Rept. Col. Agricul. Expt. Stat. for 1893, 1894, p. 53 (brief mention).

THOMPSON: in Insect Life, vi, 1893, p. 37 (in Tasmania).

GARMAN: in 5th Ann. Rept. Ky. Agr. Expt. Stat., 1894, pp. 56–59, fig. 8 (brief account as *Heliophila*); in 7th do. for 1894, 1895, p. xxxvii (very common in Ky., May 23, June 25–Sept. 1).

MURTFELDT: in Bull. 32 Divis. Entomol., U. S. Dept. Agricul., 1894, p. 37 (injuries in Mo. in 1893).

COMSTOCKS: Manual Study Insects, 1895, pp. 303–304, figs. 366, 367 (brief notice).

FORBUSH: in The Gypsy Moth, a Rept. of the Work Mass. Bd. Agricul., 1896, p. 33 (gypsy moth mistaken for army-worm), p. 121 (cyclone burner for army-worm).

LOUNSBURY: Bull. 28 Mass. Agricul. Expt. Stat. (Hatch), 1895, pp. 10–17, figs. 5–7 (cranberries injured, general account).

MCCARTHY: in Bull. 115 N. C. Agricul. Expt. Stat., 1895, pp. 164–165 (remedies, as *Heliophila*).

HOPKINS–RUMSEY: Bull. 44 W. Va. Agricul. Expt. Stat., 1896, pp. 261–262, 310, 312, 316 (brief description, remedies).

JOHNSON: in 9th Rept. Md. Agricul. Expt. Stat., 1896., p. 225 (ravages in Sept.).

KIRKLAND: in Bull. 3 Series of 1896, Mass. Crop Rept., July, 1896, pp. 28–37, figs. 1–6 (general account of in Mass.); Bull. 46 Hatch Expt. Stat. Mass. Agricul. Coll., 1897, p. 23 (toads eating army-worms).

LOWE: Bull. 104 N. Y. Agricul. Expt. Stat., 1896, pp. 121–129, figs. 1, 2, pls. I, II (general account and recent ravages).

LUGGER: 2d Ann. Rept. Entomol. State Expt. Stat., Univer. Minn., for 1896, pp. 14–20, figs. 8–10, pl. II, fig. 11 (recent injuries in Minn., general account); the same in Bull. 48 Minn. Agricul. Expt. Stat., 1896, pp. 42–48.

PERKINS: in 9th Rept. Vt. Agricul. Expt. Stat., 1896, pp. 134–142, figs. 20–25 (general account of, in Vermont).
TRUMAN: in Entomolog. News, vii, 1896, p. 299 (common in South Dakota).
WEED, C. M.: Bull. 39 N. H. Coll. Agricul. Expt. Stat., 1896, pp. 62–75, figs. 1–10 (general account of, in New Hampshire).
BROOKS: in 34th Rept. Mass. Agricul. Coll., 1897, pp. 82–84 (damage by, on college farm).
CHITTENDEN: Bull. 8 New Ser., Divis. Entomol., U. S. Dept. Agricul., 1897, p. 42 (*Carcelia leucaniæ* a common parasite).
DEARNESS: in 27th Ann. Rept. Entomolog. Soc. Ont. for 1896, 1897, p. 23 (injuries in Ontario).
FYLES: in 27th Ann. Rept. Entomolog. Soc. Ont. for 1896, 1897, pp. 101–102 (brief mention).
PANTON: in 27th Ann. Rept. Entomolog. Soc. Ont. for 1896, 1897, pp. 44–51, figs. 45–50, 1 map (general account of distribution and ravages in Ontario).
BRITTON: in 20th Rept. Conn. Agricul. Exp. St. for 1896, 1897, pp. 236–238, pl. 3, figs. *a–d* (in Conn., natural history, remedies).
SLINGERLAND: in Proc. 42nd Ann. Meet. West. N. Y. Horticul. Soc., 1897, pp. 23–24 (brief account of ravages in 1896 in New York); in Amer. Agricul., 59, for May 8, 1897, p. 582 (rarely injurious a second year); Bull. 133 Cornell Agricul. Expt. Stat., 1897, pp. 233–258, figs. 68–72 (extended account, in New York).
SOULE: in Psyche, viii, 1897, p. 11 (moths swarming in New Hampshire and at sea).

(The references above are additional to those given in the extended account of this insect by Prof. Riley in the 3rd Report of the U. S. Entomological Commission, 1883, pp. 146–156).

The notable entomological event of the year (1896) for the State of New York, has been the occurrence and severe ravages of the army-worm, *Leucania unipuncta*, over the greater part of the State. This insect is a quite common species, which is widely distributed over the country. When but moderately abundant it is but rarely, if ever, noticed by the farmer; occasionally, however, the caterpillars are so numerous and destructive as to create much alarm and lead to many wild surmises as to their origin.

Unprecedented Ravages in the State of New York.

The abundance of the caterpillars and the damage by them to the crops throughout the State is believed to be greater than had ever been observed before. Previous ravages of this insect in the State have been confined to limited portions, but the past year it has been destructive over by far its greater portion, ranging from its extreme east to the west and from the north to the south. The insect has been authentically reported from fifty-five of the sixty counties, but has probably been present, to a greater or less extent, in all. The following are known to have been infested to a greater or less extent:

Albany.	Essex.	Oneida.	Schuyler.
Allegany.	Franklin.	Onondaga.	Seneca.
Broome.	Fulton.	Ontario.	St. Lawrence.
Cattaraugus.	Genesee.	Orange.	Steuben.
Cayuga.	Greene.	Orleans.	Suffolk.
Chautauqua.	Herkimer.	Oswego.	Sullivan.
Chemung.	Jefferson.	Otsego.	Tioga.
Chenango.	Kings.	Putnam.	Tompkins.
Clinton.	Lewis.	Queens.	Ulster.
Columbia.	Livingston.	Rensselaer.	Washington.
Cortland.	Madison.	Rockland.	Wayne.
Delaware.	Monroe.	Saratoga.	Westchester.
Dutchess.	Montgomery.	Schenectady.	Wyoming.
Erie.	Niagara.	Schoharie.	

It has not been reported, so far as known, in the following counties: Hamilton, New York, Richmond, Warren and Yates.

From the nature of the attack, and from the reports at hand, it would be useless to estimate the damage caused by this insect to the farming interests of the State of New York the past year. The habit that the caterpillars have of feeding largely under cover of darkness, renders it quite safe to assume that in each of the fifty-five counties from which they have been reported, considerable injury to the crops has resulted. Besides the injuries reported, there are many individuals who have suffered considerable loss in silence. In addition to this, there is also the damage inflicted by the insect unknown even to the owners of the property involved. The two latter items would swell the total loss caused by this insect in the State the past year to a very formidable sum. The following newspaper items will give some idea of its abundance and destructiveness in the State of New York in its recent invasion:

In the vicinity of Easthampton [L. I.] the army-worm has appeared to the number of many thousands and has destroyed crops belonging to farmers, as well as fields and lawns of private residences.

The Journal, July 9.

The so-called army-worm was brought to my notice during the first week in July. It was then attacking the oat fields in northern Westchester and southern Putnam counties. It developed northward into Putnam county with great rapidity and much alarm was felt, although it was hoped that many fields would escape and be cut later for the grain.

On July 12th all hope of saving the grain was abandoned and every oat field was hastily cut with scythe and mowing machine to save the straw for fodder. At this time many oat fields were utterly ruined on the southern border of the county, and those farther to the north were seriously injured in part. The oats in this section were unusually vigorous, the straw in many places measuring five feet in height, with leaves long, broad and succulent. The heads were heavy and well filled. In fact, the worms were well supplied with ample food and made a rapid development.

G. W. H. Brewster (Putnam county), N. Y.

The army-worm has destroyed a considerable portion of the crops in Dutchess and Orange counties within the past two weeks.

The Independent, New Paltz (Ulster county) July 24.

The much dreaded army-worm has invaded Columbia county and is working havoc with the crops in several towns. Over in Kline Kill the destructive pests have appeared in alarming numbers * * * *. They are also attacking growing vegetation on Abm. Vosburgh's land in Ghent. In Kinderhook the Scully farm is overrun with the worms which are spreading from field to field, devouring everything in their progress, except potatoes. Several other farms in the same town are also suffering from the pest.

Chatham Republican (Columbia county), July 15.

Wherever the worm appears ruin follows its tracks, and many a farmer sees all prospect of abundant harvest fade away in a few hours. From the Plains come numerous accounts of their ravages, which are also reported on the South Side, where H. F. Slade had a fine piece of oats, covering eight acres, and last week estimated to yield 75 bushels to the acre. Sunday the worms were seen in the field for the first time. Monday their ravages had become so apparent, that it was decided to save the remainder of the crop by harvesting it at once. On Tuesday when it was cut with a reaper, the leaves had all been eaten off, and in many instances the head also, so that the field is nearly a total loss.

The Oneonta Herald (Otsego county), July 16.

In Chenango county the worms have confined their destructive work to the lowlands. Along the roads and fences, great swarms or droves of the pest may be seen making their way in one great wriggling, squirming mass from field to field. In Oxford the old fair grounds had been sown to oats and corn and also the pieces adjoining them. The worms migrated from one field to another, and in doing so, crawled over the building once used as a grand stand, that being used in place of a fence. The structure was one moving mass and attracted much attention from the village and surrounding country.

The Watertown Reformer (Jefferson county), July 18.

Anyone wishing to see the army-worm, should go to the Fairbanks farm on North Main street, near the Catholic cemetery, where the worms may be seen by the million in the oat fields. Every stalk and spear is literally covered with them. Mr. Fairbanks has as fine a piece of oats as is often seen in this section, but the terrible ravages of this pest will, in a few days, destroy the entire crop. The ground is so thickly covered with them, that it is impossible to step without treading on some.

The Jamestown Journal (Chautauqua county), July 10.

Farmers owning land on the west side of Black river, just east of Lowville [Lewis county], will have a new pest to contend with, and one that is making great havoc in pastures and meadows. The pest is a smooth, dark colored worm, about one and one-half inches long, resembling the army-worm. They made their appearance about a week ago, and as to numbers represent a vast army. They move in solid masses and devour everything in their track. Pastures that have been attacked are as barren of feed as a street pavement.

Oswego Times, July 10.

The army-worm has reached South Trenton [Oneida county], and is working sad havoc in the oat and corn fields. One prominent farmer who expected to raise about 400 bushels of oats said this week, after seeing the worms at work in his field, that he probably would not have a solitary oat. The worms appear very ravenous and have been known to eat grass that had matured and turned brown.

Utica Semi-Weekly Herald, July 17.

The army-worm which is working among farmers' crops in the eastern part of the State, is doing considerable damage at Walworth [Wayne county]. T. G. Yeomans & Sons, the leading farmers in the town of Walworth, seem to be troubled most with the worm, which began eating the grass in the pastures, whereupon the grass was set afire so as to get rid of them. Then the fodder corn was next tackled by the pest.

Rochester Democrat and Chronicle, July 22.

Earlville [Madison county], July 15. — The army-worms have reached this section and are doing their destructive work among the farmers by devouring their corn and oats in large quantities. This is the first time the worms ever appeared in this vicinity, and are thought to be passing by and steadily moving northward.

Rome Sentinel, July 17.

In the town of Bethlehem, Albany county, near the farm of Hon. John M. Bailey, they were seen by me on July 7th, completely eating up every hill of corn in their progress over a large field (Pl. II, also IV, fig 2). A piece of timothy was badly eaten and rapidly being consumed by the host of hungry caterpillars — the heads bending down beneath their weight. They were found in millions in the field of rye in which they were first noticed, and as the rye was being cut, they were [illegible] n thousands underneath the sheaves. They were reportedon a farm just outside of Albany on Delaware avenue as eating everything before them — oats, corn, and many vegetables, while they were so thick that one could not take a step without crushing many of them. So abundant were they that if a man stood still for a few minutes, they would crawl upon him in so great numbers that he could not easily divest himself of them. They were also very numerous just beyond the toll-gate on Western avenue where they had stripped all the leaves from a number of fields of fine looking oats, and leaving these, many had wandered on to the plank road where large numbers were crushed by passing vehicles.

The serious nature of the ravages of this insect was evidenced by the many telegrams and letters received concerning it, — the replies to which formed a considerable part of the correspondence of the Office for the month of July. In addition, numerous inquiries relating to the new depredator were sent to the Commissioner of Agriculture, to the Experiment Stations at Ithaca and at Geneva, and to the branch Station at Jamaica, Long Island.

In response to a telegram, the State Entomologist visited Governor Morton's farm at Ellerslie, and found that hordes of hungry worms were threatening the destruction of nearly 200 acres of his corn and oats. The condition of affairs was found to be exceedingly alarming, and it was only by the work of fifty men continued long into the night that the crops were in the main preserved. In a similar manner the army-worms were destroying the corn of George Canaday of Kinderhook, N. Y., at the rate of an acre a day. Mr. Canaday at once sent a special messenger with examples of the caterpillars to the office of the State Entomologist, to learn the proper methods of combating this enemy. The prompt action of this gentleman in accordance with the directions given him, enabled him to protect the greater portion of his fields.

Its Work in Other States.

The ravages of the army-worm during the year have also been marked in other States of the Union. Serious outbreaks occurred in Maine, and in the central and southern portions of New Hampshire and Vermont. In Massachusetts the cranberry crop in the three towns of Dennis, Harwich and Yarmouth on Cape Cod, was damaged to an estimated extent of $100,000. The injury to the grass and grain crops in the State, was estimated at fully $200,000, making a total loss by the army-worm of over $300,000. Serious ravages by this insect were also reported from Connecticut.

In New Jersey the insect was quite destructive in limited localities in different portions of the State. The damage in Pennsylvania appears to have been severe and extensive over a large part of the State — Centre, Tioga, Bradford, Susquehanna, Chester, Dauphin, Perry, Bucks, Lancaster, York and Cumberland counties, being the most unfortunate in this respect. It was widespread in Ohio, although its injuries were local and could be hardly termed general. It was reported as quite injurious in Marinette, Menomenee and Monroe counties, in Wisconsin. In Minnesota its ravages extended over most of the State, and were represented as very severe. It was reported as more or less destructive in the following additional States: Missouri, California, Maryland and Iowa. In towns of the Province of Ontario, Canada, it was also quite injurious.

Earlier Losses in the State of New York.

The first authentic record of injury in this State by the army-worm, so far as we have found, was given by the Albany Argus in 1817. In this year many meadows and pastures in the northern towns of Rensselaer county, and in the eastern portions of Saratoga county were rendered "as barren as heath" by this insect. In 1842 some injury from it, was reported in the western part of the State. It committed severe ravages in the vicinity of Buffalo in 1861, also near the head of Seneca lake, and at several other points in the southern and western counties. In 1871 it was reported from Tioga county. Four years later it attracted attention the latter part of July, and in the middle of August it was quite abundant on Long Island. In 1880, it was again destructive in this State. The caterpillars appeared in June on Long Island, where they caused much alarm by their ravages. At this time they also occurred in some of the southern and eastern counties of the State.

It will be seen from the above that all the earlier appearances of this pest have been limited to comparatively small areas in the State, and, although the losses were considerable in some instances, especially in the visitation of 1880, it is believed that none approached in magnitude those of the present year.

Its Extended Distribution.

The army-worm has a remarkably extended distribution. Dr. Packard, in his map published in 1877, limited its range as follows: north, at latitude 48° in Minnesota, and at Cape Rozier in Quebec; east by the eastern portion of Nova Scotia; south, at the southern point of Texas; west, at parallel 102°. This range can now be considerably extended. It has been reported from Newfoundland, Prince Edward Island, and as widespread all over Canada. In the United States, in addition to the area given by Dr. Packard, the insect has been reported from South Dakota, Nebraska, Wyoming, Colorado, New Mexico; and the past summer, "The Weekly Chronicle" reported ravages of the army-worm in July in the vicinity of Stockton, California. If the latter report can be regarded as authentic, it is safe to infer that the insect is, or may occur very soon, in every State in the Union.

Living specimens were also observed to issue from Mexican cereals exhibited at the World's Fair held at Chicago.

It has been recorded from the Island of Jamaica, and will probably be found in other islands of the West Indies. Other localities are: various parts of South America,—Venezuela, United States of Colombia, and Brazil; Isle of Wight; Lewes, South England; Maderia; Province of Nepaul, North India; Java; several places in Australia; New Zealand and Tasmania. *Leucania unipuncta* may well be deemed cosmopolitan, although only in the United States does its ravages attract much attention.

Description of the Insect.

Although the insect is a common one, and occurs in considerable numbers each year in the State of New York, yet from its seldom attracting particular attention, owing to its ordinary nocturnal habits, it appears to be known to very few persons other than entomologists. The following account of its features in its several stages may serve as a guide to its recognition.

The eggs.—They will rarely be seen by the ordinary farmer, but when met with, they may be recognized from the following characters: They are smooth, white when first laid, turning gradually to a pale straw color before hatching, about 0.023 inch in diameter, and usually deposited in masses glued together by an adhesive substance. They may be found between the leaf-sheath and the stem of grasses,—the toughest stalks in the thickest clumps being preferred for their place of deposit. They are also at times, laid on other herbage, on dead stems, sticks, and in other less favorable places when the moths are abundant.

The young caterpillars.—They are rarely seen and yet it is of great importance that the farmer should be able to recognize them before extensive depredations have proclaimed their true character. The recently hatched army-worms are about 0.07 of an inch (1.7 mm.) long and of a dull translucent white color. The head is brownish-black or yellowish with dark eyes. On both head and body there are minute scattering hairs. The young larvæ walk in a looping manner, as the two anterior pairs of abdominal legs are atrophied.

After the first molt the larvæ are about 0.2 of an inch (5 mm.) long. The head is a little darker in some cases and the striping seen in the full grown caterpillars is becoming apparent. The general color of the body is yellowish-green with three, more or less well defined, rose-brown lines on each side of the body,—the lower line being the broadest and the most conspicuous. In this stage the minute black hairy tubercles of the body may be seen. The caterpillar still loops as it walks and spins a thread as it drops from a leaf when disturbed, as in the first stage. After the second molt the striping is more pronounced, though the general color is the same. The habit of looping when walking and of spinning a thread when it drops is lost: instead of the latter it curls itself up as it falls to the ground. After the third molt the caterpillars become a dull, dark green color and the head is mottled with dark brown. The striping is nearly that of the full-grown caterpillar. In the next two molts there is but little change in its markings and other features.

The full-grown caterpillar.—When full-grown or nearly full-grown, there is quite a range of coloring to be seen among a large number. Their general appearance is such that once seen they are easily recognized. The larger ones are about one inch and one-half (38 mm.) long, but associated with them are many smaller individuals, some of which are only about half the length of the largest. This range in size may be seen at the time when their ravages attract attention. They may be recognized in their latter stages by the median white line beginning at the head and extending a variable distance along the back — in some of the lighter and younger ones it may be traced the length of the body. On either side of the median white line, there is a broad brown stripe more or less distinct (in lighter individuals there may be a white mottling along this stripe), bordered laterally by a narrow one of darker brown. Next is a white line similar to the median one but more constant, and between it and the next white line there is a stripe of variable brown, sometimes mottled with white; it is usually lighter than the stripe on either side of the median white line. Next comes the stigmatal stripe which in well-marked individuals is the most striking, it being as dark as any, and below it is the white substigmatal stripe; these two are somewhat variable in color in different caterpillars. The ventral surface is a variable yellowish-green: the abdominal legs are brown at the base. The light and dark varieties of the caterpillars are represented in the two lower figures of Plate III.

The pupa.—The mahogany-brown pupa is about three-fourths of an inch (18 to 20 mm.) long. It is rather stout and on the anal extremity there is a pair of slightly converging spines, and on each side of these, two fine curled hooks. The spiracles are nearly black.

The imago.—The moth is a plain appearing reddish-gray or fawn colored insect with a spread of wing, averaging about one inch and one-half. The fore-wing has two large ill-defined spots of a slightly lighter color anterior to its center; behind the outer one, is the small characteristic white spot indistinctly bordered with black. There is a faintly indicated oblique line from the apex to near the outer third of the hind margin of the wing, of which only the portion of the line near the apex is continuous, the remainder being represented by dots. The tips of the veins are usually indicated by black, and the whole surface of the wing is slightly and variably specked with the same. The outer portions of the hind wing is a uniform dark gray; the basal portion lighter. Fringe with a grayish, silvery luster. Beneath, the wings are a silvery gray. The moth is shown in Plate III, figures *a, b* and *c*.

Life-history and Habits.

The life-history and habits of this, at times, very destructive insect are of the utmost importance in preventing its ravages or in checking it after the destructive work of the larvæ becomes apparent. Most, if not all, of its demonstrations are characterized by the sudden discovery of large numbers of caterpillars rapidly destroying the crops, and usually when thus discovered, it is too late to prevent serious loss. The number of broods in a year is controlled largely by the length of the season in connection with an abundance of suitable food. In the North there are but two or three generations in a year, while in the South, it is stated that as many as six may occur. The insect may pass the winter, in the northern portion of its range, either as moths or larvæ, and possibly in the pupal stage; in the southern portion, it may exceptionally hibernate in the egg.

The habits of the imago.—The moths may be seen on the wing in the early evening hours or during the day in cloudy weather. The flight is usually near the ground and is accompanied by a low humming sound, similar to, but less intense than that of the hawk-moths; it is strong, irregular, and plunging. They are probably capable of long-sustained flights, as on one occasion when they were swarming in houses in the vicinity of the Atlantic coast, fishermen reported a great cloud of the moths over their boat out at sea.

Their food is quite varied: they have been taken on the blossoms of apple-trees, on honeysuckle, soap-wort (*Saponaria officinalis*), and yucca. In August of the present year they were attracted in great numbers to the red berries of the Tartarian honeysuckle (*Lonicera Tartarica*), in Washington park, Albany, upon which they fed, either by puncturing or abrading them, as many of the berries were more or less bruised, and but few other insects were seen around them. It is quite probable that they are drawn to the nectar of flowers and the juices of various fruits. They are also attracted by plant-lice, probably for the purpose of imbibing the honey-dew excreted by these insects. Mr. Van Duzee records an instance (*loc. cit.*) of the moths swarming around an apple-tree badly infested with *Aphis mali.* Dr. Smith, in his Report for 1896, p. 450, mentions their occurrence in large numbers among the plant-lice on melon-vines. The moths seem to require an unusual amount of food, the reason of which may be that the eggs are not developed in recently issued females: no traces of them were found in a number of females dissected during this year.

Oviposition is said not to begin until a week or more after the moth has emerged, and it is believed to continue for the remainder of the adult existence, which may amount to several weeks. No eggs were obtained the past season from females which were either reared from caterpillars or from pupæ collected in the field, although moths taken at the Tartarian honeysuckle berries oviposited within a few days. The eggs are ordinarily deposited by preference in thick tufts of grass, especially such as have been stimulated in growth by the droppings of cattle in pastures, and in other similar localities. The oldest and toughest stalks are selected, and on these the eggs are thrust down between the sheath and the stalk and usually secured in place by a gummy secretion. Early in the season the moth is known to deposit apparently by preference in cut straw of old stacks, in hay ricks, and even in old fodder stacks of corn stalks. Its eggs may also be found in bits of corn stalks on the surface of the ground, and in the preceding year's stalks of grasses; or, the moth may oviposit in the spring in young grain, and at times, on the leaves of plants upon which the larvæ rarely feed, as on clover. The eggs are most frequently deposited late in the afternoon and during the earlier hours of the night, in strings of fifteen to twenty ordinarily, although batches of nearly a hundred, in from three to eight rows on a single stalk have been found. In breeding cages the eggs have been placed in masses of over a hundred, arranged in several rows between two sticks. The first moth dissected by Dr. Riley was found to contain upwards of 200 eggs, but later dissections resulted in finding 562 and 737 eggs respectively, which is probably nearer the average number.

Habits of the larvæ.—The eggs hatch in from eight to ten days. The young larvæ remain in hiding most of the time, feeding only during cloudy weather and at night. They shelter themselves in the folds of leaves, in stubble, and even under the bark of adjacent posts for the first few days, or they may simply rest at full length along a well-shaded leaf. Their habit of dropping upon the slightest disturbance, renders their detection more difficult. During their first week, they eat only of the lower epidermis of the leaf in a manner similar to young Crambid larvæ — at least such was the habit of those reared the past season. In about a week they begin to eat holes in the sides of the leaves, and thereafter their appetites develop rapidly. There is considerable difference in the growth of the larvæ even from the same mass of eggs and under almost identical conditions, some being nearly a molt in advance of the others. This same difference is the more marked in caterpillars growing under natural conditions in the field, where variation is the rule and not the exception. The abundance and the condition of the food has a great influence on the rapidity of their growth, for if abundant and succulent it will be most rapid, while if dry it will be much slower. The parent moth apparently seeks to give her offspring the best conditions when she searches out the thickest and greenest herbage in which to place her eggs, and in most cases it is in just such spots that the destructive armies have their origin. They are really centers of distribution, and should be so regarded.

Migrations.—The earlier stages of the army-worm escape observation in most instances, and it is only when they are unusually abundant and after they have become half-grown that they attract attention. It is not until then, and after all the food has been devoured in their immediate vicinity, that they are noticed. The caterpillars are now forced to move elsewhere or starve. In ordinary years this rarely occurs, for they are not sufficiently abundant to work any serious injury, unless it be a slight thinning of the crop. It will be seen, therefore, that the "marching" habit is abnormal, although it may be the one most familiar to many. The uniform movement of the caterpillars in the same direction may be explained as the most natural, because it is the easiest when they are abundant, for otherwise their opposing motions would be a hindrance to one another. The determination of the direction of the march is probably the result of chance to a great extent, and is governed largely by the direction taken by the first to move, although some are inclined to think that the insects march more frequently toward a certain point of the compass, and others believe that they scent a favorite crop in the distance. The food of the caterpillars is so abundant that it hardly seems necessary to suppose that they are guided to it by a special sense, and it is equally difficult to see how a knowledge of the points of the compass would aid materially in such a search.

In their marches the caterpillars move, so far as possible, in a nearly straight line, turning aside for nothing that can be surmounted. It has even been stated that they will climb the trunk of a tree to the lowest fork and descend on the other side. A number of instances have been reported in which they marched over buildings, where in some instances they were so thick as to cover the sides of the structure. They can not bear the hot sun, and so far as possible, avoid it in their travels, and after crossing a sunny field they may be seen resting in the shade of fences or shrubbery that may offer the desired relief. Water does not deter them. The rear ones push forward over the bridge formed by the dead and dying of the vanguard: if it be a large running stream they perish by the millions. Their march is not a very rapid one; it has been computed at, ordinarily, the rate of 30 yards an hour.

Occasionally it happens, that the army-worm will migrate from the fields for the sole purpose of finding a suitable place for pupation, as in instances when there is abundant food in a grain field, but the soil is too hard for the caterpillars to bury in easily. This was noticed to a limited extent in the outskirts of Albany, where after partly stripping the leaves in an oat field, the caterpillars in migrating, inflicted little damage to a corn and grass field adjacent, but later their pupæ were found in abundance under the leaves and grasses beside the outer fence — 35 being counted within an area of about two square feet.

Associates.—It is not an uncommon occurrence, that cut-worms are associated with the army-worm in its ravages. In the 11th Illinois Report, Mr. Coquillett records the presence of *Agrotis c-nigrum* in an army-worm attack, in the proportion of one cut-worm to eight or ten army-worms, while Dr. Howard found the proportion to be as high as one to five.* A single example of *Agrotis ypsilon*, was detected in a lot of over 100 army-worms received from Ghent, N. Y., early in October of the past year.

Food of the Caterpillars.

The favorite food of the army-worm is undoubtedly, the green succulent leaves of a luxuriant growth of some member of the true grass family, the *Gramineæ*. In fields of small grain, the greener leaves are quickly stripped from the stalk, and, if the stem is not too hard, the heads will frequently be eaten off and fall to the ground. Occasionally, the heads are partly eaten after they they have been lopped off, but more frequently they are left untouched by the caterpillars. This wanton habit of the army-worm, increases its harmfulness in grain fields, without any

*In 3*rd Rept. U. S. Entomological Commission* 1883, p. 135.

commensurate gain to itself. Of the cultivated crops, wheat and oats appear to be the favorites. Corn is perhaps less frequently attacked, for the reason that its method of cultivation is such as to discourage the insect breeding in fields of it, while, as shown before, the attack of any field after marching has begun is determined largely by chance. Rye and barley are eaten, but apparently with less relish. When pressed by hunger, the army-worm can readily accommodate itself to circumstances and devour many plants differing widely in character from its chosen forage. The most important of these are: flax, clover, beans, peas, strawberry, leaves of fruit-trees, watermelon, cucumber, rag-weed (*Ambrosia artemisiæfolia*), cranberry, wild Solanum, capsicum pepper, Amarantus, asparagus, and onions. There are a number of other plants upon which the caterpillars have been successfully reared, and upon which they would probably feed in nature, if nothing else was convenient to them. Some of the food-plants mentioned above, have been reported as not eaten by the army-worm, while others report them as occasionally injured. It is probable that the caterpillars are guided largely by the demands of nature for sustenance, and in proportion to their necessity do they turn to whatever is at hand.

Pupation.

Many accounts of the army-worm record its sudden disappearance, "as if by magic." A field may be swarming with its hosts, and in a day or two none will be seen. But if one will examine the loose surface soil in a recently infested field or will look beneath the brush and dried grass on its borders, the mahogany-brown pupæ will readily be found. The caterpillars have simply entered the ground for pupation and will soon reappear as moths. The duration of the pupa state is governed largely by the temperature; in July of last year, it was about 20 days in this State, while in September it was lengthened to about 30.

Number of Generations.

In this State there were three broods the past season, which is probably the usual number. No observations were made on the first generation, therefore it is safe to assume that it was quite a limited one. It was the second that attracted attention throughout the State during the first two weeks of July. They completed their growth and pupated before the end of the month. The first of August moths were emerging, and by the 7th, no pupæ could be found in searching in what had been a badly infested field, although pupal shells were abundant. Numbers of moths were seen in Washington Park, in Albany, on August 14th and 17th, but a week thereafter they had all disappeared.

On September 26th, larvæ of the third brood were reported as committing serious ravages on the farm of Jacob Harder, Ghent, N. Y., where the second brood had been destructive in July.* A number of the larvæ were sent to my office, of which the last buried for pupation, about October 12th. Moths from these began to emerge the 27th, and continued to do so until November 21st. During this time, 77 moths made their appearance, coming out most abundantly from November 2nd to the 10th. The appearance of the adults so late in the season, renders it quite probable that they hibernate in the imago state in Albany, as has been observed at Cambridge, Mass., although a portion of the brood may also winter as pupæ. According to Dr. Howard, the insect may exceptionally pass the winter in the egg in some of the Southern States. It will be seen that these observations on the life-history of this insect agree quite closely with those of Prof. Weed, at Durham, New Hampshire; and other observations render it probable that there are ordinarily three broods each year in the other New England States, with the exception of northern Maine. In New Jersey, Dr. Smith reports three generations as the normal number in the northern portion of the State, while in the southern part a fourth is by no means unusual.

Summary of Life-history.

The life-history of the army-worm, so far as known in this State and the vicinity, may be briefly summarized as follows: Overwintered moths or recently emerged ones, which may have hibernated as larvæ, or possibly pupæ, deposit eggs early in the spring, and from them the first brood of larvæ develop. From their comparatively small number, they rarely prove very destructive and are consequently unnoticed. They mature, pupate, and the adults emerge and lay the eggs from which is produced the second brood. These in turn become nearly full-grown early in July, and we have the brood usually destructive, and the one which committed such widespread ravages in the State the present year. Pupation occurs in July and the moths emerge early in August. They deposit eggs the latter part of the month, and early in September the third brood makes its appearance and by the latter part of the month they are full-grown. This is the brood which was quite destructive the present season, at Ghent, N. Y., pupating the last of September, or early in October,—the moths emerging the last of October and into November, and most probably passing the winter in the imago state.

*They were also reported as destructive on several farms in Berlin, Bolton, Northboro, and other places in Worcester county, Mass., during the last of the month.

Natural Agents Controlling the Army-worm.

The inquiries are frequently made: Where do the army-worms come from? Will they be abundant next year? The first question has already been answered, but the answer to the second may not be so readily given. The comparative abundance or scarcity of this insect, as well as of others, from year to year is controlled by natural causes. The most prominent of these are the relative abundance and quality of its food, the favorable or adverse climatic conditions, and the number and activity of its natural enemies. Temperature and moisture have an important bearing on the production of its food-plants, and all know that without an amply supply of proper food, the caterpillars would die while young or immature, and no serious injury to crops would result from their presence. Weather conditions have also marked effect upon insect growth and development. Cold and wet serve to impair lepidopterous life, and when such prevails while the insect is in its tender larval stages, great mortality is the result. Hibernation is a severe ordeal for many insects, and alternate freezings and thawings, to which they may be subjected, may terminate many insect lives. It is only when the climatic conditions in connection with other controlling causes are favorable to the rapid growth and multiplication of the insect, that the ravages of the army-worm reach the ruinous extent of the present year. Such combinations can not be predicted. They very rarely occur in consecutive years. The theory has been advanced, that a dry season followed by a wet one, is likely to be an army-worm year, and it is apparently borne out by records made. But the attempt to predict the abundance of the army-worm solely from the amount of rain-fall for the year, ignores the important part that the predaceous and parasitic enemies of this insect have in its control.

The army-worm is also subject to a deadly bacterial disease, which may be fatal to large numbers. In the western portion of the State, 25 per cent. were killed by it in some localities (Lowe, *loc cit.*, p. 128). Unfortunately, the disease is only effective, it is believed, under certain conditions, and these are rarely favorable in nature to any extended action, or even to artificial propagation.

Predaceous Enemies.

Fortunately for the farmer, the army-worm has a large number of foes that prey upon it. Swine are said to eat them greedily, and to prefer them to corn. Shrews, skunks, and weasels, are reported as consuming large numbers. Domestic fowls, especially ducks and geese, are valuable allies in fighting an army of these caterpillars. Most, if not all, of the insectivorous birds feed readily on them. Some of the most serviceable are the bobolink, blackbird, robin, and meadow lark. The English sparrow should be credited with feeding on the army-worm to a certain extent. Others that have been observed are the king-bird, blue-jay, golden-winged woodpecker, phœbe, cow-bird, Baltimore oriole, chipping sparrow, chickadee, and quail. Frogs and toads devour them with a relish, the remains of as many as fifty-five having been found in the stomach of one garden toad.

A number of predaceous insects are known to prey on the caterpillars. The more common and perhaps the most important belong to the family of *Carabidæ*, or ground-beetles, which may be found under stones and other shelters in the fields. One of the most efficient of these in this State, is the fiery ground-beetle, *Calosoma calidum* (Fabr.). This fine beetle may be easily recognized by the six rows of large coppery-red, or golden spots on the wing-covers. Both the beetle and its larva, are fierce enemies of the ordinary cut-worms, as well as army-worms. In the Southern States, the allied *Calosoma scrutator* (Fabr.), with its bright green wing-covers margined with a resplendent coppery-red, is an equally deadly enemy of the army-worm. Two other species of this genus, *C. externum* (Say) and *C. Wilcoxi* Lec., have also been observed preying on the caterpillars. A common tiger-beetle in this State, *Cicindela repanda* Dej., is another of its deadly foes. Besides these, the following ground-beetles have been observed preying on the caterpillars: *Elaphrus ruscarius* Say, *Pasimachus elongatus* Lec., *Pterostichus sculptus* Lec., *Amara angustata* Say, *Platynus sinuatus* (Dej.), *Cratacanthus dubius* (Beauv.), *Harpalus caliginosus* (Fabr.), *H. Pennsylvanicus* (DeGeer), *Selenophorus pedicularius* (Dej.,) and *Anisodactylus rusticus* (Say). A large southern bug, *Metapodius femoratus* (Fabr.), has been observed in large numbers sucking the juices from the army-worms. This rapacious insect, it is said, has the peculiar habit of hanging the caterpillar skins after it has sucked them dry, in the crotches of May-weed in the infested field.

The large ground spiders are said to prey freely on the army-worms, and the spinning forms often entrap the moths in their webs for their food.

Parasites.

The army-worm is subject to the attacks of a large number of true parasites, several of which are very destructive to the caterpillars, and may be classed with natural enemies, having an important part in keeping the insect from becoming excessively abundant. The most important of these are the red-tailed Tachina-fly, *Winthemia 4-pustulata* (Fabr.), formerly known as *Nemoræa leucaniæ* (Kirk.), but which has recently been found identical with this European species; and the yellow-tailed Tachina-fly, which was described as *Exorista flavicauda* by Riley, but it has recently been pronounced identical with *Belvoisia unifasciata* Desv., by Mr. Coquillett. These two flies are frequently seen in numbers in fields where the army-worm is numerous. They are often so abundant that their buzzing reminds one of a swarm of bees. Their conspicuous white eggs are usually deposited on the head or thoracic segments of the caterpillar, where they can not be reached by the jaws of the victim for their removal; occasionally they may be found on the anterior abdominal segments. As many as eighteen eggs have been counted on a single caterpillar, but the average is about five. The eggs soon hatch and the young maggots make their way into the body of their host, where they revel in its juices and eventually cause its death. This Tachina oviposition is not, however, necessarily fatal to the larvæ, for if it occurs at near the molting, the eggs may be cast with the skin before the time for their hatching. The proportion of caterpillars parasitized in the vicinity of Albany, was observed to be quite small, probably about 8 per cent., but in the central and western portions of the State, the eggs of these parasites were comparatively abundant.

The following flies have been reared from the army-worm: *Cistogaster immaculata* Mcq., *Ocyptera euchenor* Wlk., *Miltogramma argentifrons* Twns., *Myophasia ænea* Wied., *Sarcophaga helicis* Twns., *Sarcophaga œdipodinis* Twns., *Sarcophaga* (two species), *Lucilia cæsar* (Linn.). It is more than probable that some of these are not true parasites.

Next in importance perhaps to the Tachina flies as parasites, are the minute four-winged Microgasters, several species of which are parasitic on the army-worm. The most abundant of these is the military Microgaster, *Apanteles militaris* (Walsh), which is usually present, wherever the army-worm abounds. From sixty-two to ninety-six of its larvæ have been found in the body of one caterpillar. Its whitish cocoons are often attached to the grass, or to the under side of sticks, stones, etc., in small masses surrounded by more or less loose silk. *Apanteles limenitidis* (Riley) is another species parasitic on the army-worm. Unfortunately, these two beneficial insects are in turn parasitized by a Chalcid, *Glyphe viridascens* Walsh, and by a small Ichneumonid, *Mesochorus vitreus* Walsh. *Haltichella perpulchra* (Walsh), is also a parasite of one of the Microgasters above-named. Another smaller parasite of the army-worm is the wingless *Pezomachus minimus* Walsh, which in turn has its Chalcid parasite, *Smicra albifrons* (Walsh). *Ophion purgatum* Say, is one of its larger parasites, and in some localities it is often quite abundant. In Minnesota its cocoons were numerous in the infested fields the past year. The following species are also recorded among its parasites: *Ichneumon leucaniæ* Fitch and *I. flavizonatus* Cress., *Hemiteles laticinctus* Riley MS., *Stibeutes gentilis* Cress., *Limneria oxylus* Cress., *Mesochorus scitulus* Cress., and *Rhogas terminalis* Cress. *Bassus scutellaris* Cress. was observed apparently ovipositing on the army-worm.

Preventives and Remedies.

When a field has become badly infested with half-grown army-worms, little can be done to save the crop beyond cutting at once what remains and promptly removing it from the field. In order to prevent injuries by this insect, the intelligent farmer will, so far as possible, combat it along two lines. In the first place he will endeavor to prevent it breeding in numbers in his fields by so cultivating and caring for his crops as to offer the least favorable conditions for hibernation, oviposition, and the subsequent growth and development of the caterpillars. Secondly he will make effort to protect and favor its natural enemies.

Destruction of hibernating forms.—Whether the insect passes the winter as a moth or a caterpillar is not so very important to the farmer, provided he can destroy them in either state. In nature both the moths and caterpillars shelter themselves largely under thick grass and rubbish as winter approaches. The burning over of such places late in the autumn or preferably in the early spring must result in the destruction of large numbers of the insects. This measure would at the same time kill many other injurious insects hibernating in such places, and also, unfortunately, some beneficial forms. It is believed, however, that the benefit resulting from the burning would far outweigh the loss caused by the destruction of our insect friends.

Proper cultivation.—It has been shown in the preceding pages that the moth exhibits a decided preference for thick herbage of some kind when about to deposit her eggs, and that such areas are distributing centers to other portions of the infested fields. Many such places are to be found in the neglected weeds and grasses springing up beside fences, or they may occur in the middle of fields, as the result of unequal manuring. The good farmer by keeping his entire fields clean, and avoiding uneven manuring, will not offer conditions that invite oviposition.

Encouraging natural enemies.— Among the most beneficial may be counted many of our insectivorous birds. They have repeatedly been observed feeding on the army-worms in badly infested fields. If the grain fields are not sown too thickly, not only is a better crop secured, but the birds, having more wing room in the grain, will feed to a much larger extent on the caterpillars. Unfortunately, little can be done toward encouraging the insect enemies of the army-worm beyond protecting them so far as possible, and giving them the favorable conditions that may attract them.

Watching for indications.— The measures given above are not to be depended upon entirely, even though carried out to the letter. They should be supplemented by watchfulness. If the army-worm commences its operations in a field in unusual abundance, it is of the utmost importance that its presence should be known at once. The discovery is usually made, and advice sought in the matter, when it is too late to save more than a scanty half or less of the crop attacked. It is not a difficult task to discover the caterpillars some days before they are usually seen, and no man should begrudge the time devoted to the search. The thickest portion of a field should be examined for their small black or brown droppings, and the condition of the lower leaves of the grass or grain noticed. If the leaves are injured or absent, something has been eating them. The enemy may be found hidden under loose shelter of any kind on the ground or just below the surface, or when very small, upon the plants. If they are discovered before serious injury has been done to the crop, it is comparatively easy to decide whether or not to cut it at once. If the field is thickly infested, they will destroy the crop unless it is taken from them.

The commencement of an army-worm attack, as above noted, will rarely be detected. It is only when their operations can no longer be hidden from ordinary observation that alarm is excited, and the necessity of active measures for arresting their destructive marches from field to field becomes apparent. Some of the following measures will then be found of service:

Lime, dust, etc.— If the army-worms are numerous in a field—at an early stage in their operations, it would probably be wise to cut the crop at once and save what is left of it, although air-slaked lime, land plaster, or even road dust freely distributed over the vegetation when it is wet with dew or rain, would render it unpalatable to the caterpillars and compel them to seek other food.

Poisoned bran mash.—This was used in different localities in the State the present year with considerable success in infested fields. It was reported in several instances that the caterpillars would even leave the corn upon which they were feeding and descend to the ground for the purpose of eating the attractive bait. Large numbers were killed by its use and the crops were protected to a considerable extent. The recipe for its preparation is as follows: 35 lbs. wheat bran, 1 gallon of molasses and 1 lb. Paris green mixed to a proper consistency with hot water. It should be distributed just before nightfall, as then the caterpillars are usually beginning their feeding.

Ditching.—This method is of value only in keeping the army-worms out of fields comparatively free from them, and it is quite effective if properly conducted. The ditch may be made by plowing a rather deep furrow with its perpendicular side towards the field to be protected. At intervals in the ditch of fifteen or twenty feet, holes of about two feet in depth should be made (easily done with a post-hole auger) into which the caterpillars, unable to climb the wall, will fall and die. As often as the holes become filled they may be easily killed and removed. The furrow or ditch should have the perpendicular side clear of all weeds, roots, and other matter that might aid in climbing out. An improvement on the single furrow has been recommended by a resident of Dutchess county. The first furrow is turned towards the crop to be protected, and then returning with the plow in the furrow, the perpendicular wall is made next to the crop. By this means soft crumbly earth is obtained on both sides of the furrow, which will be more difficult for a caterpillar to climb than a smooth firm surface. If the one ditch should by any means prove insufficient, a second, a short distance in advance of the other, could be made.

Bands of tar.— Broad bands of tar have been used in some of the Western states in lieu of ditches, but, as they require to be renewed as often as they become bridged or the tar hardened, this method would doubtless be more expensive than the ditching. Another method is the tarring of boards and setting them up on edge as barriers. This is more effectual than bands of tar, but it is more expensive.

Poisoned strips.—A field may often be protected by spraying an exposed strip heavily with Paris green and water, or by sprinkling it with land plaster and Paris green. In either case it should be heavily poisoned. The poisoned portion of the crop should be carefully destroyed after it has served its purpose, in order to prevent the chance of its being eaten by stock.

Spraying with kerosene.—A safer way and just as effectual as poisoning strips with Paris green, would be found in spraying a strip with kerosene or a strong kerosene emulsion; but repeated applications — as many possibly as six in a day might be required to keep the traveling army in check.

Dragging the rope.— This method has been recommended in former years, but its efficacy may be questioned. It is simply drawing a long rope, held by a man at each end, over the infested field. The grass or grain bows under the weight of the rope and, as it springs back, the caterpillars drop to the ground where they remain for some time. It would need frequent repetition and would prove effective only when the field is not badly infested.

As means of protection from the ravages of this destructive pest, a number of methods have been named from which selection may be made of those which seem the most practicable for use in the localities or fields invaded. It not infrequently occurs that a remedy for some insect depredation which fully accomplishes its purpose under certain soil and other conditions, will in places where the conditions are of a markedly different character, prove to be of no value whatever.

Steganoptycha Claypoliana (Riley).

A New Maple-Tree Insect.

(Ord. LEPIDOPTERA: Fam. TORTRICIDÆ.)

RILEY: in Amer. Nat., xv, 1881, pp. 1009–1010 (compared to *Proteoteras æsculana*); in id., xvi, 1882, pp. 913-914 (the name of *Proteoteras Claypoliana* proposed); the same in Scien. Amer., Suppl., No. 363, Dec. 16, 1882, p. 5797; in Amer. Nat., xvii, 1883, p. 978 (compared with *Proteoteras æsculana*, and referred to *Steganoptycha*); reprint of same in Papilio, iii, 1883, p. 191.
CLAYPOLE: in Proc. Amer. Assoc. Adv. Sci. for 1881, 1882, pp, 269–270 (abstract of life-history; erroneously referred to *Sericoris instrutana*); in Psyche, iii, 1882, pp. 364–367 (notes on life-history).
SMITH: List Lepidopt. Bor. Amer., 1891, p. 93, No. 4976.
LINTNER: in Country Gentleman, lx, 1895, pp. 484–485 (recorded on maple, life-history); 11th Rept. Ins. N. Y., 1896, pp. 278, 285 (abstract of preceding, mention).

The interesting insect named above is very unobtrusive in its habits, if one may judge from the few notices that have appeared of it. There is no record of its having been observed in the field by more than four different individuals. Although it appears never to have been so abundant as to cause much damage, yet it is most probable that careful observation would reveal its presence in many hitherto unsuspected localities.

Burrowing in the Petioles of Maple Leaves.

The following communication from a correspondent of the *Country Gentleman*, gives a brief account of the operations of this insect when for the first time detected upon the maple (in 1895), so far as any record is to be found:

> I enclose leaves of sugar maple, the petioles of which are infested with a minute larva. My attention was first attracted by numerous green and half withered leaves lying on the ground with only a short portion of the petiole attached, which led me to look for the remaining portion; this I found attached to the tree, with a small channel extending towards its base. At the end of this was the larva. About a year ago I passed some rows of sugar maples appearing as mine do now, and I attributed the cause to a fungoid blight, but without examination. W. T.
>
> *Concordville, Pa.*

When fallen maple leaves have been noticed during the early part of the year, it has usually been ascribed either to frost or some fungus attack. But in this instance, the leaves affected in the manner stated happening to come under the eye of a close observer, the cause was looked for, and careful search disclosed it in a small caterpillar burrowing within the portion of the leaf-stalk remaining upon the tree.*

From the examples of the leaves and separate portions of the stems or petioles sent, the operations of the caterpillars have been followed and its species determined. It proves to be the larva of a small Tortricid moth which has received the name of *Steganoptycha Claypoliana* — after Prof. Claypole, who had studied and made first publication of the insect when working in the leaf-stalk of the horse-chestnut, in Ohio.

Confused with a Closely Allied Insect.

This species was confused at first with a closely allied form, *Proteoteras æsculana* Riley, reared from larvæ found boring the leaf-stalks and the tender terminal twigs of the buckeye and maple in Missouri, and was referred to this form. A little later, it was regarded and described by Prof. Riley as a distinct species of the genus. Finally it was referred to *Steganoptycha* by Prof. Fernald.

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* Mr. Zabriskie has placed on record an injury to the petioles of maples at Flatbush, L. I., which is most probably the work of this insect (see *Journ. N. Y. Entomolog. Soc.* iii, 1895, p. 144).

It may be distinguished from *P. æsculana* by the following characters, according to its describer:

Claypoliana lacks the notch in posterior borders of primaries, the tufts of raised scales on the discs of same, and the peculiar tuft or pencil of hairs on the upper surface of secondaries in the male, between the margin and the costal vein. It is a shorter, broader-winged species; the ocellate spot is less distinctly relieved, the median oblique band more broken, the basal-costal portion paler and contrasted along the median vein with a dark shade which may be almost black, and which broadens posteriorly till near the middle of wing, where it is abruptly relieved by a pale space obliquing basally.

Description of Several Stages.

The moth has been characterized briefly by Prof. Claypole as follows: "It was small, with a peculiar hopping flight, the fore wing mottled black and white, and the hind wing more uniform in color, dusky, and slightly spotted with black near the tip."

The light red pupa was inclosed in a rolled up leaf lined inside with silk. Eight abdominal segments were visible.

A larva examined May 13th was two-fifths of an inch long with a yellow head and yellowish body. The minute granulations of the skin are smooth,—not pointed as in *P. æsculana*. The same general appearance was retained until pupation, except that it became a little darker.

Operations and Life-History.

In the leaf-stalks of the buckeye, *Æsculus glabra*, Prof. Claypole found the insect during the early part of May. About the 10th, they deserted the petioles through the holes by which they had entered, and betook themselves to the fading leaves. Upon the dying foliage they completed their growth naturally to all appearances. This food-habit is apparently normal, as no nibbled green leaves were found on the infested trees after the larvæ had deserted the leaf-stalks. Pupation occurs the latter part of May,—the first pupa being found on the 25th. The moth appears about fifteen days later. Prof. Claypole was not able to ascertain the place and manner of the deposit of its eggs, the number of broods, or the form in which it hibernates.

The work of this insect in the maple leaves coincides closely with that in the buckeye. The egg of the parent moth appears to be placed at the base of the leaf,—perhaps at the divarication of the ribs. As the young larva tunnels the petiole, the portion traversed by it shrivels, blackens, dries, and is broken off by the weight of the leaf. The larva continues its course downward, and on the stalks examined could usually be found at the end of a freshly cut channel of about one-half inch in length. In several instances a small opening was visible in the petiole through which the larva had emerged to undergo its transformations within a fold of a shriveling leaf, or possibly among the leaves on the ground.

Its Habits Compared with Those of Proteoteras æsculana.

These closely allied insects have different habits that are of value in distinguishing the species. *S. Claypoliana* bores the leaf-stalk of both the buckeye and maple and very rarely the twigs of the former. It is also known to feed on the blossoms of the buckeye. The larva of *P. æsculana* bores the slender terminal twigs of both these trees and often forms a swelling or pseudo-gall—the former insect never produces a gall. *P. æsculana* bores the petioles and terminal twigs for a distance of from one-half an inch to two inches, and lives in the gall, apparently through most of its larval existence. It feeds also on the winged seeds of the maple. *S. Claypoliana,* on the contrary, seldom or never bores along the leaf-stem more than half an inch, very rarely enters the terminal twigs, and lives in the rolled up leaf after the first two or three days.

Remedies.

The mining within the leaf-stalk by this insect has caused many leaves of the buckeye and maple to fall in certain localities, yet it is not probable that it will multiply and spread to such an extent as to become a serious pest, although in one of the maple twigs sent, four of the five leaves that it bore contained larvæ within the petioles.

Should further observations show that many of the fallen leaves carry with them to the ground the infested portion of the petiole or the insect within the folds of the leaf, as they appear to do in some instances, then it would be of service to collect and burn the leaves as soon as they fall, and before the larva has left them.

Oxyptilus periscelidactylus (Fitch).

The Gartered Plume-Moth.

(Ord. Lepidoptera: Fam. Pterophoridæ.)

Fitch: in Trans. N. Y. State Agricul. Soc. for 1854, 1855, pp. 843–847 (larva, pupa, imago, described, habits; as *Pterophorus*); the same in 1st–2d Rept. Ins. N. Y., 1856, pp. 139–143.

Packard: Guide Study Ins., 1869, pp. 356–357, Pl. 8, figs, 23, *23a*, *23b* (brief account, as *Pterophorus*); Entomol. for Beginn., 1888, p. 150, fig. 179 (as *Pterophorus*).

Riley: 1st Ann. Rept. Ins. Mo., 1869, pp. 137–138, Pl. II, figs. 15, 16 (common in Mo., description; as *Pterophorus*); in Amer. Entomol.–Bot. ii, 1870, pp. 234–235, fig. 148 (injuries, life-history; as *Pterophorus*); the same in 3d Ann. Rept. Ins. Mo., 1871, pp. 65–68, fig. 27; Bull. 31 Divis. Entomol., U. S. Dept. Agricul., 1893, p. 32 (reference).

Saunders: in 1st Ann. Rept. Entomolog. Soc. Ont., 1871, pp. 102–103, fig. 42 (life-history, habits; as *Pterophorus*); the same in Rept. Fruit Growers' Assoc. of Ont. for 1870, 1871; in 2d Ann. Rept. Entomolog. Soc. Ont., 1872, p. 18, fig. 11 (troublesome in Ontario, as *Pterophorus*); in Canad. Entomol., v, 1873, pp. 99–100, fig. 15 (description, life-history; as *Pterophorus*); Ins. Inj. Fruits, 1883, 1889, pp. 268–270, fig. 278 (general account).

Perkins: in 5th Rept. Vt. Bd. Agricul., 1878, pp. 274–275, fig. 22 (brief account, as *Pterophorus*).

French: in 7th Rept. Ins. Ill., 1878, p. 268 (brief notice, as *Pterophorus*).

Dimmock: in Psyche, iii, 1882, p. 390 (liability to parasitism), p. 403 (bibliography).

Kellicott: in Bull. Buff. Soc. Nat. Sci., Jan., 1882, separate, p. 1 (mention).

Cooke: Inj. Ins. Orch.-Vin., 1883, pp. 191–192, fig. 177 (brief account, as *Pterophorus*).

Fernald: in Kingsley's Stand. Nat. Hist., ii, Crust. and Ins., 1884, p. 437 (brief account); Bull. 12 Hatch Expt. Stat. Mass. Agricul. Coll., 1891, p. 32, fig. 26 (brief account).

Smith: in 10th Ann. Rept. N. J. State Agricul. Expt. Stat. for 1889, 1890, pp. 288–290, fig. 16 (brief account of, in N. J.); Cat. Ins. N. J., 1890, p. 359 (common); List. Lepidopt. Bor. Amer., 1891, p. 88, no. 4594; Econom. Entomol., 1896, pp. 318–319, fig. 366 (brief account).

Lintner: in Country Gent., lvi, 1891, p. 497 (general notice); 8th Rept. Ins. N. Y., 1893, p. 284 (abstract of preceding), p. 297 (reference); 10th do., 1895, p. 516 (reference).

Riley–Howard: in Insect Life, iii, 1891, pp. 469–470 (brief mention as *Pterophorus*, one annual brood).

Bruner: in Rept. Nebr. State Hort. Soc. for 1895, pp. 72, 147–148, fig. 77 (brief account, after Saunders).

Comstocks: Man. Study Insects, 1895, p. 238, fig. 284 (brief account).

Dyar: in Psyche, vii, 1895, p. 253, fig. 4 (larval tubercles, setæ).

Among the many insects that prey upon the grapevine, this, in the winged form, notwithstanding its small size, is one of the prettiest and most peculiarly formed of the many species that have the vine for their food-plant. It is not ordinarily very destructive, although widely distributed and more or less injurious from year to year. The present season, however, State Botanist Peck, found it in unusual abundance in his garden at Menands, N. Y., necessitating his going over the vines and destroying the larvæ in the young tips (by pinching with the thumb and forefinger), six times during the season, whereas in former years, only two inspections were needed to keep them under control.

This species was unusually destructive in Westchester county, N. Y., in 1891, as appears from the following letter to the *Country Gentleman* :

I inclose bud and leaf of grapevine, in which you will find a small white hairy worm, which in its first stage appears to be black or brownish, and has the habit of spinning a web and gluing the budding leaves together. It is a voracious feeder, and soon destroys the leaves of the vines and young grapes. To-day, I sprayed the vines with whale oil soap suds, and if this is not effective in destroying the pests, I will try Paris green. Perhaps, Dr. Lintner can give the name, and suggest some good way to destroy this enemy of the grape. D. J. G.

The insect was readily identified as the gartered plume-moth, *Oxyptilus periscelidactylus* (Fitch), and reply was made giving its general family characters, habits, and distribution, together with the best remedies.

Characters of the Family.

This moth and its closely related species, comprising the small family of *Pterophoridæ*, are easily distinguished from all others, by their wings being split into two or more long narrow lobes. From this peculiar wing-structure, Latreille, many years ago, termed them *Fissipennes*, or Split-wings. The borders of the wings are densely ciliated, the hind margin of the fore-wings, and the fore and hind margins of the lobes of the two pairs of wings have very long ciliæ. The long slender legs are provided with stout spines at the apex of the tibiæ, a single one on the fore tibia, a pair at the apex of the remaining, and the hind tibiæ with an additional pair of spines midway of their length.

Description of the Moth.

"The moth, which is shown in figures 8, 9, Pl. V, is an elegant little insect, its wings measuring, when expanded, about seven-tenths of an inch across. The fore wings are long and narrow, and cleft down the middle about half-way to their base, the posterior half of the wing having a notch in the outer margin. Their color is a yellowish brown, with a metallic lustre, and several dull-whitish streaks and spots. The hind wings are similar in color to the anterior pair, and are divided into three lobes; the lower division is complete, extending to the base, the upper one not more than two-thirds of the distance. The outer and hind margins of the wings, as well as all the edges of their lobes, are bordered with a deep whitish fringe, sprinkled here and there with brown; the body is long and slender, and a little darker than the wings. The antennæ are moderately long and thread-like, nearly black, but beautifully dotted with white throughout their whole length. The legs are long, banded alternately with yellowish brown and white, the hind ones ornamented with two pairs of diverging spines, having at their base a garter-like tuft of long brown scales, from which feature the moth derives its name." (Saunders.)

The Pupa.

The greenish or yellowish pupa of this insect has a very peculiar form. It may be found hanging from the leaves or bark of the grape, as an irregular, ragged looking object with an inclination to the supporting surface of about 40°. The head is obliquely truncate, from which the body tapers, slightly curving dorsally to the tip (fig. 5, Pl, IV). It is ridged, angulated, and with numerous projections—the most prominent of which is the dorsal, located about midway of its length. Dr. Fitch has compared it to the dead fragments of a little scraggy twig. The pupæ vary considerably in color, being either green or some shade of brown. It is said that the green ones are found only on the green leaves and the brown on the brown bark of the twigs; in each case they harmonize so perfectly with their surroundings that it is not easy to detect them; and such was found to be the rule among a large number reared recently. The changing of the numerous larvæ to this state under such protective conditions, has frequently led to the statement that the insect had suddenly disappeared. The duration of the pupa state is usually six or eight days, but it may be prolonged to fourteen by cold or other unfavorable conditions.

The Larva.

In the early spring as the leaves of the grape begin to unfold, here and there some of them may be seen webbed together. Within these clusters of developing leaves, represented in figure 3, Pl. IV, the greenish white-haired larvæ of this insect may be found. As an aid in identification, its description by Dr. Fitch is herewith transcribed.

The larva when full grown measures about half an inch in length. It is almost cylindrical, sixteen-footed, of a very pale green color, divided into fourteen segments by rather deep wide transverse constrictions. It has two rows of elevated white spots along the back, and one along each side, each segment having one spot in each row, or four spots in all. and between the spots is a smaller white elevated dot, and another similar dot below the lower spots. From each of these elevated spots and dots white bristles of different lengths stand out in all directions. (Pl. IV, fig. 4.)

Life-history of the Insect.

There seems to be very little definite knowledge of the life-history of this insect. The larvæ may be found soon after the leaves begin to appear, and complete their growth during the last of May or early in June. Prof. Riley gives the duration of the larval existence as about three weeks. Several larvæ received from Prof. Peck the past season pupated May 25th and others June 1st. The moths emerge about the middle of June. From this time until the appearance of the caterpillars on the vines the following spring, nothing definite seems to be known of the life-history of this insect. There is but a single brood in a season, according to Dr. Fernald. Mr. Saunders is of the same opinion and he suggests that it may pass the winter in eggs deposited on the canes of the vines near the base of the bud from which the next year's branch is developed. Prof. Riley, reasoning from analogy, suggests that the insect has two annual broods and that the second hibernates in the adult form. According to Furneaux,* the late feeding Pterophori emerge in the autumn and hibernate as moths, but of the hibernation of the earlier appearing ones no hint is given. It is in the imago state that the second brood of the English *Agdistis bennetii* passes the winter (see Fernald *loc. cit.*). No one has reported examples of a second brood of *O. periscelidactylus*, although several careful observers have looked for them. The moths of the single-brooded *Alucita hexadactyla* emerge in England during August, and remain on the wing until October, and then hibernate. After making due allowance for the difference in climate between this country and England, it seems reasonable to suggest that our gartered plume may fly through July into August under normal conditions, and then pass into hibernation, or, as suggested by Mr. Saunders, it may winter in the egg state. There appears to be little ground for supposing the insect to be double-brooded.

Of a large number of the moths which were reared during the latter half of June — a few days after they had emerged, several were observed

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in coition. No eggs were apparently deposited by them, and in the course of about ten days the adults were all dead. As they had no proper food, this probably hastened their death and might also account for the non-production of eggs.

Earlier History and Nature of its Injuries.

The operations of the insect first came under the notice of Dr. Fitch in 1854, and at that time it seemed to him more destructive than any other grapevine-feeding species whose life-history had hitherto been given. It was reported in 1869 as very common in Missouri by Prof. Riley, and the following year it was more injurious than usual in that section. The same year it was very troublesome in Canada, according to Mr. Saunders.

The principal injury by this insect is the destruction of the unfolding leaves in the early spring, and if unmolested the young larvæ will later devour the forming blossoms.

Distribution.

The gartered plume has a wide distribution throughout Canada, the Eastern United States, and westward at least as far as Missouri. It is also known to occur in Nebraska, and California, and it will probably be found in all of the Northern and Middle States of the Union.

Parasites.

Several parasites have been reared from this insect by Dr. George Dimmock, who simply records the fact without giving the names. None were obtained by me the past season, and there is no record at hand of rearings by others. From this, it may be inferred, that the parasites of this insect are not abundant.

Remedies.

The presence of the larvæ, is readily indicated by the webbing together of the terminal leaves. The caterpillars are so sheltered within the inclosing leaves, that arsenical spraying would be of little value against them. The most practicable method of keeping the insect in check, appears to be the simple one of going over the vines a few times in the early spring and crushing the concealed caterpillars by hand within their nests, which are easily detected.

Additional Notes on Sciara.*

The Fungus Gnats.

(Ord. DIPTERA: Fam. MYCETOPHILIDÆ.)

A number of species of this genus were noticed in the *Tenth Report on the Injurious and Other Insects of the State of New York*, and two, believed to be new to science, were described. During the present year several other forms were received from Dr. J. B. Smith, of the New Jersey Agricultural Experiment Station, who had bred them from mushrooms, decaying potatoes, and decaying blackberry roots. On his request they have been given some study. The species of *Sciara* are so similar to one another in many respects, that it is difficult to recognize the various species from some of the descriptions published. Those bred from the mushrooms and potatoes, however, do not agree with any descriptions accessible to me, of either European or American species of this genus, and they are herewith described as new:

SCIARA MULTISETA n. sp. Head and thorax fuscous; abdomen a variable dark ochreous; antennæ brownish with a thin whitish pubescence; palpi yellowish; wings somewhat iridescent, hyaline, anterior veins dark ochreous; halteres fuscous apically, pale yellowish at the base; coxa yellowish, femur darker, tibia still darker, and tarsi fuscous distally.

Antennæ longer than the head and thorax; basal segments enlarged; first, cuboidal; second, globose; third to fifteenth nearly cylindrical, length, about twice the thickness, pediceled distally; terminal segment conical. Palpi: basal segment short; second broadly ovate, apically with a large sensory pit; third, elliptical, shorter than the second; fourth, one-third longer than the preceding; each with scattering large setæ and numerous minute ones which have a verticillate arrangement on the last two segments.

Thorax with scattering hairs; on the scutum of the mesothorax there are three rows of fine setæ on its dorsal surface.

Wings, subcosta (1st longitudinal) short, not extending to the fork of the second branch of radius (3rd longitudinal) and media (4th and 5th longitudinals). First branch of radius (2nd longitudinal) extending a little beyond the middle of the wing and just beyond its middle, joined by the small cross-vein to the second branch, and joining costa before the fork of media. Second branches of radius and media, about equidistant from the apex of the wing. Second branch of media (5th longitudinal) and the two branches of cubitus (6th and 7th longitudinals) reaching border of wing at nearly equal distances from each other in the female—in the male, the branches of cubitus are a little nearer each other. The anal vein (8th longitudinal) over half, in the female, and two-thirds in the male the length of the preceding vein (Pl. VI, Figs. 1, 2).

*Communicated by E. P. Felt, D. Sc.

Fore coxa nearly three-fourths the length of the femur or tibia; tarsi longer, first segment nearly as long as the remaining four; middle legs about as the fore legs; posterior tibia longer than the slightly elongated femur; first segment of the tarsi equal to the remaining segments.

Abdomen of both sexes sparsely invested with setæ. That of the female enlarges to the fourth segment from which it tapers to the slender ovipositor. Terminal portion of the genital plates oval.

Abdomen of the male nearly cylindrical and bearing the usual enlarged segment with claspers which are terminated by single stout curved spines. The whole of the terminal segment is more setose than are the preceding segments, especially the claspers on their tips and inner margins. On the median line of the ventral sclerite there is a thick group of stout setæ. (Pl. VI, Fig. 11.) Near the basal third of the clasper there is a very long seta, extending nearly to the median line. There is also a pair of long, stout setæ, a dorsal and a ventral one, at the base of each clasper

Length: male, body, 2.5 mm., wing, 2.4 mm.; female, body, 3 mm., wing, 2.8 mm.

This species was reared by Dr. Smith from mushrooms.

The specimens reared by him from decaying potatoes resemble the preceding species in many ways; however, on further study it was found to be quite distinct. Its description follows:

Sciara pauciseta n. sp. Head, thorax and abdomen black; antennæ light brown with a thin whitish pubescence; palpi light brown; wings hyaline, somewhat iridescent, anterior veins nearly black; halteres fuscous apically, yellowish at the base; coxa and femur yellowish, tibia darker, tarsi nearly black.

Antennæ longer than head and thorax; basal segments enlarged, first, cuboidal; second, globose; third, about one-fourth longer than fourth; fourth to fifteenth nearly cylindrical; proximal segments barely twice as long as thick; distal, nearly two and one-half times as long as thick; apical segment nearly conical. Palpi: basal segment short; second elliptical oval, apically with a large sensory pit; third subelliptical, one-third shorter than either preceding or terminal segment; fourth slender; each with a few large setæ and numerous minute ones, which have a verticillate arrangement on the third and fourth segments.

Thorax with scattering hairs on the scutum of the mesothorax; the three rows of minute setæ are easily seen on its surface in some specimens.

Wings: subcosta (1st longitudinal) short, not extending to the fork of the second branch of radius (3d longitudinal) and media (4th and 5th longitudinals). First branch of radius (2d longitudinal) joining costa before the fork of media near the middle of the length of the wing and joined beyond its middle to the second branch by the short crossvein. Tip of second branch of media (5th longitudinal) nearer apex of wing than is the point where the second branch of radius joins costa. The two branches of cubitus (6th and 7th longitudinals) and the second branch of media reaching the margin of the wing nearly equidistant. Anal vein (8th longitudinal) two-thirds the length of the second branch of cubitus in the female, in the male it is but one-half. (Pl. VI, Figs. 3, 4.)

Fore coxa a little over one-half the length of femur or tibia, tarsi about one-fourth longer, first segment nearly equal to the remaining segments; middle legs nearly the same; posterior tibia one-fourth longer than the slightly elongated femur; first segment of tarsi equal in length to the remaining segments.

Abdomen of both sexes sparsely invested with setæ. The abdomen of the female enlarges slightly to the fourth segment, from which it tapers moderately to the slender ovipositor; the terminal portion of the genital plates oval.

Abdomen of the male nearly cylindrical and bearing the usual enlarged segment with claspers which are terminated by a single stout curved spine. The setæ are thickest on the claspers, especially on the apical portion and along the inner margin. On the median line of the ventral sclerite of the last segment there is a sparse group of stout setæ, each arising from an enlarged base (Pl. VI, fig. 12). Near the basal third of the clasper there is a very long seta on its inner margin, extending nearly to the median line. There is also a pair of long stout setæ, a dorsal and a ventral one, at the base of each clasper.

Length: male, body 2.75 mm., wing 2.5 mm.; female, body 3.5 mm., wing 3 mm.

This species may be separated from the preceding by the darker color of the palpi, thorax, and abdomen, by the greater length of the third antennal segment, and by the few setæ in the group on the median line of the ventral sclerite of the terminal segment in the male.

Numerous small flies of this genus were found in the mushroom cellar of Dr. Wm. Hailes, of Albany, N. Y., June 6, 1896. It was stated that at times the cellar would be almost black with this and other species, although they were by no means so abundant when the cellar was visited by me. With the advent of hot weather the flies become so numerous as to destroy the mushrooms quickly and render their further culture unprofitable.

The flies agree with no description of American forms known to me. The species is evidently closely related to *Sciara villosa* Winnertz, though apparently different.

SCIARA AGRARIA n. sp. Head and thorax a very dark brown, nearly black, shining; abdomen a variable dark brown, base of terminal segment and base of claspers in male with a yellowish cast; antennæ dark brown with a dense whitish pubescence; palpi dark brown, terminal segment a little lighter; wings iridescent, tinged with fuscous, anterior veins nearly black, the others pale yellowish: halteres fuscous apically, yellowish at the base; coxæ smutty yellow, anterior pair lighter, femora and tibiæ a little darker, and tarsi fuscous distally, tibial spurs yellow.

Antennæ half the body's length in the male, in the female about one-third; the enlarged basal segments globose; the third to the fifteenth as long as thick, cylindrical, terminal one subconical. Palpi; second segment subelliptical, with a medium sized sensory pit; third suboval, shorter; fourth slender, almost linear and equal in length to the second; each with a few scattering long setæ and numerous small ones having a more or less verticillate arrangement.

Thorax with a few longer setæ and a number of shorter ones which show traces of being arranged in three longitudinal rows on the scutum of the mesothorax.

Wings: subcosta (1st longitudinal) short; first branch of radius (2nd longitudinal) joined to the second branch (3d longitudinal) at two-thirds its length by the short cross-vein and uniting with costa about the middle of the wing, some little distance before the fork of media (4th and 5th longitudinals). Second branch of media (5th longitudinal) nearer the apex of the wing than the tip of the second branch of radius. The distance between the two branches of cubitus (6th and 7th longitudinals) along the margin of the wing is greater than between the second branch of media and the first branch of cubitus. The anal vein (8th longitudinal) about half the length of the second branch of cubitus (Pl. VI, figs. 5, 6).

Fore coxa a little over half the length of either femur or tibia; tarsi one-fourth longer than tibia, first tarsal segment shorter than the remaining four; segments of the middle pair of legs a little longer than in the first, those of the posterior pair still longer, the first tarsal segment nearly equal to the remaining ones.

Abdomen of both sexes sparsely clothed with fine setæ. The female abdomen enlarges gradually to the fourth segment and then tapers to the slender ovipositor. Terminal portion of the genital plate elliptical.

Abdomen of the male nearly cylindrical. Terminal segment somewhat enlarged; claspers curved, each armed with an apical curved spine and with numerous stout ones along the inner margin. Near the basal third of the clasper there is a very long seta on its inner margin, extending nearly to the median line. There are also a pair of long stout setæ, a dorsal and a ventral one, at the base of each clasper (Pl. VI, fig. 10).

Length: Male, body, 2.5 mm., wing, 2.25 mm.; female, body, 3 mm., wing, 2.5 mm.

The following species was quite common in the greenhouse of Mr. J. A. Otterson, Berlin, Mass., and in others in the vicinity. During the winter the flies were more or less abundant, and their larvæ could be found in the soil. Under the influence of the higher temperature of the early spring the flies became very abundant. As giving an idea of their prolificacy, it may be interesting to note that over 625 eggs were found in the distended abdomen of a female. In this dissection no count was made of a number (estimated at approximately 200) of what appeared to be partly developed eggs. This species, described below, is closely related to *Sciara obscura* Winnertz.

SCIARA PROLIFICA n. sp. Female. Head and thorax dull black; abdomen brownish black, posterior margins of 4th to 6th segments, occasionally others, bordered with yellowish white; ventrally the abdomen is lighter and frequently its yellowish contents show through the distended lateral membranes. Antennæ and palpi nearly black, the former with a short whitish pubescence. Wings somewhat iridescent, thickly specked with fuscous; anterior veins black, the others a smutty yellow. Knobs of halteres fuscous, pedicel yellowish. Coxæ and legs dark brown to black, the anterior coxæ sometimes lighter; tibial spurs yellow.

Antennæ equal in length to head and thorax; the two enlarged basal segments globose; 3d to 15th segments nearly cylindrical, about twice as long as thick; terminal segment subconical. Palpi; basal segment short; second irregular, rounded dorsally; third a little shorter than second, subrectangular in outline; terminal segment as long as second, slender; both large and small setæ exceptionally stout and numerous; smaller, verticillately arranged.

Thorax with scattering setæ. Wings: subcosta (1st longitudinal) short; first branch of radius (2d longitudinal) joined to the second branch (3d longitudinal) about midway of its length by the short cross-vein and uniting with costa at the outer third of the wing just beyond the fork of media (4th and 5th longitudinals); second branch of media (5th longitudinal) nearer the apex of the wing than the tip of the second branch of radius; the distance between the two branches of cubitus (6th and 7th longitudinals) along the margin of the wing is greater than that between the second branch of media and the first branch of cubitus (Pl. VI, figs. 8, 9). Fore coxa a little over half the length of either femur or tibia; tarsi one-fourth longer than tibia; first tarsal segment shorter than the remaining four; femur and tibia of middle pair longer, of the posterior still longer, than those of the anterior legs; first segment of middle tarsi not quite so long as the remaining segments, while that of the posterior is longer.

Abdomen sparsely clothed with fine setæ. The distended abdomen of the female enlarges to the third or fourth segment, and then tapers gradually to the slender ovipositor,— terminal portion of the genital plates oval.

The male differs in having a nearly cylindrical abdomen which is vested with stouter setæ. The basal portion of the enlarged terminal segment is unusually stout and the claspers are comparatively weak and irregular. Tips of the claspers terminated by a stout recurved spine and by numerous straight bristles on its inner margin.

Length: male, body 4.4 mm., wing 3.7 mm.; female, body 5.6 mm., wing 5 mm.

Males of the following species were reared by Dr. Smith from decaying blackberry roots. They resemble *Sciara ochrolabis* Loew closely, but differ from the types in the antennæ being barely as long as the head and thorax, while in *ochrolabis* they are longer. The basal joints of the antennæ in Loew's species appear to be much shorter than in the insect under discussion. It will also be found that the terminal abdominal segments are more hairy and the claspers more triangular than in *ochrolabis*.

SCIARI FULVICAUDA n. sp. Face ochreous; vertex dark ochreous; scape of antennæ yellow, flagellum dark ochreous with a rather dense whitish pubescence; palpi fuscous; dorsum of thorax yellowish to rufous, the scutellum of the metathorax with variable dark stripes, in some specimens hardly discernible; pleura yellow; wings hyaline, iridescent, anterior veins fuscous, the lighter veins brown; knob of halteres fuscous with yellowish tip, pedicel yellowish; tip of trochanter black; coxa and femur dull yellow; tibia darker; tarsi fuscous apically; abdomen fuscous except the yellow terminal segment bearing the large ochreous claspers which are tipped with fuscous.

Antennæ barely as long as head and thorax; first segment cuboidal, second globose, third about one-fourth longer than the following; fourth to terminal one are nearly cylindrical, the proximal ones slightly gibbous and not twice as long as thick, length of distal ones about twice their thickness. Palpi; the small basal segment was not seen; the second is flattened, narrow at its base and is broadly oval distally, nearly equal to subsequent segments in length; third suboval, nearly equal to last; terminal segment rectangular in outline, about one-fourth longer than wide; each with a few scattering large setæ and numerous minute ones, which on the last segments have somewhat of a verticillate arrangement.

Dorsum of thorax invested with a number of large scattering hairs. Wings; subcosta (1st longitudinal) indistinct, short; first branch of radius (2nd longitudinal) joined before its middle by the short cross-vein to the second branch (3rd longitudinal), and uniting with costa beyond the middle of the wing and about on a level with the fork of media (4th & 5th longitudinals); tip of second branch of radius and media about equidistant from the apex of the wing; the second branch of media (5th longitudinal) and the two branches of cubitus (6th & 7th longitudinals) about equidistant on the border of the wing. Anal vein (8th longitudinal) about one-third the length of the second branch of cubitus (Pl. VI, fig. 7). Fore coxa about three-fourths the length of either femur or tibia; tarsi longer, first segment not so long as the remaining ones; middle legs about the same; posterior tibia about one-fifth longer than the slightly elongated femur, first segment of tarsi equal to the remaining ones.

Abdomen with numerous stout setæ. The enlarged terminal segment more thickly clothed with setæ and bearing large, subtriangular claspers (Pl. VI, fig. 13).

Length of body 4 mm., of wing 2.75 mm. Female unknown.

Phora albidihalteris n. sp.*

A Mushroom Phora.

(Ord. DIPTERA: Fam. PHORIDÆ.)

This insect was reared in numbers by Dr. J. B. Smith, from mushrooms. It is believed to be another form new to science and is herewith described.

PHORA ALBIDIHALTERIS.— Head and thorax jet black; palpi orange yellow; abdomen black in some specimens, in others the lateral margins and dorsum of terminal segments are dull yellow; wings hyaline, iridescent, heavy veins ochreous; capitulum of halteres yellowish white; legs a variable ochreous with the terminal segments darker.

* By E. P. Felt, D. Sc.

Ocellar triangle defined by a deep suture which extends down the front; three transverse rows of bristles occur on the front; six in the posterior row, consisting of a median pair and four lateral; the middle row is composed of four nearly equidistant bristles; six nearly so in the anterior row, the median pair and the smaller ones just in front point downward. Eyes bordered behind and below with a single row of bristles,— very minute setæ occur at the angles of the facets. Antennæ five-segmented; first short, irregular; second very large, subspherical; third and fourth cylindrical, slightly expanded apically; basal portion of the fifth cylindrical and more slender than the preceding, distal portion setaceous, much elongated, plumose. Labium yellow, usually retracted; palpi yellowish brown, somewhat fusiform and bearing several apical bristles; basal portion short, obscurely divided into several subsegments.

Dorsum of thorax thickly pubescent, several stout bristles occur near the posterior border of the scutum of the mesothorax and near the base of the wings. Costal vein less than half the length of the wing; first heavy vein joining costa near apical third of same; second heavy vein forked near the apex; costal margin fringed with stout setæ to tip of second heavy vein; the four wing pores on this vein are even more distinct than in *Phora agarici* Lintn.; first light vein nearly straight; second curved at basal fifth and apical fourth; third, fourth, and fifth, sinuate. Basal portion of halteres brownish-black, apical portion inflated, yellowish-white. Several apical bristles occur on the front and outer portions of the coxæ; fore tibiæ unarmed; middle and posterior tibiæ fringed with stout spines posteriorly, each with a large apical spine; tarsi about one-fourth longer than the tibiæ. Abdomen rounded dorsally, tapering from a broad base.

Length of body 1.92 mm.; of wing 2.4 mm.

Described from a number of specimens, all females. The puparium of this species resembles closely that of *Phora agarici* except that it is a little larger,— being about 2.4 mm. long.

Piophila casei (Linn.).

The Cheese Skipper: The Ham Skipper.

(Ord. DIPTERA: Fam. PIOPHILIDÆ.)

MACQUART: Hist. Nat. Ins.—Dipt., ii, 1835, pp. 541–542 (common).
WESTWOOD: Introduct. Class. Ins., ii, 1840, pp. 573–574 (mention).
KIRBY–SPENCE: Introduct. Entomol., 1846, p. 168 (mention as *Tyrophaga casei*).
?TREAT: in Harper's New Month. Mag., xxii, 1861, p. 609, fig. 2 (popular account).
HARRIS: Ins. Inj. Veg., 1862, p. 621 (brief mention).
LOEW: in Amer. Journ. Sci.-Art., 2d Ser., xxxvii, 1864, p. 320 (accompanying man; translation by Baron Osten Sacken).
OSTEN SACKEN: in Amer. Journ. Sci.-Art., 2d Ser., xxxvii, 1864, p. 318 (common to Europe and America); Cat. Dipt. N. Amer., 1878, p. 199.

PACKARD: Guide Study Ins., 1869, pp. 413–414, fig. 335; Entomol. for Beginn., 1888, p. 128, fig. 149 (brief mention).

RILEY: 2nd Rept. Ins. Mo., 1870, p. 10 (an imported pest); in Amer. Entomol., ii, 1870, pp. 78-79 (habits of skippers; their natural food), pp. 180, 339 (mention); in id., iii, 1880, pp. 23-24 (injuring smoked hams).

WILLARD: in Amer. Entomol., ii, 1870, p. 78 (treatment of skippery cheese).

GLOVER: MS. Notes from My Journ., 1874, p. 40 (said to have been bred from salt alone by Germar).

————: Country Gent., xliv, 1879, p. 727 (general account).

JACOBS: in Comp.-Rend. des Séances, Soc. Ent. Belg., 1882, pp. cxxiv–cxxv (synonymy, notes).

MANN: in Psyche, iv, 1884, p. 207 (reference).

FYLES; in 17th Ann. Rept. Entomolog. Soc. Ont., 1887, p. 38 (brief notice).

RITZEMA BOS: Tiersche Schädl. Nützlinge, 1891, pp. 620–621 (brief mention).

KELLOGG: in Insect Life, v, 1892, p. 116 (injuring smoked meats, duration of stages),

MURTFELDT: in Insect Life, v, 1892, pp. 135–136 (bred from ham); in id., vi, 1893, pp. 170–175 (detailed account); the same in 24th Ann. Rept. Entomolog. Soc. Ont., 1895, pp. 98–102.

RILEY–HOWARD: Insect Life, vi, 1894, p. 209 (damage by, duration of stages), p. 226 (mention.)

COMSTOCKS: Manual Study Insects, 1895, pp. 486–487 (brief mention).

HOWARD: in Bull. 4 New Series, Div. Entomol., U. S. Dept. Agricul., 1896, pp. 102–104, fig. 48 (general account).

LINTNER: in Country Gentleman, lxi, 1896, p. 293 (general account).

SMITH: Econom. Entomol., 1896, pp. 367–369, fig. 423 (habits, remedies).

A gentleman writing from Moorefield, W. Va., states, that about the 15th of January, some meat in his cellar which had lain in salt two months, was found infested with "skippers." He was of the opinion that "the insect was in the meat when butchered, and if the meat had been properly cured by salt, the germ would have been destroyed."

Request was made for some of the infested meat containing the "skippers," but answer was returned that there was none of it left,—what disposition had been made of it was not stated. It was learned that the meat was pork, and was on the point of being removed for converting into bacon, when the infestation was discovered.

There can be but little doubt that the insect was the "cheese-skipper," which is also known as the "ham-skipper" from its frequent occurrence in smoked hams. There would be no hesitation in referring it, without question, to this insect, were it not, first, for the unusual time of its appearance—early in January,—the earliest record heretofore given of it. It was thought that its early appearance may have been the result of a furnace-heated or otherwise unusually warm cellar drawing the flies prematurely from their winter hiding-places; but it was learned from the gentleman that the cellar was not particularly warm, but that it was a dry one. Second; it has not hitherto been reported, so far as we know, upon meat simply salted and not yet smoked, nor has the experiment to rear it thereon been successful. Miss Murtfeldt has written: "I have not been able to make it oviposit on fresh meat of any kind, nor does it seem able to breed upon that which is simply salted, but not smoked, not even when such meat is folded in wrapping papers."

Description of the Insect.

The perfect insect is a small black fly about 5 mm. long, with a rather large head bearing reddish, prominent eyes, shown in both sexes at *d* and *e* in fig. 1. The veins of the wings are nearly colorless and much weaker than those of the common house-fly; it is also about half the size of the latter. The lower side of the head, the basal portions of the legs, portions of the tibiæ and tarsi of the posterior two pairs are a variable

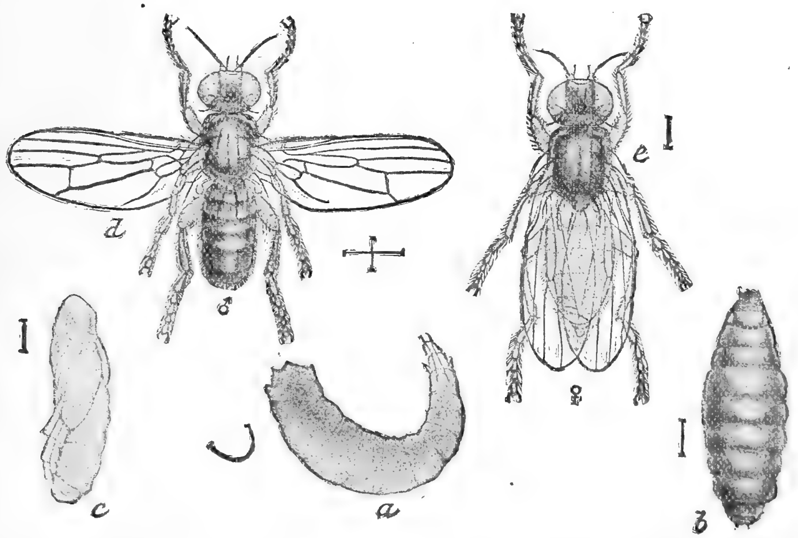

FIG. 1.—PIOPHILA CASEI: *a*, larva; *b*, puparium; *c*, pupa; *d*, male fly; *e*, female with wings folded—all enlarged. (After Howard, Bull. 4 New Ser., Divis. Entomol. U. S. Dept. Agricul.)

yellow. The females are a little stouter than the males. The puparium from which the fly emerges has been described as of a golden yellow color—length about 4 mm.—its appearance is represented at *b*.

Though the parent flies may be seen in the vicinity of cheese and around smoked meats, they usually do not attract so much attention as do their larvæ, commonly known as "skippers," from their habit of bringing the two ends of the body together and by sudden straightening with a quick muscular action throwing themselves to a distance of four or five inches or more. The larva or skipper "is cylindrical, tapering gradually toward the anterior end, truncate posteriorly, and furnished at this extremity with two horny projecting stigmata and a pair of fleshy filaments (see *a* in the figure). The egg is pearly white, slender oblong, slightly curved, 1 mm. in length, with a diameter of about one-fourth the length" (Murtfeldt).

Life-History.

For our knowledge of the life-history of the insect, we are mainly indebted to the careful observations of Miss Murtfeldt.

The eggs are deposited in more or less compact clusters of five to fifteen in the cracks and checks of cheese, upon the surface of cured or partially cured meats, and, in the case of canvassed meats, on the covering or in its folds; sometimes they are scattered singly. The number of eggs deposited averaged about thirty in the breeding cages, though the conditions were not normal and the number may have been diminished in consequence. A popular article in *Harper's New Monthly Magazine* (*loc. cit.*) credits this insect with depositing nearly three hundred eggs, which is probably a gross over-estimate.

The eggs hatch within thirty-six hours, and the tiny white maggots attack at once their food — in meat, the fatty portions. They complete their growth in seven to eight days and are then seven to nine millimeters (about one-third of an inch) in length. The transformation from the full-grown larva to the perfect fly occupies ten days. In the breeding cage, adult flies on an average did not live longer than a week. They would sip a little at sweets but were not greatly attracted to them, while the odor of smoked meats speedily drew them. The flies were not active at night, although they could perform their functions in partially darkened places. No definite succession of generations could be noted, but the insect in all stages was present from May until into October or November. Severe and protracted cold proved fatal to the insect in all its stages. The above is the result of Miss Murtfeldt's observations on the insect in the month of August and later.

In February of the same year, Prof. Kellogg, then of the Kansas State University, studied the development of this insect. According to his observations, the egg stage lasted four days; the larvæ required two weeks to complete their growth, and they remained in the pupa state one week. Dr. H. F. Kessler, as quoted by Dr. Howard, has carefully studied the life-history of this fly in Europe. He found that the average time from the egg to the adult is four to five weeks, and that there are two or three generations during the summer,—the last occurring in September, the larva hibernating in the puparium and transforming to the pupa in May. Other writers claim that the insect passes the winter in the adult stage.

Food Habits.

The insect has long been known as a cheese pest. In a notice of it in 1879, by Prof. Riley, it is suggested that the original food of the skippers before cheese was ever made, must have been some analogous substance —possibly a peculiar kind of fungus. The following year he established the identity of the meat skipper with the well known pest in cheese.

In addition to smoked ham and bacon, the fly will also oviposit and breed in smoked beef, but apparently has a decided preference for pork. Such was the experience of a correspondent of Miss Murtfeldt, who wrote concerning injury to beef by skippers as follows: "If a beef ham were hanging beside that of a hog, the former would most likely be O. K. while the latter would be stung." Dr. Howard mentions chipped beef as one of the meats in which the fly will breed. To the above it seems that salt pork may also be added. "Germar is said to have bred this insect from salt alone" (Glover, *loc. cit.*), but if so, the larva must have developed in some other food and entered the salt for pupation.

The fly is said to be an excellent judge of cheese, and it is usually the best qualities that are affected. So marked is this, that "skippery" cheese may be pronounced of good quality, although hardly so because of the presence of the skippers.

Losses Caused by the Insect.

The principal damage in this country is believed to be confined to meats, although Mr. X. A. Willard (*loc. cit.*) in 1879 writes: "Immense losses are sustained every year on account of skippery cheese. Sometimes thousands of pounds in factories are tainted in this way, and the cheese has to be sold for what it will bring, while a portion is not infrequently so badly affected that it has to be thrown away at the factory."

In 1880, Prof. Riley (*loc. cit.*) recorded an injury of smoked hams to the extent of over two thousand dollars, inflicted by this insect upon a single firm in Peoria, Ill. Miss Murtfeldt, in 1892, was informed by an employé in one of the largest packing and curing establishments in the West, as follows: "It entails an enormous loss upon all our packing-house companies." Similarly, Prof. Kellogg's attention was called to the insect through the packing-houses of Kansas City, Mo., being seriously troubled by the pest.

Preventives and Remedies.

It is easier and much more desirable to prevent the infestation of cheese or cured meats than to remedy it after the trouble has begun. The primary cause of "skippery" cheese is said to be the want of proper care, and the same is equally true of "skippery" meat.

The flies can be excluded from rooms by the use of fine screens — a 24-to-the-inch wire mesh is said to be sufficiently fine. In households, cheese and cured meats can usually be stored in fly-proof receptacles, or else kept in absolute darkness, in which it is said the flies can not complete their life-cycle. Darkness would therefore be of service in large store-rooms for these articles.

Scrupulous cleanliness in and about all places where these products are handled or stored, will do much to lessen the attraction for the flies. In cheese factories, it has been recommended to wash the ranges and tables upon which the cheese is placed with hot whey, thus removing grease and giving a clean surface, not attractive to the insect. In hot weather, the bandages and sides of the cheese should be rubbed over at the daily turning, for the purpose of destroying or brushing off eggs which may have been deposited on the surface. The cheese may also be washed with hot whey or with lye, — the latter is a repellant as the fly avoids alkalies.

Smoked meats should be carefully guarded from infestation during the process of curing, and in hams and other meats that are encased, the covering should be so thick and so closely applied, as to effectually exclude the fly or its larvæ.

Infested rooms and factories should be thoroughly cleaned, fumigated with burning sulphur, and, where possible, washed with kerosene emulsion.

Skippery cheese and meat is not necessarily a total loss, although their presence seriously impairs the market value of the product and may render it unsalable. In many cases large portions will be found free from the skippers and in good condition, as their work does not induce putresence with its attendant odor; if the affected parts are removed, the remainder may safely be used for food. In cheese the surface colonies of skippers can readily be cut out, and the young more deeply located, can be drawn to the surface, by pasting thick oiled paper over the place so as to exclude the air, and, by removing it from time to time for the destruction of the skippers collected beneath, and replacing it, the cheese may be freed from the infestation.

Lebia grandis (Hentz).

(Ord. COLEOPTERA: Fam. CARABIDÆ.)

HENTZ: in Trans. Amer. Philosoph. Soc., N. S., III, 1830, p. 253 (description).

WALSH: in Pract. Entomol., ii, 1867, p. 121 (habits and description).

GLOVER: in Rept. Comm. Agricul. for 1867, 1868, p. 63 (in Ill.); in id. for 1868, 1869, p. 80, fig. 6 (features and feeding habits).

RILEY: in Amer. Entomol.-Bot., ii, 1870, p. 290-291, fig. 181 (destroys Potato beetle in Missouri); the same in 3rd. Rept. Ins. Mo., 1871, p. 100, fig. 41; in Insect Life, iv, 1891, p. 204 (in So. Dakota); Bull. 31 Divis. Entomol., U. S. Dept. Agricul., 1893, p. 87 (taken on golden rod).

LEBARON: 1st. Rept. Ins. Ill., 1871, p. 64 (mentioned); 4th do., 1874, p. 45, fig. 11 (mention).

REED: in Rept. Entomolog. Soc. Ont. for 1871, 1872, p. 71 (mention).

THOMAS: 6th Rept. Ins. Ill., 1877, p. 90 (description), p. 162 (mention).

SAUNDERS: in Rept. Entomolog. Soc. Ont. for 1878, 1879, p. 6 (operations in Canada); in do. for 1881, 1882, p. 10 (reference to captures).

COMSTOCK: in Rept. Comm. Agricul. for 1879, 1880, p. 245, Pl. V, fig. 3 (active in New York); Manual Study Ins., 1895, p. 520, fig. 625 (mention).

DIMMOCK: in Stand. Nat. Hist., ii, 1884, p. 396, fig. 481 (mention).

LINTNER: in Orange County Farmer for Oct. 19, 1893, xiii, p. 1, c. 7 (identification and habits); 10th Rept. Ins. N. Y., 1895, p. 496 (abstract of preceding).

SMITH: in Rept. N. J. Agricul. Expt. Stat. for 1893, 1894, pp. 566, 567, fig. 146 (mention); in id. for 1895, 1896, p. 455, fig. 60 (description, work in New Jersey); Econom. Entomol., 1896, p. 168 (mention).

During the month of October, examples of a beetle were received by me for identification, from Port Jervis, Orange Co., N. Y., of which marvelous stories had been in circulation in the vicinity among the farmers, and had found their way in a sensational article in the newspapers. It had been stated that it had made its appearance for the first time during the past summer, and that it was accomplishing wonders in destroying the potato beetle. It was to be seen running rapidly over the plants, seizing a beetle, giving it a bite and instantly killing it, and then treating one after another in the same summary manner.

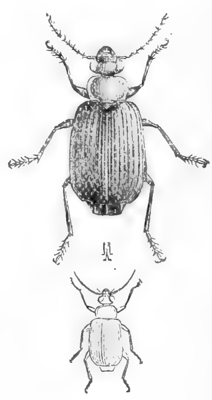

FIG. 2.—LEBIA GRANDIS. In natural size and enlarged.

As no insect of such remarkable ferocity and power was known to us as having been sent to our aid in efforts to control the Colorado potato beetle, it was suspected that our new ally might be *Lebia grandis* which had been for many years rendering excellent service against the potato beetle in western States,— and such the insect, when received as above, proved to be.

The beetle has been described as follows:

Size rather below medium; elytra truncate or cut off at the extremity, leaving the tip of the abdomen exposed; anterior tibiæ, with the notch on the inner edge; claws distinctly pectinate; abdomen somewhat pedunculated; thorax rounded on the sides and wider than long; the posterior margin straight, with the angles somewhat obtuse, but not rounded, narrower than the elytra; elytra slightly widened posteriorly, of a deep or dark blue color, distinctly striate and without visible punctures. The thorax horny, yellow, smooth, with an impressed longitudinal dorsal line. Head yellowish, but a little darker than the thorax, the legs and breast also yellow. Length about or slightly over two-fifths of an inch; width of the elytra a little less than half the length.

It belongs to the large family of *Carabidæ*, which are commonly known as ground beetles and which render valuable service to the agriculturist in their preying upon many insect pests.

As may be seen from the references given above, this insect has long been recognized as one of the most efficient, if not the most efficient, of the thirty or more species of insects that have been observed to prey upon the Colorado potato beetle.

The first record, so far as we know, of the fondness of this insect for the Colorado potato beetle, is the brief mention by Mr. Glover, in his annual report to the Department of Agriculture, for the year 1867, to this effect: "Dr. Benjamin Morris, of Pittsfield, Illinois, found a species of ground beetle, *Lebia grandis*, feeding voraciously upon the larvæ in a potato field in that neighborhood. Hundreds of this comparatively rare insect were taken by him in the same locality, and always preying upon the grubs of the potato beetle."

In 1869, another notice of its operations in Illinois appears, in a statement made by Mr. Walsh, the entomologist of the State at that time, that it had been found destroying the larvæ of the potato beetle, while "so intent on its prey as to retain its hold even when the leaf was gathered on which it stood." In the notice of its identification by Mr. Walsh, he wrote of it: "This beetle is one of the vast group of ground beetles (*Carabus* family) almost all of which are cannibals; but the genus to which it belongs, unlike most of the other Ground beetles, haunts plants and is active by day, instead of living on the ground and being nocturnal in its habits."

In 1871, when the potato beetle had for the first time invaded the Dominion of Canada, and had not yet entered New York, Prof. Riley reported that this beetle was proving to be an efficient enemy of the new pest in several of the western States; and that although it had previously been rare in the State of Missouri it had suddenly become abundant and was actively engaged in destroying both the eggs and the larvæ of the potato beetle.

This beetle has a distribution throughout the United States which is almost co-extensive with that of the insect upon which it specially preys. Unfortunately, although so abundant oftimes, and aided by nearly two score of other species, it is not able to greatly reduce the number of the greedy and insatiable Doryphora.

Plagionotus speciosus (Say).

The Sugar Maple Borer.

(Ord. COLEOPTERA: Fam. CERAMBYCIDÆ.)

SAY: Long's 2nd Expedit, 1824, p. 292 (original description, as *Clytus*); the same reprinted in Amer. Entomology, iii, 1828, p. 118, Pl. 53, fig. 1; Compl. Writ., Lec. edit., 1883, I, pp. 118, 193.

FITCH: in Amer. Quart. Journ. Agricul.-Sci., 1, 1845, p. 253, Pl. 3, fig. 3 (brief account, as *Clytus*).

HARRIS: Ins. Inj. Veg., 1862, pp. 101–102 (brief account, as *Clytus*).

PACKARD: Guide Study Ins., 1869, pp. 496–497 (mention, as *Clytus*); Bull. 7 U. S. Entomolog. Comm., 1881, pp. 103–105, fig. 45 (general account, as *Glycobius*); in Amer. Nat., xviii, 1884, pp. 1151–1152 (oviposition, as *Glycobius*); 5th Rept. U. S. Entomolog. Comm., 1890, pp. 374–379, figs. 137–140) general account, as *Glycobius*).

WALSH–RILEY: in Amer. Entomol., i, 1869, p. 146 (description, as *Arhopalus*).

COWDRY: in Canad. Entomol., ii, 1870, p. 38 (as *Clytus*, rare at Stratford, Ont.).

CLEMENTI: in Canad. Entomol., iv, 1872, p. 37 (as *Clytus*, at Peterboro, Ont.).

REED: in Rept. Entomolog. Soc. Ont. for 1872, 1873, pp. 35–36, fig. 26 (description and life-history, as *Clytus*).

LEBARON: 4th Rept. Ins. Ill., 1874, p. 154 (reference, as *Clytus*).

BETHUNE: in Canad. Entomol., ix, 1877, p. 222, fig. 2 on Plate (brief account, as *Clytus*); the same in Ann. Rept. Entomolog. Soc. Ont., 1877, p. 23, fig. 2 on Plate.

THOMAS: 6th Rept. Ins. Ill., 1877, pp. 38, 44, 83, 151, iii, iv (in northern Illinois, as *Clytus*).

SAUNDERS: in Rept. Entomolog. Soc. Ont. for 1878, 1879, pp. 32–33 fig. 13 (brief account, as *Clytus*).

Rogers: in Canad. Entomol., xii, 1880, pp. 149–151, fig. 21 (popular account, as *Clytus*); the same in Rept. Entomolog. Soc. Ont. for 1880, 1881, pp. 32–33, fig. 13.
Zesch–Reinecke: List Coleopt. Buffalo and Vicinity, 1880, p. 9 (listed, as *Glycobius*).
Bell: in Canad. Entomol., xiii, 1881, p. 236 (mention, as *Clytus*).
Lintner: 1st Rept. Ins. N. Y., 1882, p. 297 (reference); in Country Gentleman, xlvii, 1882, p. 625 (very injurious to maples); 2d Rept. Ins. N. Y., 1885, p. 227 (abstract); 3d do. for 1886, 1887, pp. 103–105 (notice of injuries, remedies); in Country Gentleman, liv, 1889, p. 579 (characteristics, remedies); 6th Rept. Ins. N. Y., 1890, p. 169 (abstract); in Country Gentleman, lvii, 1892, p. 552 (attack identified); 8th Rept. Ins. N. Y., 1893, pp. 202–205, fig. 45 (ravages and remedies); 9th do., 1893, p. 442 (abstract); in Country Gentleman, lviii, 1893, p. 557 (identified, remedies); in Gardening, iii, 1894, p. 56 (mention, figure); 10th Rept. Ins. N. Y., 1895, p. 497 (reference, in all preceding referred to *Glycobius*), p. 504 (abstract), p. 511 (reference); in Country Gentleman, lx, 1895, p. 583 (remedies); 11th Rept. Ins. N. Y., 1896, p. 280 (abstract), p. 286 (mention).
Dimmock: in Stand. Nat. Hist., ii, Crust. Ins., 1884, pp. 330–331, fig. 368 (brief mention).
Fletcher: Rept. Entomol. for 1885, p. 31 (brief mention, as *Glycobius*).
Harrington: in 17th Ann. Rept. Entomolog., Soc. Ont., 1887, pp. 29–30, fig. 3 (brief mention, as *Glycobius*).
Townsend: in Psyche, v. 1889, p. 233 (listed from Michigan).
Smith: Cat. Ins. N. J., 1890, p. 203 (on oaks).
Pickering: in Psyche, vi. 1892, p. 346 (mentioned, as *Clytus*).
Comstocks: Manual Study Ins., 1895, p. 570, fig. 694 (mention).
Fyles: in 26th Ann. Rept. Entomolog. Soc. Ont. for 1895, 1896, p. 24, fig. 8 (mention, as *Glycobius*).
Weed: Bull. 33 N. H. Agricul. Expt. Stat., 1895, pp. 7–9, figs. 3, 4 (general account, as *Glycobius*).
Kirkland: in Bull. 2 Mass. Crop Rept., ser. of 1897, pp. 30–34, figs. 1, 2 (general account).

This large and beautifully marked beetle in its bright golden-yellow bands and bars and angulated lines on a background of black, is a desirable and attractive addition to one's collection (Pl. VII, fig. 1). Despite its beauty, it is a highly pernicious insect. Not content, as are most of its associates, with burrowing in dead or sickly trees, its attack is usually made on those perfectly healthy.

A Long-horned Borer.

This insect belongs to the family *Cerambycidæ*, or long-horned wood-borers, — so named on account of their long antennæ and the habit their larvæ have, of living and boring in wood. The antennæ of some species are of extraordinary length, as in the instance of *Monohammus confusor*

(Kirby), in which they measure from about once and a half the length of the body in the female, to nearly four times its length in the male. Many of the members of this large family are remarkable for their size, beauty of color, or elegance of form, and have been, on these accounts, favorites with collectors. Unfortunately, a large number of the species, are quite harmful to the trees that they infest. Among the notorious and well-known pests, may be mentioned the oak-pruner, *Elaphidion parallelum* Newm.; the round-headed apple-tree borer, *Saperda candida* Fabr.; and the common elm-tree borer, *Saperda tridentata* Oliv.

Description of the Beetle.

"The head is yellow, with the antennæ and the eyes reddish-black; the thorax is black, with two transverse yellow spots on each side; the wing covers, for about two-thirds of their length, are black, the remaining third is yellow, and they are ornamented with bands and spots arranged in the following manner: a yellow spot on each shoulder, a broad yellow curved band or arch, of which, the yellow scutel forms the keystone on the base of the wing-covers; behind this a zigzag yellow band forming the letter W; across the middle another yellow band arching backwards, and on the yellow tip a curved band and spot of a black color; legs yellow, and the under side of the body is reddish-yellow, variegated with brown. Nearly an inch in length." (Harris.)

Ravages of the Insect.

This borer has for many years been destroying a large number of our sugar maples, as its burrows are usually carried around the trunk beneath the bark, and when several occur in the same tree, they girdle it by their interlacings and thus kill the tree. Even when they are not fatal to the tree, they occasion unsightly cracking of the bark and serious deformities of growth.*

As early as 1859, my attention was attracted by the operations of this insect in a long row of sugar maples bordering a lawn at Schoharie, N. Y. One tree which I had examined, of some ten inches in diameter at the base, which had been more seriously affected than the others, and probably was the first to be attacked, had been nearly destroyed. Several of the grubs had commenced their ravages side by side, and their united cuttings had in places exposed the trunk for over a hand's breadth. The tree had

*For additional features of these burrows see the Report of the Entomologist for the year 1886, [being the Third Report on the Injurious and Other Insects of the State of New York], page 104.

been attacked in various places from above its first limbs nearly to its base. The entire circumference of the tree had been grooved, although not continuously. In the above row of maples scarcely a single tree was entirely exempt from injury — all apparently the work of this grub.

A few years ago it was an occasion of much pain to me to see at Bennington, Vt., the large number of old maples that were standing dead upon the street or rapidly dying from the merciless burrowing of this borer which had scarred and excavated their trunks. Recently the same ravages, although not as yet to the same extent, were observed by me at Glens Falls, N. Y. This insect was recently very destructive to some fine maples at Canajoharie, N. Y. It is also a serious pest in some other states. In a recent publication, Mr. Kirkland (*loc. cit.*) records extensive injuries by this borer in the sugar orchards of western Massachusetts, their work being preceded in most instances by the clearing up of the underbrush. It was thought that the additional light around the trunks of the trees may have served the insect as an invitation to enter upon and prosecute its pernicious work. The maples on the grounds of Bowdoin College, Brunswick, Me., were observed by Dr. Packard to be seriously injured by this pest in 1873 and 1874. In London, Ontario, this insect is spreading rapidly and proving very destructive. In South Quebec the borer is so abundant as to be found frequently in woodsheds, having developed from maple wood stored for domestic use.

Formerly a Rare Insect.

This beetle was regarded by its original describer, Dr. Say, as a rare insect, for at the time of its description only two examples were known. It is one of our native forms which seems to have found the cultivated trees better adapted to its needs than the wild — their proximity, location and abundance having supplied ample means for a rapid increase. It is now a common insect and a serious menace to the safety of sugar maples, either in ornamental grounds or as shade trees along the road side.

Life-History.

The beetles make their appearance in this latitude during the latter part of June, through July and into August.* The eggs are laid during the latter two months. The place of oviposition may be recognized, as stated by Dr. Packard, "by a rusty irregular discoloration of the bark about the size of a cent, and especially by the 'frass' or castings which to the length of an inch or more are attached like a broken corkscrew to

* Examples in the State collection bear dates of capture from June 23d to August 9th.

the bark." The egg is deposited on the trunk at various heights from the ground upward to at least ten feet in low branching trees, and even higher when the infestation has been of long continuance. The newly hatched larva, about one-fifth of an inch in length, may be found within its burrow at a depth perhaps of one-tenth of an inch, by cutting in at the places indicated as above. September 12th, Dr. Packard found that the mines or burrows of the young larvæ were already about an inch long, most of them being directed upward. They pass the winter in shallow burrows in the bark. The following spring they burrow deeper and mine the cambium layer and the living wood,— the burrows steadily increasing in size with the growth of the larvæ. It is probable that the insect requires two years to complete its transformations, and that an entire season is spent by the long white fleshy grubs, with deeply marked transverse incisions, in running their mines or burrows, about one-third of an inch in depth and one-half an inch in width, in all directions beneath the bark. On the approach of the second winter the larvæ probably burrow to the depth of an inch or two in the trunk and there hibernate. In the spring feeding is resumed and the burrows continued a distance nearly equal to that of the previous season, before the pupal chamber is excavated in the wood. Mr. Kirkland found a number of burrows in an infested tree with a chamber midway of their length, and thought that this might indicate the place of hibernation. The larval burrows usually run upward and partially around the trees, but occasionally downward. They frequently intersect, and thus a badly infested tree may be effectually girdled and killed.

Distribution.

The recorded distribution of this beetle is curiously limited. The explanation may be that only within this area has it been sufficiently abundant to attract attention, although it would seem that even if rare, some examples should fall into the hands of collectors and the localities be made known. The reported distribution is as follows; South Quebec, the southeastern portion of Ontario, Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Michigan, Indiana, Northern Illinois and Wisconsin. This record indicates comparatively narrow bounds, but it will probably be found that it extends over a much greater area than indicated above. There is apparently no reason why it should not extend to the Rocky Mountains, if not to the Pacific coast.

Food Plants.

This insect, so far as known, is mainly confined to the sugar maple, while exceptionally attacking other of the maples. In New Jersey there are very few maples where it was found, and in every instance the beetles were taken on oaks. It was therefore thought that possibly it may infest some of the species of oak (Smith : *loc. cit.*).

Natural Enemies.

The only natural enemies of this insect recorded are various species of woodpeckers. Dr. Packard mentions having observed them at work, but he failed to indicate the species. Mr. Kirkland observed the hairy woodpecker, the downy woodpecker, and the flicker feeding upon white larvæ taken from beneath the bark of infested trees.

Remedies.

Perhaps the best remedy is the cutting out or destroying the young grubs while still within easy reach. By carefully examining the trunks sometime in the early autumn, the location of the recently hatched grub may be easily detected by the indications stated on a preceding page.

The trunks of the trees may be painted or sprayed with a solution of soft soap and carbolic acid, renewing the application as often as it is washed off by the rains. If this be done during the months of July and August (the period of oviposition), the beetles will be deterred from depositing their eggs in the trunks so treated and there will be no necessity of searching for and digging out the young grubs later in the season.

In maple sugar groves, Mr. Kirkland recommends that as much underbrush be allowed to grow as will not be in the way of the sugar making, as he has observed that the clearing up of the shrubbery has repeatedly been followed by severe attacks of these borers. The beetles are sun-loving insects which delight in sunny places and if there are few such spots in a sugar grove, there would be less attraction for them. All badly infested trees should be cut for fuel during the autumn and burned before the time for the appearance of the beetle the following June.

Saperda tridentata Olivier.

The Elm Borer.

(Ord. COLEOPTERA: Fam. CERAMBYCIDÆ.)

FITCH: in Trans. N. Y. St. Agricul. Soc. for 1858, 1859, pp. 839–840 (brief account); 5th Rept. Nox. Other Ins. N. Y., 1859, pp. 59–60 (the same).

HARRIS: Ins. Inj. Veg., 1862, pp. 111–113, Pl. II, fig. 13 (description and ravages).

PACKARD: in Amer. Nat., iv, 1870, pp. 588–591, figs. 115, 116 (general account after Harris, as *Compsidea tridentata*); Bul. 7 U. S. Entomol. Comm., 1881, pp. 58–59, fig. 17 (brief account); 5th Rept. do., 1890, pp. 224–226, fig. 71 (general account), p. 424 (infesting maple).

HUBBARD: in Psyche, i, 1874, p. 5 (mention); in id., ii, 1877, p. 40 (mention, as *S. trinlieata*).

LECONTE: in Smith. Misc. Coll., xi, 1874, pp. 238–239 (table of species of *Saperda*).

THOMAS: 6th Rept. Ins. Ill., 1877, pp. 38, 44, 156–157, ii (brief notice).

ZESCH–REINECKE: List. Coleopt. Buffalo and Vicin., 1880, p. x.

HARRINGTON: in Canad. Entomol., xv, 1883, p. 79 (infesting maple); the same in 14th Rept. Entomol. Soc. Ont., 1884, p. 35; in Canad. Entomol., xxii, 1890, p. 186 (listed from the counties of Argenteuil and Ottawa).

FORBES: 14th Rept. Ins. Ill., 1885, pp. 112–114, Pl. xii, fig. 2 (general account of ravages, remedy).

SMITH: Cat. Ins. N. J., 1890, p. 212 (common at Newark, Caldwell).

CAULFIELD: in 21st Ann. Rept. Entomol. Soc. Ont., 1891, pp. 73–74 (brief account).

GARMAN: Bull. 47 Ky. Agricul. Expt. Stat., 1893, pp. 44–50, figs. 12, 13 (general account); the same in 6th Rept. do., 1894, pp. 122–127, figs. 12, 13.

LINTNER: in Proc. West. N. Y. Horticul. Soc., 1893, separate, pp. 7–9 (ravages, remedies); republished in Gard. Forest, vi, 1893, p. 76, and in 9th Rept. Ins. N. Y., 1893, pp. 427–429; in Albany Evening Journ., for May 7, 1894 (work in Albany, remedies); 10th Rept. Ins. N. Y., 1895, pp. 484, 485, 499 (abstracts of preceding notices); in Country Gentleman, lxi, 1896, p. 746 (remedies).

This insect appears to be as injurious to the beautiful white elm, *Ulmus Americana*, which has been so liberally planted and is so highly prized as our most valuable shade-tree, as the maple borer, *Plagionotus speciosus*, is to the very desirable sugar maple. The borers in the wood and bark of our trees are dreaded most deservedly, not only on account of their ofttimes excessive injuries, but for the reason that their operations are of such a nature that severe damage, if not fatal injury, is often done before their presence is even suspected. The unthrifty condition of the infested tree is attributed to unusual dry weather, to the impervious street pavements of many of our cities, to defective gaspipes, or some other cause, while the true agents of the mischief continue their destructive work unknown and undisturbed. Throughout the entire State, and beyond its limits, the American elm has for a number of years been suffering from the ravages of this hidden and insidious enemy, the trees dying one by one from a cause, not apparent, and known to but a few.

Character and Extent of Injury.

The larvæ or grubs of this insect work in the inner bark and sap-wood of the trunk,— the attack apparently commencing not far above the ground and gradually extending upward. Most of the burrows are in the inner bark, although a few occur at the depth of an inch or more. When the grubs are numerous, their broad flat burrows, varying from one-tenth to two-tenths of an inch in width and about one-tenth of an inch deep, so reticulate and run into one another as effectually to girdle trunks of trees two or three feet in diameter, when, with the circulation arrested, the death of the tree inevitably follows. The bark is frequently so badly infested that in old trees it can be detached in large sheets. The work of this pest is shown in figures 4, 5, of plate VII.

As early as 1847 and 1848, Dr. Harris had noticed that this insect was very injurious to the elms on Boston Common. He wrote as follows:

> The trees were found to have suffered terribly from the ravages of these insects. Several of them had already been cut down, as past recovery; others were in a dying state, and nearly all of them were more or less affected with disease or premature decay. Their bark was perforated, to the height of thirty feet from the ground, with numerous holes through which insects had escaped; and large pieces had become so loose by the undermining of the grubs as to yield to slight efforts, and come off in flakes. The inner bark was filled with the burrows of the grubs, great numbers of which, in various stages of growth, together with some in the pupa state, were found therein; and even the surface of the wood, in many cases, was furrowed with their irregular tracks.

Most of the wood and bark borers are partial to diseased and dying trees, as is well known to many. An enfeebled condition of the trees from their age or some other cause, may account for the severity of the attack noted above. Dr. Fitch, in his Fifth Report, records that the larvæ of this insect infested the remaining bark of all of the slippery elms, *Ulmus fulva*, in his vicinity, after the best of it had been stripped off for medicinal purposes. The operations of this insect appear to be notorious, for it has been characterized by Dr. Packard as the most destructive borer in the Northern and Eastern States, often killing trees by the wholesale. In 1884, its ravages were so serious that Prof. Forbes wrote:

"From the present appearance of the elms throughout the towns of Central Illinois, where I have had an opportunity to examine their condition, and from the rapid progress which this pest has made among them during the last two or three years, it seems extremely likely that it will totally exterminate the trees unless it be promptly arrested by general action." A serious attack is recorded upon the elms at Frankfort, Ky., in 1892, when several were killed and a number badly injured. The insect has also been very destructive to elms in Albany and in Gloversville, N. Y. It does not appear to be so injurious in Canada as in the United States. It has been found infesting a dead maple by Mr. Harrington.

Description of the Insect.

The beetle is an innocent appearing slate-colored insect with dull orange markings as follows: a curved line behind each eye, a line on each side of the thorax, and margined wing-covers with three nearly equidistant points extending from the border. They vary in length from about one-third to one-half an inch. The females are considerably stouter and with shorter antennæ than the males (Pl. VII, fig. 2).

The borers (the larvæ of the beetles), are similar in form and general appearance to the notorious round-headed borer of the apple, belonging, indeed, to the same genus. They rarely exceed three-fourths of an inch in length, are destitute of feet, and have the usual enlargement of the first segment of the body immediately behind the head. (Forbes.)

The larva is white, subcylindrical, a little flattened, with the lateral fold of the body rather prominent; end of the body flattened, obtuse, and nearly as wide at the end as at the first abdominal ring. The head is one-half as wide as the prothoracic ring, being rather large. The prothoracic segment, or that next to the head, is transversely oblong, being about twice as broad as long; there is a pale dorsal corneous transversely oblong shield, being about two-thirds as long as wide, and nearly as long as the four succeeding segments; this plate is smooth, except on the posterior half, which is rough, with the front edge irregular and not extending far down the sides. Fine hairs arise from the front edge and side of the plate, and similar hairs are scattered over the body and especially around the end. On the upper side of each segment is a transversely oblong ovate roughened area with the front edge slightly convex, and behind slightly arcuate On the under side of each segment are similar rough horny plates, but arcuate in front, with the hinder edge straight. (Packard.)

The larva differs from the allied linden borer, *Saperda vestita* Say, in its shorter, broader, and more hairy body, and having the tip of the abdomen hairy and more depressed. The prothoracic segment is broader and flatter, and the rough portions of the dorsal plates are larger and not so transversely ovate. The mandibles are much longer and more slender, and the antennæ much smaller than in *S. vestita.*

Life-History.

The period required by this insect to complete its life cycle is at least one year and is probably several. The eggs are deposited upon the bark in June and the larvæ hatching therefrom are nearly full grown before winter, according to Dr. Fitch. On the other hand, Dr. Packard, writing in December, 1870, mentions finding "three different sizes of the larvæ, evidently one, two, and three years old, or more properly six, eighteen, and thirty months old." This latter statement has evidently been overlooked by more recent investigators, and no attempt seems to have been made to determine the true period of development. Possibly the beetle may complete its transformations in one year, yet the allied round-headed borer of the apple-tree, *Saperda candida*, requires three. The winter is passed in the larval or grub stage. Pupation occurs about the middle of April in central Illinois, and imagoes may emerge from early in May until the latter part of June in that latitude. In Massachusetts, Harris records taking living beetles repeatedly from early June to the 10th of July. Mr. Harrington has taken the beetle June 15th in Canada.

Associated Insects.

An ally of the Saperda is found in *Neoclytus erythrocephalus* (Fabr.). This insect appears to feed mostly on dead wood, apparently following the attacks of the more pernicious species. Occasionally it occurs in numbers in trees infested with *Saperda tridentata*. It may feed in such places only on the dying tissues left by its predecessor. As an evidence of its abundance, the following may be noted: From a section of the trunk of an elm, three inches long and six inches in diameter, infested by the Saperda and brought to my office about the first of April, eleven examples of the Neoclytus emerged between April 29th and May 12th, 1882. Large numbers of them were bred from other portions of the affected tree secured later—sixteen examples on the 23d of June, and others thereafter until July 1st. It has also been reared by me from hickory, from twigs of locust, and from pear twigs infested with *Xyleborus*, received from Mr. Pomroy of Lockport, N. Y. It is represented in figure 3 of plate VII. Another insect found associated with it in the dead wood of infested elms is the Curculionid, *Magdalis armicollis* (Say). This insect usually attacks the upper branches, but also occurs with the Saperda and Neoclytus in the trunk.

Distribution.

The ravages of this insect have been reported from the Provinces of Ontario and Quebec, and from the following states: Massachusetts, Rhode Island, New York, New Jersey, Kentucky, Illinois and Michigan. In all probability it occurs also in the intervening states of Pennsylvania, Ohio and Indiana.

Parasites.

Several parasites have been bred from this insect or the species associated with it in infested trees, but they are comparatively few in number and can therefore be of little importance in keeping this pest or its associates in check. The parasites apparently have not been identified or referred positively to the proper host.

Remedies.

Badly infested trees should be cut and the wood burned or the grubs within destroyed in the winter or early spring before they have had an opportunity to escape and perpetuate their kind.

If the attack has not proceeded too far, protection may probably be obtained by coating the bark with some thick repellent substance (of which carbolic acid and Paris green should be components) that would repel egg deposit or prevent the entrance of the newly hatched larvæ. This coating need not be applied to the entire trunk, but might be limited to a broad zone of several feet, at and beyond that part where the burrows of the preceding year were mainly run — to be found by removing portions of the bark, which will readily scale off from the older infested portions.

A still better remedy, probably, would be the following: Remove the outer bark from the entire infested portion of the tree in the spring (occupied at the time by the larvæ or the pupæ) by shaving it down to the inner bark until the first indications of the fresh burrows are disclosed. A kerosene emulsion of good strength brushed over the shaven surface would kill the insects, after which a coating of some thick substance, as lime and cow-dung, should be applied to prevent the splitting of the sapwood from exposure to the sun, drying winds or extreme weather.

That the barking of elms to even a greater extent than the above may safely be resorted to, appears from experiments made in France by M. Robert, detailed in the *Gardeners' Chronicle and Agricultural Gazette*, for April 29th, 1848, and quoted by Dr. Packard in his report on "Insects Injurious to Forest and Shade Trees" (1890), as follows:

"The whole of the outer bark was removed from the elm (this may be done conveniently by a scraping-knife shaped like a spoke-shave). This operation caused a great flow of sap in the inner lining of the bark (the liber) and the grubs of the Scolytus beetle were found in almost all cases to perish shortly after. The treatment was applied on a large scale, and the barked trees were found, after examination by the commissioners at two different periods, to be in more vigorous health than the neighboring ones of which the bark was untouched. More than two thousand elms were thus treated."

M. Robert had also obtained good results from cutting out strips of the bark of old elms of about two inches wide from the boughs down to the ground. "It was found that where the young bark pressed forward to heal the wound and a vigorous flow of sap took place, many of the larvæ near it were killed,— the bark that had not entirely been undermined was consolidated, and the health of the tree improved."

Crioceris 12-punctata (Linn.).

The Twelve-spotted Asparagus Beetle.

(Ord. COLEOPTERA: Fam. CHRYSOMELIDÆ.)

LINNÆUS: Syst. Nat., Edit. xii, i, pars ii, 1767, p. 601, no. 110 (description).

LINTNER: 1st Rept. Ins. N. Y., 1882, p. 244 (recently introduced); 8th do., 1893, p. 250 (mention); 10th do., 1895, p. 517 (from Brighton, Monroe Co., N. Y.).

RILEY: in Amer. Nat. for Feb. 1883, p. 199 (introduction); Bull 31 Divis. Entomol., U. S. Dept. Agricul., 1893, p. 67 (listed).

HORN: in Canad. Entomol., xvi, 1884, pp. 183–184 (mention).

RILEY-HOWARD: in Insect Life, iv, 1892, pp. 395–396 (occurrence in Maryland and District of Columbia).

HOWARD: in Insect Life, v, 1892, p. 98 (spreading slowly).

SMITH: in Insect Life, v, 1892, p. 94 (in New Jersey); in id., vi, 1893, p. 191 (spread); in Rept. N. J. Agricul. Expt. Stat. for 1892, 1893, p. 393 (spreading in New Jersey); in id. for 1893, 1894, pp. 444–445 (continues to spread); in Bull. 6 New Ser., Divis. Entomol., U. S. Dept. Agricul., 1896, p. 62 (spreading over entire State); Econom. Entomol., 1896, p. 212 (brief mention); in Entomolog. News, viii, 1897, p. 181 (in Monmouth Co., N. J).

WEBSTER: Bull. 51 Ohio Agricul. Expt. Stat., 1894, p. 121 (mention).

LAURENT: in Entomolog. News, v, 1894, p. 292 (mention).

JOHNSON: in Bull. 6 New Ser., Divis. Entomol., U. S. Dept. Agricul., 1896, p. 65 (becoming quite common); in 9th Rept. Md. Agricul. Expt. Stat., 1896, p 225 (common and spreading).

WICKHAM: in Canad. Entomol., xxviii, 1896, p. 74 (mention).
CHITTENDEN: in Year Book U. S. Dept. Agricul. for 1896, 1897, pp. 349-352, fig. 89 (general account).
SKINNER: in Entomolog. News, viii, 1897, p. 230 (in localities in Pa).

The common asparagus beetle, *Crioceris asparagi* (Linn.), has long been known to most growers of this plant on and near the Atlantic coast in New Jersey, Delaware and Maryland, while recently it has extended its range inwardly, and has appeared in various localities in eastern, central and western New York, and has entered Ohio. This destructive pest is, however, not the only asparagus beetle now established within the State of New York.

Twelve-spotted Asparagus Beetle in Monroe County.

This near relative of the common asparagus beetle was found infesting an asparagus bed in Brighton, Monroe county, N. Y., in comparatively small numbers in 1893 on the farm of Mr. Silas J. Robbins. Early in May of the following year a few of the 12-spotted variety were to be seen among the hundreds of the more common species. The latter part of the month, however, Mr. Robbins wrote: "Yesterday the asparagus beetles came out in full force. In many places quite as many red ones [*12-punctata*] as of the common kind." The appearance of the insect in such large numbers the second year of its observed presence would indicate that the climatic conditions of its newly adopted home were very favorable to its multiplication.

This insect has evidently prospered in this new locality as Mr. C. J. Chism, of Brighton, informed me in Sept., 1897, that it was very injurious, more so than *C. asparagi*. It had spread from the farm of Mr. Robbins to others in the vicinity and was regarded as a serious pest. The beetle was said to eat into the growing shoots more than does the common species, and thus render them unfit for market.

Description of the Insect.

The beetles of this species are easily distinguished from the more common form. They may be recognized by the twelve black spots on their orange-red elytra. The thorax is a deeper orange red. The eyes, antennæ, tips of the femora and tibiæ, the tarsi, and portions of the ventral surface are black. In form it is a stouter and larger insect than *asparagi*. At a little distance, they resemble somewhat closely, it is said, the ripening asparagus berry.

"The full-grown larva is shown in the illustration at fig. 3*b*. It measures, when extended, three-tenths of an inch (8 mm.), being of about the same proportions as the larva of the common species, but is readily separable by its ochraceous orange color. The ground color is light yellowish cream with an overlay of ochraceous orange which is most pronounced on the exterior portions of the abdominal segments.

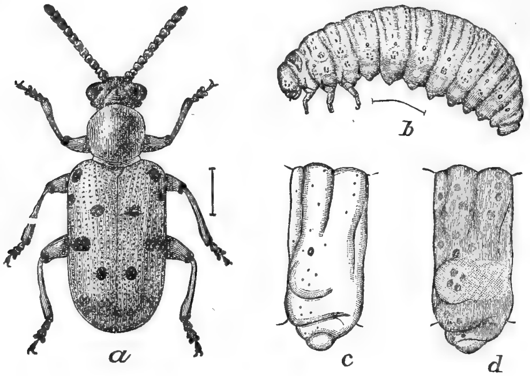

FIG. 3.—CRIOCERIS 12-PUNCTATA: *a*, beetle; *b*, larva. (After Chittenden, Year-book U. S. Dept. Agr., 1896.)

The head, with the exception of the mouth-parts, is also ochraceous, the thoracic plate is prominent, divided into two parts, and is of a dark-brown color. Enlarged figures of the second abdominal segment of both species are presented at fig. 3 *c* and *d*, for comparison." (Chittenden.)

Life-History and Habits.

Comparatively little is known of the life-history of this species. Two annual broods are ascribed to it in Europe, while there are presumably three in this country, especially in the southern portions. The eggs are not known, although it has been suggested that they may be deposited, like those of *C. asparagi*, on the leaves and stems. But few larvæ have been observed. One was found on the foliage and others in various stages, were feeding in the berries. The infested fruit reddens prematurely, is reduced to pulp, and the larvæ, on completing their growth, enter the ground for pupation. The food of the earlier brood appears unknown, unless it be the foliage, as with the common species. In the latter part of the season the berries are preferred by the larvæ. In Europe, the insect is said to pass the winter in the pupa state, but in this country some, judging by analogy, are of the opinion that it more probably hibernates in the adult form. Pupation occupies about two or three weeks during the summer and if the insects hibernate as beetles, the pupation of the later brood would probably occupy but little longer.

The few beetles observed by Mr. Robbins in early May were most likely the last of the overwintered beetles or, if hibernating as pupæ, recently issued ones. Their abundance noted by him the latter part of the month is possibly due to the appearance of individuals of the second brood. The beetles feed, like the more common species, on the foliage. They will also feed on the berries, in confinement, at least. This insect is more ready to take to flight and is less apt to hide behind the stems when disturbed, than is its congener.

Introduction and Distribution.

This is another addition to the list of insect pests accidentally introduced into this country from Europe. It was discovered in 1881 in the vicinity of Baltimore, Md., by Dr. Otto Lugger. The insect was quite abundant when found, showing that the date of its introduction was probably several years earlier.

Assuming Baltimore or its vicinity as the place of introduction, the spread of the insect may be traced southward across several counties and into the District of Columbia, where it was detected in 1896. Later it invaded Virginia in the vicinity of Washington, and now it has been detected as far south as Westmoreland county of that State. In 1892 it was found in Gloucester county, N. J. When spreading from Maryland to New Jersey, it also established itself in northern Delaware. The next year its presence was announced in the adjoining counties of Cumberland and Camden, N. J. The progress of the insect over New Jersey has been so rapid that in 1897, Dr. Smith found the insect in Monmouth county, nearly as far north as Staten Island. It has also established itself in parts of Pennsylvania near the southern portion of New Jersey, having been found there in 1894. The same year it was received by me from Monroe county, N. Y.

The known distribution of this insect is about as follows: The northeastern portion of Virginia along the Potomac and Chesapeake bay, the District of Columbia, Maryland, the northern portion of Delaware, the southeastern part of Pennsylvania, New Jersey as far north as Monmouth county, at least, and a colony in the vicinity of Rochester, Monroe county, N. Y. It will probably spread over a considerable area in the central portion of the State, and it may be expected to enter both Staten and Long Island in the near future, from its northern extension in New Jersey.

Distribution of Crioceris asparagi.

The distribution and spread of the common species will give some idea of what may be expected of the twelve-spotted form. *Crioceris asparagi* was first detected in this country in Queens county, Long

Island. It is now generally distributed through the States of Maryland, Delaware, New Jersey and in Pennsylvania along the Delaware river. It is known in Connecticut and Rhode Island, and is widely, though locally, distributed in Massachusetts. In the latter State it has worked along the seacoast, establishing itself in places where its food-plant was found. It has also made its way to a considerable distance inland, presumably on the plants purchased for the setting out of new beds. In this manner it has extended back from the sea for a distance of nearly forty miles. The insect has been abundant for a number of years at Berlin, Mass., where large quantities of asparagus are grown for the Boston market, and it has made its way along the coast to Portsmouth, N. H., and up the Merrimac river to Nashua, N. H. It may also enter both New Hampshire and Vermont through the Connecticut valley, besides touching the southern coast of Maine.

In this State the common species occurs over all Long Island. It has been traced up the Hudson river valley as far as Mechanicsville, about twenty miles north of Albany. It occurs in a number of widely separated localities in the western central portion of the State, having been reported from the following places: Vernon, Oneida county; Oswego, Oswego county: Newark, Wayne county; Geneva, Ontario county; Geneseo, Livingston county; Rochester, Monroe county; and Buffalo, Erie county. The insect will probably spread to all parts of the State lying within the Upper Austral Life-zone (see Plate IV in my 11th Report). It is known in nine counties in the northeastern part of Ohio, and is now slowly spreading over that State. The twelve-spotted species may be expected to eventually occupy a not much less extended range of territory.

Remedies.

The methods of value against the common asparagus beetle will be found of service in fighting this insect under similar conditions. The larvæ of the twelve-spotted form feed in the berries the latter part of the season, and are then out of reach of the common insecticides, but when feeding on the foliage they can be destroyed by dusting air-slacked lime over the plants when still wet with dew. The beetles can be poisoned upon the foliage with Paris green or arsenate of lead. If the insects are very abundant during the cutting season, it may pay to allow portions of the field to grow up and serve as lures to attract the beetles from the young shoots, where they may be poisoned.

Galerucella luteola (Müller).

The Elm-Leaf Beetle in Albany and Troy.

(Ord. COLEOPTERA: Fam. CHRYSOMELIDÆ.)

Additional Bibliography to that contained in the Fifth Report on the Insects of New York, 1889.

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CHITTENDEN: in Insect Life, vii, 1895, p. 419 (synonymy).

FERNALD: in Bull. 2 New Ser., Divis. Entomol., U. S. Dept. Agricul., 1895, p. 58 (at Amherst, Mass.); in 34th Rept. Mass. Agricul. Coll., 1897, p. 186 (mention).

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MARLATT: Circ. 8 2nd Ser., Divis. Entomol., U. S. Dept. Agricul., 1895, pp. 1–4, fig. 1 (general account); in Bull. 2 New Ser., Divis Entomol., U. S. Dept. Agricul., 1895, pp. 47–50, 58 (work in Washington).

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COOLEY: Bull. 36 Hatch Expt. Stat. Mass. Agricul. Coll., 1896, pp. 3–7, fig. 1 (brief account).

JOHNSON: in Bull. 6 New Ser., Divis. Entomol., U. S. Dept. Agricul., 1896, p 66 (injuries and remedies).

In the preceding Report, the observed progress was given of the elm-leaf beetle along the Hudson river from Newburg northward until it reached Albany in 1892, and its subsequent spread in a portion of the city. It is proposed in the present article, to present some additional observations made upon this insect, which, from its serious injuries to a favorite shade-tree, is exciting much interest.

This insect was very destructive the present year to the foliage of the English elms (*Ulmus campestris*) in both Albany and Troy. A second brood of the beetle was observed in 1895, but, owing to absence from town, it was impossible to make the continuous observations upon it desirable. The present year an effort was made to settle some of the disputed points concerning the habits of the insect so far north. Two annual broods were known to occur in the southern part of New Jersey, while, according to the observations of Dr. Smith in successive years, the insect was limited to a single brood at New Brunswick, in the northern part of the State. On this account it had been taken for granted that but a single brood would develop further north, and observations made by Dr. Howard in Connecticut in 1895, seemed to confirm this belief. It was, therefore quite a surprise when, beyond question, two well marked broods were observed by me in Albany in 1895, and a small third one the present year (1896). Instead of retiring in midsummer to hibernating quarters, there to remain until the following spring, as at New Brunswick, the beetles continued their feeding and oviposition so late in the season that larvæ were to be found so long as any leaves remained suitable for their food.

Broods in 1896, in Albany.

The larvæ of the first brood, those from eggs deposited by the over wintered beetles, were observed descending the trees for pupation on June 19th. On the 22nd a number of the pupæ were collected. The first beetles of this lot appeared the 30th, and by July 7th they had all transformed.

Most of the English elms in the vicinity of South Hawk street, Albany, were completely defoliated by the first brood. A close watch of this district was maintained throughout the remainder of the season. July 11th a cluster of eggs was found on the large lower leaves of one tree. Unfortunately the tops of the tall trees were so inaccessible as to make their close observation impracticable. It is probable that numbers of eggs were laid on the foliage of the higher branches during the month of July, as eggs were found from day to day on the rather fresh lower leaves at a time when the upper appeared to be in even better condition.

On South Hawk street, an English elm, which had been defoliated by the first brood, was throwing out a fresh crop of leaves July 30th. This recent growth was abundantly infested with both eggs and young larvæ. August 11th, eggs and larvæ were still abundant on this tree, although its foliage was almost entirely destroyed, while at its base many larvæ and a number of pupæ were seen. Two days later the pupæ were more abundant. August 21st this tree began to throw out a third crop of leaves, and most of the pupæ at its base had transformed. This new growth was but little injured, although a week later other trees in its vicinity were found to have been recently infested. These latter larvæ may have been portions of a third brood.

A striking example of the work of the second brood and the continued breeding of the insect until late in the autumn was observed on Washington avenue about three blocks above the Capitol. A number of English elms, which had been but slightly attacked last year and had suffered very little by the first brood the present year, were badly injured by the second. Many of the leaves were skeletonized in midsummer, and August 19th pupæ were lying abundantly around the trees. Pupæ continued to be found in large numbers until after the middle of September, and in lessening numbers until November 1st. Larvæ were to be found as late as October 15th.

On Lancaster street, near Lark, there are several English elms which had suffered little injury during the summer. Much to my surprise, hundreds of full grown larvæ were on the walk beneath the trees on October 12th. Their abundance so late in the season in such numbers render it quite probable that they belonged to the third brood, rather than that they were belated individuals of the second.

Observations in Troy.

The occurrence of two, and probably of three, broods was even more conclusively shown by the observations made at Troy, N. Y. On Eagle street in that city, there is a row of small English elms, which when first visited on August 18th presented a sad sight. Every leaf had been skeletonized, and there were only the dried remains of what had been a luxuriant foliage. In other parts of the city the trees had given out new leaves, which were badly infested with eggs. Eleven days later, the new leafage on Eagle street was already badly infested with eggs and recently hatched larvæ. Four egg clusters were counted on a small twig bearing but five leaves. September 9th there were many young larvæ and a few nearly full-grown, and numerous egg clusters — on a single leaf there were six. A week later the new foliage had suffered severely. Four or five larvæ were commonly found on a small leaf. Most of them were about half-grown, and a few were full-grown. September 25th many larvæ and a few pupæ were found on the trunks of the trees. A number of half-grown larvæ and some beetles were feeding on the leaves. October 1st a few larvæ were feeding; full-grown ones and numbers of pupæ were seen on the trunks and at the base of the trees, and beetles were feeding on the leaves. On the 22d of October several young larvæ were seen on a bunch of the greenest leaves, and near them a cluster of egg shells from which they had probably emerged within a few days. October 31st several full grown larvæ and a pupa were found at the base of one tree, and also a beetle just completing its transformations. On one tree with exceptionally green leaves, a number of very small larvæ were seen, and near them a cluster of egg shells. At this time most of the English elms were leafless. One week later, November 7th (the last observation for the season), a few pupæ were still to be found, which transformed successfully to beetles. The above facts indicate most clearly that the beetles would continue reproduction so long as there was suitable food. It also seems reasonable to refer the latest larvæ and pupæ to a limited third brood, rather than to the progeny of belated individuals of the second brood.

Notes on Oviposition and Transformations.

In connection with observations of the beetle in nature, breeding experiments were also attempted. Owing to the difficulty of obtaining new leaves for the larvæ, they were not so successful as could be desired.

On the 6th of July a large number of recently transformed beetles were confined with fresh, though old, elm leaves. They fed so voraciously that a new supply was furnished them every two or three days; especial care was taken to introduce no eggs with the food. Egg clusters were found as follows: 1 on the 8th; 4 on the 11th; 1 on the 13th; 3 on the 14th; 2 on the 16th; 15 on the 18th; 9 on the 21st; 3 on the 23rd; and 2 on the 25th,— the oviposition having extended over seventeen days. Most of the eggs were deposited in normal clusters and were fertile, although the conditions in the cage were not quite normal. From the above data it would appear that in summer most of the eggs are laid 12 to 14 days after the perfect form is assumed.

At this time tender leaves could not be obtained, and the young larvæ, under the ordeal of their confinement, perished a few days after emerging from the eggs. Some recently hatched larvæ were found on a tree July 30th, and were successfully reared to the pupa — one assuming that form August 11th and others a few days later. Young larvæ taken on a tree September 9th, pupated October 7th. The eggs and larvæ of this insect on a leaf are represented in figure 1 of plate VIII,—in the lower left-hand corner an egg cluster is shown enlarged.

The duration of the egg stage in July averaged about 5 days, that of the larva 15 to 20 days, and of the pupa 7 days. In the autumn, as might be expected, these periods are considerably prolonged by the colder weather. In September, the pupa stage was observed to last 12 days, and in October twice as long.

The duration of the beetle's existence is also of interest since it has a bearing on the probability of the occurrence of a third brood. A record of the mortality of those confined in a cage July 6th (see above) was kept, which is as follows: 7 dead the 16th; 4 the 18th; 5 the 21st; 2 the 23rd; 15 the 25th. Most of those that died the 23rd or before were badly affected with a fungus, *Sporotrichum entomophilum* Peck, and many of them may have been killed by it. The death of the others may have been hastened by the unnatural conditions of confinement. As but few of the beetles died before most of the eggs had been laid, it is probable that they live but a short time after having provided for the perpetuity of the species.

Although eggs and larvæ were not obtained from individuals known to belong to the second brood, yet the rearing to the pupa and imago stages, of those collected abroad as cited above, show conclusively that there was ample time for three generations during the activity of the insect. The beetles were seen feeding the latter part of August, during September, and even into October, and eggs, or evidences of recent oviposition, existed throughout the time. The limited life of the beetles after oviposition observed in July, renders it most probable that the same was true later in the season. From the preceding, there is hardly room for doubt that there was a genuine third brood of the insect in Albany and Troy the present year.

Food-Habits of Larvæ and Beetles.

Some of the young larvæ obtained from eggs in July were fed with the greenest of the old leaves that could be obtained. Everyone of several lots died after a few days, and then it seemed as if they were unable to develop upon the old growth. August 11th, some half and some nearly full grown larvæ were placed on old leaves. They at once began feeding, and eventually matured. The next day some recently hatched ones found on a tree were transferred to an old leaf, and a fair proportion of them completed their transformations. That the larvæ actually mature on old foliage is rendered certain by the development of a large second brood on a number of trees which had been scarcely injured by the first brood, and by the continued breeding of the insect on them until late in the autumn, as recorded before. A leaf skeletonized by the larvæ is shown in figure 4. Many trees had nearly every leaf as badly eaten as the one photographed.

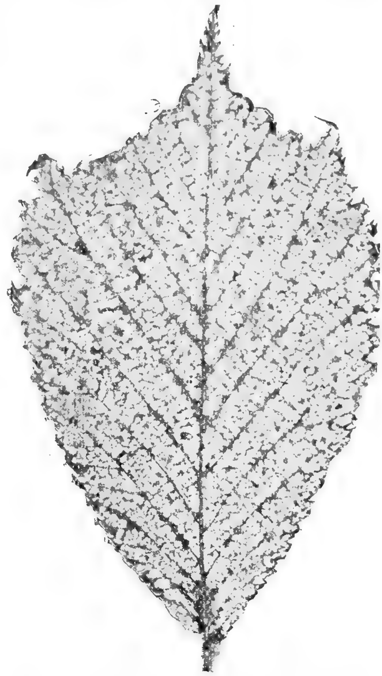

Fig. 4.— Work of elm-leaf beetle larvæ.

The ravages of the second brood of beetles in Capitol Park on the American elms (*Ulmus Americana*) was much more marked than of the one earlier in the season. One tree was nearly defoliated, and large portions of adjacent ones. The injury to American elms in other parts of the city was comparatively slight, so far as observed, although they were in close proximity to badly infested English elms.

The larvæ, under certain circumstances, may play the part of cannibals. In one instance, when food had not been given them in three days and all the leaves had been eaten, — upon opening the box containing them, a larva was seen devouring a living pupa: it had already eaten away a large portion of the dorsal wall of its thorax.

The beetles, as before noted, are ravenous feeders before oviposition— commonly eating large holes in the leaves. In one case observed August 31st, they had been skeletonizing an old leaf in a manner very similar to that of the young larvæ. The leaf was unusually dry and somewhat dusty, and its unpalatable condition may have been the cause of the departure from their ordinary feeding habit.

Spread of the Insect in Albany.

The area occupied in numbers by the first brood of the insect the present year corresponded quite closely with the thickly infested area of

1895. It would only be necessary to extend the lines indicated in 1895 a few blocks westward and northward to have the two areas coincident. The badly infested area in 1896 was the southern portion of the city bounded on the north by State street, on the west by Dove street, and on the south by Beaver Park. A limited infestation was noticed in the vicinity of North Hawk street and Clinton avenue.

The second and third broods materially extended the thickly infested area. The westward extension is to Lark street, but in Lancaster, reaching almost to Washington Park. The large second brood on the Washington avenue trees, hitherto practically free from the pest, defines the northwestern limit at the corner of Lark street and the avenue. The defoliation of trees in Capitol Park and on the streets lying off North Hawk street, indicates a northern extension of the insect which is virtually limited by Third street, and easterly and westerly by North Pearl and North Swan streets respectively.

The slow spread of the insect is in accordance with the partial migratory habit recorded by Dr. Riley, although signs of its presence in limited numbers are to be found over a much larger portion of the city than indicated above — practically the greater portion.

Ravages in Albany.

The ravages of this insect in Albany the present year were very severe. In the southern portion of the city, where the insect has been established for several years, almost every English and Scotch elm was defoliated at least once, and a number suffered the loss of their second leaves. The early part of the season, a number of fine trees had died and were removed. Apparently, it only requires three or four years of successive defoliation to kill the elms. A row of nine, on South Hawk street, formerly splendid specimens of the English elm, are nearly ruined and will probably die the coming season. The American elms were severely injured in some places, several having been nearly defoliated during the latter part of the summer. The injuries to this native species are on the increase, as is evidenced by the large number that have been attacked. It is safe to estimate that over two hundred fine elms in the southern residential portion of the city have already been killed by this pernicious pest. From present indications, it is only a question of time when the European elms will be destroyed and the American elms seriously injured, unless the insect be checked in its destructive course, by effective action of the citizens of Albany or its civic authorities.

Injuries in Troy and Vicinity.

The neighboring city of Troy, N. Y., six miles northward of Albany, was visited August 18th for the purpose of observing the operations of the elm-leaf beetle there and in the vicinity. It was found that the foliage of most of the English elms throughout the city had been completely skeletonized by the larvæ of the first brood. From the western end of Hyland avenue, commanding a view of a large portion of the city, the brown, dead leaves could be seen in all directions, and gave the impression of an extensive destruction by fire.

A closer examination of the condition of the English and Scotch elms throughout the city, showed that the infestation and consequent damage was fully as great as appeared from a general view. The elms everywhere were seriously injured, and in most instances the first crop of leaves had been completely destroyed. It was learned that the insect had been in the lower part of the city for years past—at least three. From this it would appear that the beetles must have entered Troy in 1892, and possibly earlier. The city had certainly suffered more from the insect the past year than had Albany.

The most badly infested region in Troy was between the Hudson river on the East and Fifteenth street on the West, extending from near the southern boundary of the city to Hoosick street on the north. The southern end of Green Island and, on the western bank of the river, a large portion of the city of Watervliet (formerly West Troy), was also badly infested. The insect was found in limited numbers on the high lands east of Troy, along Tibbets avenue, at Albia, and at Averill Park in the town of Sand Lake, some seven miles southeast of the city. On the north and west of Troy, signs of it in limited numbers were seen over most of adjoining Lansingburg, and in portions of Cohoes and Waterford on the opposite side of the river. It had become established at Menands, half way between Albany and Troy, in considerable numbers. It had also been found by Dr. L. O. Howard, Entomologist to the U. S. Department of Agriculture, at Mechanicville, about ten miles north of Troy.

Associated Insects.

The elm-leaf beetle finds a very efficient ally in its destructive work in the European Coccid, *Gossyparia ulmi* (Geoff.), which is widely distributed over Albany, Troy and Watervliet. The insect was so numerous on many trees that the leaves and branches were blackened by the fungus growing in its abundant secretion to such an extent as to render them conspicuous at a distance. Its occurrence in such numbers must weaken the trees to a considerable extent in the course of time. For a more extended notice of this insect see subsequent pages of this report (XII).

The injured and dying elms were also attacked by the pigeon Tremex, *Tremex columba* (Linn.), in numbers both in Albany and Troy. Many of the trees showed numerous large holes made by the Tremex larvæ. On the trunk of one small tree, two dead females were held by their inserted ovipositors, and, at the base of the tree, the remains of four others were found. The parasites of the Tremex were also active. One female of *Thalessa lunator* (Fabr.), "the lunate long-sting," was taken while ovipositing in the trunk of an infested tree. The remains of thirteen ovipositors securely fastened in the trunk of one small infested tree were eloquent testimonials to the activity of Thalessa in its search for the Tremex larvæ.

Natural Enemies.

The elm-leaf beetle has so few natural enemies that they do not appear to thin its ranks materially. A number of dipterous maggots were found among a mass of larvæ and pupæ collected at the base of a tree. There was no evidence that they attacked the living forms, yet more occurred than one would naturally suppose could find sustenance in the small amount of decaying matter present. Unfortunately they were not brought to maturity, and the species could not be determined.

Podisus spinosus (Dallas) was detected with a half-grown larva of the elm-leaf beetle on its extended beak, and it was also reported from Poughkeepsie as preying on the insect. A larva of a lace-wing fly, *Chrysopa*, was found in the vicinity of some dead larvæ of the elm-leaf beetle, and it was thought that possibly this was another of its predaceous enemies. A mite was noticed near some injured eggs, but it escaped before its identity could be established or its relation to the mischief ascertained.

Many of the beetles were killed by a fungus. It affected numbers of them in the breeding cages, and on some trees clusters of beetles would be found filled with it. Examples were submitted to State Botanist Peck, who has described the fungus as a new species in his report for 1896 under the name of *Sporotrichum entomophilum*. Like the disease affecting the chinch bug, caused by *S. globuliferum* Speg., that of the elm-leaf beetle can not develop rapidly in the absence of moisture. The affected beetles were found only where there was abundant moisture, as for example, in damp crevices in the trunks of the trees, in masses on damp ground and in moist breeding cages. The necessity of moisture to the development of *Sporotrichum entomophilum* Peck, renders the disease of doubtful value as a check on the undue increase of the elm-leaf beetle.

Remedies.

The proper and most satisfactory method of dealing with this insect is by spraying with the arsenites (one pound Paris green to 200 gallons of water) when the recently hatched larvæ are beginning to feed, as has been frequently pointed out before. Unfortunately for the general adoption of this means, the machinery necessary for spraying large trees is so expensive as to place it beyond the reach of many. Where a large number of the shade trees in a city are to be treated, some form of a steam apparatus for spraying appears to do the work with the greatest efficiency and economy. Although the machinery may be expensive, the cost of spraying per tree is by no means large. The abundance of the elm-leaf beetle in various cities has forced the authorities to resort to efficient means for protecting the trees. The cities of New Haven, Conn.; Springfield and Holyoke, Mass.; and Brooklyn, N. Y., have had constructed various successful forms of steam sprayers. Some difficulty was experienced in using the machines in these cities, either on account of their large size or the noise made by them while in operation. In New Haven it was found necessary to close the street during the spraying to avoid frightening the horses. Among the best of these may be mentioned the spraying apparatus constructed under the supervision of Dr. E. B. Southwick for the department of public parks of the city of New York. It consists of a "Diamler" gasolene motor connected with a three-piston Gould pump, the latter the smallest size of that pattern. The motor and the pump weigh about 300 pounds. The whole can be placed in a spring wagon with a 100 gallon, or larger, tank. The motor costs $250, and the pump about $50. The machine can be operated at the cost of but a few cents a day and makes so little noise when running as to scarcely attract the attention of passing horses. This apparatus will probably be found much more satisfactory than any makeshift, although it involves a greater outlay at first. For description of this apparatus, see the excellent paper by Dr. L. O. Howard on "The use of steam apparatus for spraying," in the Year Book of the U. S. Department of Agriculture for 1896, pages 69 to 88, from which the preceding has been taken.

There are now, and probably will be, a number of cities and large villages where this pest is prosecuting its destructive work, and where those in authority will not take the steps necessary for protection against it. In such localities there is an opportunity for some enterprising individual to fit up the proper apparatus and contract with property owners for spraying their trees either at so much a tree, or at so much for the season.

This has been done already in some places. At Bridgeport, Conn., Mr. W. S. Bullard has engaged in such work for the past few years. The firm of H. L. Frost & Co., 21 South Market St., Boston, Mass., is making a speciality of all kinds of spraying and of pruning trees. The members of this firm are graduates of the Massachusetts Agricultural College and deserve encouragement in this comparatively new line of work. Where no provision has been made for spraying, or where it has been carelessly done, the larvæ and pupæ that may be found on the trunk and at the base of the tree should be destroyed with hot water or kerosene emulsion. Many of the insects can be killed in this manner, but only after they have ceased feeding. This measure simply reduces the number of the insects of later broods. It may be made more effective by scraping the rough outer bark from the lower limbs and the trunk of the tree so that a larger proportion would be compelled to descend to the ground in search of a hiding place while transforming instead of pupating within the crevices of the bark. A rude inclosure or box around the base of the tree would also be of service, as it would keep the larvæ from straying where they could not be so easily reached and killed.

Odontota dorsalis Thunb.

(Ord. COLEOPTERA: Fam. CHRYSOMELIDÆ.)

——— *dorsalis* THUNBERG: Götting. Gel. Ang., 1805, p. 282.

Chrysomela scutellaris OLIVIER: Ent. Hist. Nat.— Coleopt., vi, 1808, p. 771, Pl. 2, fig. 21.

Hispa suturalis HARRIS: in Bost. Journ. Nat. Hist., i, 1835, p. 147 (pupa [Fig. 2] and imago described); Ins. Inj. Veg., 3rd Edit., 1862, p. 121 (description).

Anoplitis scutellaris. FITCH: 5th Rept. Ins N. Y., 1859, p. 54 (brief notice of larva and imago); the same in Trans. N. Y. State Agricul. Soc for 1858, xviii, 1859, p. 834; in Country Gent., xxvi, 1865, p. 190 (ravages on Long Island).

Hispa suturalis. PACKARD: Guide Study Ins., 1869, p. 504 (mention).

Odontota scutellaris. RILEY: in Amer. Entomol., iii, 1880, p. 151 (on *Robinia* and *Quercus alba*).

Anoplitis scutellaris. LINTNER: 1st Rept. Ins. N. Y., 1882, p. 320, (cites Fitch).

Odontota dorsalis. HORN: in Trans. Amer. Entomolog. Soc., x, 1883, pp. 296, 303 (description and synonymy).

Odontota scutellaris. DIMMOCK: in Kingsley's Stand. Nat. Hist., 1884, p. 315 (not confined to the locust).

Odontota scutellaris. HOWARD: Bull. 5 Divis. Entomol., U. S. Dept. Agricul., 1885, p. 7 (parasite from pupa described).

Odontota suturalis. HOWARD: in Entomolog. Amer., i, 1885, p. 117 (two parasites described).

Odontota scutellaris. PACKARD: 5th Rept. U. S. Entomolog. Comm., 1890, p. 367 (in New England).
Odontota dorsalis. HOPKINS: Bull. 16 W. Va. Agricul. Expt. Stat., 1891, p. 87, Pl. 13, fig. 1, *a-d;* in Canad. Entomol., xxviii, 1896, p. 248 (food-plants, destructive in W. Va).
Odontota suturalis. LINTNER: 10th Rept. Ins. N. Y., 1895, p. 369 (parasitized by *Derostenus*).
Odontota dorsalis. LINTNER: 11th Rept. Ins. N. Y., 1896, p. 269 (on apple).
Odontota dorsalis. BLATCHLEY: in Psyche, vii, 1896, p. 437 (in Indiana).
Odontota dorsalis. CHITTENDEN: in Bull. 9 New Ser., Divis. Entomol., U. S. Dept. Agricul, 1897, pp. 22-23 (herbaceous food-plants).
Odontota dorsalis. WEBSTER: in Bull. 74 Ohio Agricul. Expt. Stat., 1897, p. 35 (abundance in Ohio and Kentucky).
Odontota dorsalis. WICKHAM: in Canad. Entomol., xxix, 1897, p. 60, fig. 10 (in Canada).

This insect, although quite abundant at times in certain localities, had not occurred in the collections made by me in Albany and Schoharie counties, or in occasional collecting in other portions of the State. From the abundance with which it is reported below, upon the locust, it may have been overlooked by me in my limited examinations of the insect fauna of that food-plant. Dr. Fitch, writing in 1858, stated that he had never met with it in the eastern part of the State, although common in the southern.

The Insect on Long Island.

Examples were received by me on August 31, from Dr. Harrison G. Dyar, which had just been taken by him from locust trees (*Robinia*) at Yaphank, L. I. The leaves had been eaten (Pl. VIII, fig. 2) until they bore the appearance of elm leaves attacked by the elm-leaf beetle, and as the result of the severe injury, the foliage was rapidly falling.

In a re-examination of the trees by Dr. Dyar a week later — a roadside row of about twenty in number and patches of locust shrubs in a woods opposite — all the remaining foliage had turned brown. To the east and the west of this locality only a slight injury was noticeable, while to the northward, in another row of locusts between two fields, the leaves were still green and apparently uninjured.

In West Virginia.

Dr. A. D. Hopkins has written on the abundance and injuries of this Chrysomelid as observed by him in 1890, at Morgantown, W. Va., and its vicinity. In his bulletin on "Insect Ravages — Yellow Locust" (*sup. cit.*), he has stated as follows:

"This beetle was extremely plentiful on the locust leaves at the time the investigation was being made (early August), — as many as eight or ten were frequently found on a single leaf. They probably appear in May or June, when they deposit their eggs on the under side of the leaves, which hatch into small grubs that burrow into the leaves and feed upon the substance beneath the surface, forming blisters near the edges which usually extend to the midrib. * * * They change within the blister to the pupa form, from which the beetles soon emerge and feed on the surface of the remaining unaffected leaves. The blisters formed by the larvæ and the leaves skeletonized by the beetles, * * * cause the leaves to turn brown, wither and fall. * * * The beetle was also taken feeding on the leaves of the locust at Morgantown, on June 10th, and at Kanawha Station on June 16th.

"Like the plum curculio, it is the habit of this beetle to fall to the ground when alarmed, and in the case of valued shade trees, it may be possible to destroy them by the jarring process which is successful with the curculio. Their habit of feeding on the upper surface of the leaves would make it easy to treat them by spraying the trees with poisoned liquid."

Food Plants.

Although the locust is the natural food-plant of this insect, it seems not to be entirely confined to it, for Dr. Dimmock has reported it as extending its devastation to a number of other trees.

A correspondent of the American Entomologist (Vol. iii, p. 151), represents it as devouring the advanced foliage of Siberian crab-apples in the first week of May, and "in the wild woods, the tender leaves of *Ulmus Americana*." Finding insufficient food in the mined *Robinia* leaves, they attack the young leaves of red-oak (*Quercus rubra*), leaving other species of oaks near by, untouched. Mr. Hopkins (*loc. cit.*) found the insect feeding on the foliage of white oak, beech, birch and hawthorn in West Virginia, and Mr. Chittenden (*l. c.*) records instances of their feeding on red clover, hog peanut (*Falcata comosa* which is the *Amphicarpæa monoica* of Gray's Manual) and soja beans.

Dr. Harris' Account of the Insect.

According to Dr. Harris, the beetles may be found pairing in Massachusetts, in the middle of June and laying eggs on the leaves of the locust trees which are transformed to the perfect insect in August. "They measure nearly one-quarter of an inch in length, and are of a tawny yellow color, with a black longitudinal line on the middle of the back, partly on one and partly on the other wing-cover, the inner edges of which meet together and form what is called the suture; whence the species was named *Hispa suturalis* by Fabricius; the head, antennæ, body beneath, and legs are black; and the wing-covers are not so square behind as in the rosy Hispa." (Pl. VIII, fig. 3.)

The Larva.

The larva has been briefly characterized by Dr. Fitch as — "a small, flattened, whitish worm, attaining a quarter of an inch in length, tapering from before backwards, with projections along each side like the teeth of a saw, and with only three pairs of feet, which are placed on its breast; eating the parenchyma and leaving the skin of the leaf entire."

Parasites.

Several species belonging to the large parasitic family of *Chalcididæ* have been reared from this insect by Dr. Riley, and described at his request by Dr. Howard. *Spilochalcis* [*Smicra*] *odontotæ* Howard, was reared from the pupa of this locust feeder. *Sympiezus uroplatæ* Howard feeds externally on the larva within its mine. *Trichogramma odontotæ* Howard, is an egg parasite issuing in July. *Derostenus primus* Howard MS., was reared from the leaf mine of *Odontota*. Dr. Howard thinks it may be a secondary parasite, preying upon either of the first two species (*loc. cit*).

Distribution.

Dr. Horn has given the distribution of this insect as, "Middle and Southern States." Dr. Packard records it from New England, Middle and Western States. Prof. Webster has mentioned defoliations by it (more or less complete) in southern Ohio and adjacent parts of Kentucky.

Balaninus proboscideus (Fabr.): **Balaninus rectus** Say.

The Chestnut Weevils.

(Ord. Coleoptera: Fam. Curculionidæ.)

Fabricius: Ent. Syst. em., tom. i, pars ii, 1792, p. 440, No. 193 (description, as *Curculio proboscideus*).

Say: Descript. N. Amer. Curculionides, 1831, p. 16; Compl. Writ., LeCont. Ed., i, 1883, p. 279 (original description of *Balaninus rectus*).

Glover: in Rept. U. S. Dept. Agricul. for 1870, 1871, p. 70, fig. 13 (*B. rectus* injuring chestnuts, life-history in brief).

Packard: 2nd Ann. Rept. Ins. Mass., 1872, p. 17, figs. 10, 11 (weevils in chestnuts); 5th Rept. U. S. Entomolog. Comm., 1890, pp. 215–216, fig. 69 (*B. rectus* in acorns), pp. 350–352, fig. 132 (brief account of *B. caryatrypes* [*proboscideus*] in chestnuts), p. 354 (*B. rectus* in chestnuts).

RILEY: in Canad. Entomol., iv, 1872, p. 19 (*B. uniformis* erroneously referred to *B. rectus*); 4th Rept. Ins. Mo., 1872, p. 144 (injury, life-history in brief of *B. rectus*, probably *B. uniformis*).

HORN: in Proc. Amer. Philosoph. Soc., xiii, 1873, pp. 457, 458, 459 (describes *B. caryatrypes* and *B. rectus*, table of species).

BLANCHARD: in Bull. Brook. Entomol. Soc., vii, 1884, p. 107 (table of species; *B. caryatrypes*, *rectus* and others).

HAMILTON: in Canad. Entomol., xxii, 1890, pp. 1–3, 7 (habits, distribution, parasites of *B. caryatrypes* [referred to *B. proboscideus*] and *B. rectus*); in Insect Life, iv, 1891, p. 130 (*B. proboscideus* and *B. rectus* commonly infesting chestnuts and chinquapins) p. 131 (larval habits of *B. proboscideus*).

LINTNER: 7th Rept. Ins. N. Y., 1891, p. 383 (mention); in Country Gentleman, lix, 1894, p. 504 (brief mention); 10th Rept. Ins. N. Y., 1895, pp. 501, 517 (mention, all referred to *B. caryatrypes*).

RILEY-HOWARD: in Insect Life, iv, 1891, p. 93 (*B. proboscideus* and *B. rectus* reared from chestnuts and chinquapins, notes on habits).

McCARTHY: in Bull. 105 N. C. Agricul. Expt. Stat., 1894, pp. 267–272, fig. 1 (injuries by chestnut weevils, general account of *B. proboscideus*).

SMITH: in Rept. N. J. Agricul. Expt. Stat. for 1893, 1894, pp. 481–485 (general account of *B. proboscideus* and *B. rectus*); Econom. Entomol., 1896, p. 236. fig. 243 (*B. rectus* figured).

COMSTOCKS: Manual Study Ins., 1895, p. 593 (*B. caryatrypes* and *B.*, *rectus* mentioned).

SARGENT: in Gard. Forest, viii, 1895, p. 8 (brief account after Smith).

"Wormy chestnuts" are familiar to all lovers of this favorite nut, although few can recognize the parent weevil of these unwelcome grubs. In some seasons the chestnuts are so seriously infested that a large proportion of the crop is rendered worthless by their attack. It not infrequently happens that a lot of chestnuts are stored in some box or vessel soon after gathering and are found a few weeks later badly infested and sometimes almost destroyed by the white grubs or larvæ of these weevils.

Chestnuts as a Market Crop.

The growing of these nuts for market is an industry that is yet in its infancy in this country, but it is one of considerable extent and may be expected to develop to a much greater degree in the future. There are many acres in this and other States now almost unproductive, which are capable of producing large crops of the nut at a slight expense. Great quantities of Spanish nuts are imported from year to year, although equally good, if not better, ones can be grown here. As an instance of what has been done along this line — the twenty acres of bearing Paragon chestnut trees of Mr. H. M. Engle, Marietta, Pa., may be mentioned. Native trees were cut on a steep hillside and the sprouts grafted to this improved variety,— the grafts beginning to bear when about three years old. The trees were kept properly trimmed and the ground clear from underbrush. The land now yields more in value than an equal area of potatoes and at a much less expense. The improved varieties being easily grafted on native stock, makes it easy to transform in a few years comparatively worthless trees to valuable fruit producers. The most serious drawbacks are the underbrush, injury by insects, and thieves.

Extent of Injury by Chestnut Weevils.

The amount of injury by these insects varies much both with the season and the locality. Mr. R. C. Hewson, Penn Yan, N. Y., estimates the annual loss of native nuts in that vicinity at from five to ten per cent of the crop. This appears to be rather a conservative estimate, since in Massachusetts as high as forty per cent of the chestnuts in certain seasons are injured by these weevils. Sometimes in New Jersey fifty per cent of the Japanese and Spanish varieties are ruined, and Dr. Smith cites an instance in which the crop was almost entirely destroyed at the Parry Brothers nursery. The loss in Maryland ranges from ten to twenty-five per cent, in Delaware from thirty to forty, and in North Carolina from ten to fifty—possibly averaging, about twenty per cent. From five to twenty-five per cent of the few native nuts in Michigan are injured by the weevils.

The Genus Balaninus,

This genus is remarkable among the *Curculionidæ* or snout beetles for the unusually long proboscis or snout, — it being rarely shorter than the body, and in the female it is frequently twice the length. The members of this genus feed in the larval state on chestnuts, walnuts, hickory nuts and hazelnuts — all having thick husks and hence necessitating a very long beak for the purpose of perforating to the kernel that the eggs may be deposited near a suitable food supply. The extremely long beak may well be regarded as a special adaption to the requirements of the existence of this genus. It also differs from the other *Curculionidæ*, and in fact from all other known Coleoptera, by having the mandibles vertical instead of horizontal. The structure of this form is so different from its allies that it has been raised to sub-family rank (LeConte-Horn: *Rhynchophora of America*, 1876, p. 322).

Two Species Attacking Chestnuts.

There are at least two species that injure chestnuts in this country. The great chestnut weevil, *Balaninus proboscideus* (Fabr.), formerly known as *B. caryatrypes* Bohm., is the larger. This form may be separated from the other American species of this genus by the first joint of the antenna being shorter than the second. It is beautifully variegated with fuscous lines and spots interspersed among the dense clothing of ochreous scales on the thorax and wing-covers. Some examples are entirely ochreous. The beak of the female varies in length from one and one-fourth to twice the length of the body. Its distribution has been given as follows: Massachusetts, New Jersey, Pennsylvania, District of Columbia, North Carolina, West Virginia, Ohio, Illinois, Tennessee, Middle States westward. Other localities are recorded by McCarthy for chestnut weevils, but the species are not indicated. The smaller chestnut weevil, *Balaninus rectus* Say, has a wider recorded distribution, as follows: Canada, Massachusetts, New York, New Jersey, Pennsylvania, District of Columbia, Virginia, West Virginia, Ohio, Southern States and Arizona. Besides the above, chestnut weevils have been reported from Delaware, Maryland, Georgia, Michigan and Missouri, but without having been referred to either species. Possibly each of the species may have a distribution over the United States co-extensive with its chosen food.

B. rectus varies in size from about one-sixth to one-third of an inch in length. The general color of the scales and hair is light brown above, paler below; on the thorax there is a dark brown discal stripe, which is limited at the sides and divided longitudinally by a pale yellow line. The elytra are variously marked with the same color. The beak of the female is very long, being equal to or even longer in proportion than in *B. proboscideus*. The long beak and the long conical thorax is said to distinguish *B. rectus* from the other species of the genus. The male is not so easily recognized: "It has a shorter thorax, but it is still narrowed anteriorly; this, with small femoral tooth, oval elytra rapidly narrowed from base, and a yellowish or brownish spot of condensed scales on each side of the central line of the metasternum (occasionally obsolete), will, with practice, distinguish it." (Hamilton.) (See Pl. VIII, figs. 4, 6.)

Life-History.

The life-history of these two species agrees quite closely, so far as known. The weevils of *B. proboscideus* appear about the time of the blossoming of the chestnut trees, — this being variable in the different latitudes, and oviposit in the young burrs. The long beak of the female is used to pierce the husk to the kernel, and one or more eggs are then deposited therein. The slight injury done the burr and the nut at this early period of its development soon heals and shows no indication of the grub within as it comes to maturity. The holes noticed in "wormy chestnuts" are made for the exit of the larva (Pl. VIII, fig. 5). The female lives but a short time,—a week or two at the most. All of the larvæ of this species enter the ground in the autumn, none wintering in the nuts although thought probable by some writers.

The adults of *B. rectus* appear also about the time of the blossoming of the chestnuts. When rearing this species, Dr. Hamilton found that its appearance in the breeding cage was much more irregular than was that of the preceding,—varying from June 28 to October 1. On the latter date, there were in the cage pupæ in various stages and many larvæ that would doubtless live over the approaching winter. A delay until the second season is quite common in this species and is one of nature's safeguards against extermination should there be an entire failure of the crop in any one year, as happens occasionally. The preceding species has been reared only from chestnuts, while *B. rectus* is known to breed also in chinquapin nuts and acorns. This diversity of food habit in *B. rectus* may account in part for the marked irregularity of the appearance of the weevils. There appears to be no record of *B. proboscideus* remaining over until the second year in the pupa state, although it is probable that such instances occur. The method of oviposition of the smaller weevil appears to be practically the same as in the larger species.

Urosigalphus armatus Ashm., is the only known parasite of this genus, having been reared from all the species except *B. obtusus* Blanch.

Remedies and Preventives.

It would not be worth while to attempt to prevent oviposition in the growing nuts by poisoning the weevils, even if practicable, on account of the labor involved. Moreover, it has not been shown, as in the case of the related plum curculio, *Conotrachelus nenuphar*, that these weevils could be killed in this manner. Their short adult existence in comparison with that of the plum curculio would lead one to doubt the efficacy of any such measure.

The best methods of controlling these insects will be in preventive measures. All infested nuts should be destroyed each year before their occupants have had opportunity for leaving them and entering the ground for their transformations. When the nuts are not picked from the trees they should be gathered as soon as they fall and tested by turning them into a vessel of water, when, by brisk stirring, most of the wormy ones, being lighter than the liquid, will float to the surface and may easily be removed and destroyed. The others should be taken from the water and after drying, placed in a tight receptacle until shipped, so that if there are still infested nuts, the grubs can not leave and enter the ground and continue their attack another year. A more thorough treatment would be to subject the nuts in a tight room or box to the fumes of carbon bisulphide for about twenty-four hours, using one pound of the carbon bisulphide in shallow vessels to each 1,000 cubic feet of space. Fire must be kept away from this chemical as its fumes are inflammable and explosive. The nuts will not be injured by this treatment.

Jarring the trees has been found very effectual with the plum curculio, and it should be of equal value against these weevils, while requiring fewer repetitions, owing to the shorter period of oviposition. By visiting the trees each morning and catching the weevils as they fall upon a broad sheet prepared for the purpose, for the short space of a week or two, the crop would be comparatively free from these pests. Oaks and wild chestnuts should be as remote from the cultivated ones as possible, that they may not serve the insects for breeding purposes.

Cicada septendecim Linn.

The Periodical Cicada.

(Ord. HEMIPTERA: Subord. HOMOPTERA: FAM. CICADIDÆ.)

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The appearance of the periodical Cicada in any locality is of great popular interest on account of the number of years the insect spends in the larva or immature form under ground. The loud noise made by the adults and their occurrence usually in large numbers, brings them to the attention of even the most casual observer. The appearance of the insect is followed by a flood of local literature on its advent, and the many stories of all kinds concerning it and its ways find ready credence among the people. Each return is also of interest to scientists as it gives, for a brief time, an opportunity for studying the ways of this singular insect. It is only by carefully observing their number as they appear from time to time, that an approximate idea can be obtained of the rate at which the insect is diminishing in number with its successive returns. Thanks to the studies of the late Dr. Riley, we know pretty closely the distribution of the different broods of the insect in this country and are able to foretell their appearance. The advent of the Hudson river valley brood in 1894 is of special interest to us, because it is the widest in range and the most numerous of any of the six or seven broods known to occur in the State of New York.

Characteristics of the Insect.

Most people have seen a Cicada (commonly known as a locust) and many have seen both pupæ and adults of the "periodical Cicada." The wingless, red-eyed pupa will be readily recognized with the aid of figure 2 of plate IX, and needs no further description. The perfect insect may easily be distinguished from the common dog-day Cicada or harvest-fly, *Cicada tibicen*, by the eyes and the veins of the wings being a bright red. More or less of the ventral surface of the abdomen (especially in the male) and the legs are of a dull red. The dorsal surface of the body is almost entirely black. If we compare the periodical Cicada with the dog-day Cicada or harvest-fly, we will find that the latter is a considerably stouter insect with green markings on the thorax, greenish eyes, and the veins of the wings bright green, while the ventral surface is more or less covered with a white powdery substance. The male and female of the periodical Cicada with their wings expanded, and one with its wings closed as in rest, are represented in figure 1 of plate IX.

Oviposition.

The female, when ready for oviposition, selects a small branch, preferably of oak or apple, but almost any tree except the pines, and placing herself near its tip she proceeds to deposit her eggs. With her ovipositor she saws a series of oblique holes in the twig with splintered outer edges, as represented in figure 5. In each she places from ten to twenty eggs, in pairs side by side, but separated from each other by portions of woody fibre, and inserted somewhat obliquely so that their ends point upward. A fissure is made and filled with eggs in from fifteen to forty minutes, when at a slight distance on the twig the operation is repeated.

The following account of the manner of oviposition of the Cicada is based on some interesting observations communicated to me in a letter by Mr. Ira H. Lawton, Superintendent of Schools at Nyack:

After finishing one fissure the female moved slowly forward about two steps, depressed her ovipositor about 45°, and setting her saws in motion, first alternately and then simultaneously, rapidly penetrated the bark, but the ovipositor was soon elevated to 25°. After penetrating to the full length of her ovipositor and filling that chamber with eggs, she swung a little to one side and through the same hole in the bark excavated the opposite chamber and filled it with eggs. The making of each chamber occupied a little over 20 minutes or a total of 45 minutes for the whole. During the cutting of a fissure, the saws made about 80 strokes to the minute, and after making four, the female would rest for a time. The head of the Cicadas was directed, in the main, from the tree but not invariably so, as some worked with their head toward the trunk of the tree.

FIG. 5.—Cicada punctures in twig.

Sometimes fifty of these fissures may be made by the same female in a twig, provided it is suitable to her needs. After depositing her complement of from 400 to 500 eggs, she drops exhausted from the branch and dies.

Natural History.

The time required for the hatching of the eggs has been variously stated at fifty-two days, forty-two days, and even so brief as fourteen days.

The newly hatched Cicadas are slender, grub-like creatures about one-sixteenth of an inch long (Fig. 6). They are as lively as ants, and after running about on the tree for a short time they drop to the ground where they bury. Their strong fore legs are admirably adapted for digging, and by their use they burrow in search of the tender, succulent rootlets into which they insert their beaks and extract their modicum of needed nourishment. The larvæ grow so slowly and require so little food, that they cause but slight injury to the trees or the shrubs to which they attach themselves. Ordinarily they remain at a moderate depth, especially during the earlier and later portions of their existence, though at times they have been found a number of feet below the surface.

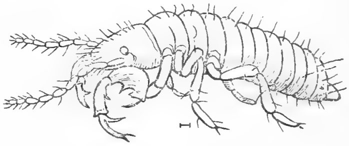

FIG. 6. Young Cicada, greatly enlarged.

Seventeen years, less the few weeks spent in the adult and egg states above ground, are passed by this insect in slow growth and development below the surface. There is but little change, except increase in size, in the appearance of the larva during this long period, but toward its close there may be noticed four scale-like appendages which represent the rudimentary wings. These have been gradually developed during the later stages of the larval existence. The emergence of the insect from its underground retreat, although separated by such a long period of years, is remarkably punctual, rarely varying more than a few days from the usual time. In the spring of the seventeenth year the larva makes its way, sometimes with great difficulty from obstacles encountered, to near the surface through a circuitous, smooth, and firmly compacted gallery, of a diameter barely sufficient to permit its passage. In its upper portion, at the proper time, it transforms to the pupa, which in turn forsakes the gallery just before it is ready to assume the perfect form and climbs the nearest tree or other support.* Here the pupa fixes itself firmly and awaits the time for the final change. The pupal shell (Pl. IX, fig. 2) soon splits along the back and the creamy-white adult with its red eyes and the black spots on the thorax works itself slowly out of the old case. It is soft just after emerging, and as it dries, the parts begin to harden and slowly to assume the colors natural to the perfect insect.

The cold weather that prevailed for the first week or two of their appearance, in 1894, resulted fatally to many, and large numbers of the dead might be seen lying upon the ground or clinging to the trees, — in the latter case often half-way out of the pupal shell. The adults live several weeks, feeding at will by means of their beak on the sap of trees. After pairing, oviposition occurs, and the long life-cycle of another brood is commenced.

A Thirteen-Year Brood.

In the Northern States of the Union this insect occupies seventeen years in completing its round of life as stated above, but in the Southern States, ranging as far north as southern Illinois, there is a form which requires but thirteen years for its transformations. It is to all appearances identical with the one occurring in the Northern States, except in a few minor details. The greater length of the growing season in the south may perhaps account for the quicker development of the larva. Dr. Riley was of the opinion that the thirteen-year form was but a race of *C. septendecim*, and not a distinct species.

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* Under certain conditions the larva extends the gallery into an above-ground earthern chamber, which will be noticed hereafter.

It will here be opportune to refer to the attempt by Dr. Riley to determine by experiment, whether these two broods were really distinct species or only races. In 1885, eggs of the thirteen-year brood were sent to several places in the Northern States, and similar transfers of the eggs of the seventeen-year brood were made to the Southern States. The object of the transfer was to test the question whether the change from a warm latitude to a colder, and *vice versa*, would have any marked effect in retarding or hastening the life-period of the insect. Two lots of eggs of the thirteen-year brood were received by me in July from Dr. Riley and were placed in the apple orchard of Mr. Erastus Corning, at Kenwood, near Albany. The tree under which they were placed bears the following inscription on a zinc label:

"*Thirteen-year brood of Cicada (Riley's Brood, No. VII)—eggs from Oxford, Mississippi, planted July* 4, 1885."

Additional eggs, together with the larvæ that had hatched while in transit, were placed under the same tree July 21. If any of the insects have lived and remain true to their period, their appearance may be expected in May or June, 1898. Should they fail to appear at that time, search will be made for them, if need be, for two or three successive years, and the results reported to the Entomological Division of the Department of Agriculture at Washington. Eggs of this same brood were also sent by Dr. Riley, to Ithaca, N. Y.; Boston, Mass.; Kittery Point and Brunswick, Me., and Ames, Iowa.

Distribution of the Hudson River Valley Brood.

Dr. Fitch, in 1856, gives as the limits of this brood, the valley of the Hudson river, from the vicinity of Schuylerville and Fort Miller* on the north, southward along both sides of the Hudson to its mouth, where it extends northeastwardly, at least to New Haven in Connecticut, and southward across the northern part of New Jersey and into Pennsylvania. Later observations enabled Dr. Riley to extend the limits of this brood,—including the greater part of the State of New Jersey most probably; localities in Fairfax, Albemarle, Campbell, and Fulvanna counties, Virginia; Charles county, Maryland, and the District of Columbia.

Observations and reports upon the occurrence of this brood in 1894 enable us to give the following as its distribution so far as known:

In New York the brood was reported from the Rural cemetery four miles north of Albany, and thence southward in localities on both sides of the Hudson river to New York City; at New Brighton,

* Forty-seven miles north of Albany.

Staten Island, in millions, and also in abundance at Bay Ridge, Flushing, and Queens, on Long Island. The occurrence of the brood along the Hudson may be briefly indicated by the following notes: New York county, abundant in certain localities in Woodlawn cemetery; Westchester county, in great numbers north to Croton; Rockland county, abundant at Palisades-on-the-Hudson, millions at Nyack; Orange county, millions at Highland Falls, West Point, Cornwall-on-Hudson, New Windsor, Newburg, and Middletown; Dutchess county, very abundant at Beekman, Poughkeepsie, Johnsville, Bangall, Annandale, Rhinebeck, Rock City, Redhook, Pine Plains, and Barrytown; Ulster county, abundant at Wallkill, millions at Marlboro, and large numbers at Milton, some at New Paltz, a few at Saugerties, abundant at Quarryville; Columbia county, very abundant at Clermont, and Claverack, millions at Hillsdale, reported from Livingston and Stuyvesant; Greene county, many at Catskill, very abundant at Athens and New Baltimore; Rensselaer county, abundant at Bath-on-Hudson; Albany county, swarms at New Scotland, many found at Voorheesville, large numbers at Bethlehem Center, some at Kenwood, abundant near Clarksville, and in the Albany Rural cemetery at Menands.

It will be seen from the above given data that the Cicada was quite numerous in localities near the river up to Putnam county. In Orange county they were reported very numerous at Middletown, twenty miles back from the river, and also at several places nearer the Hudson, showing that this is one of the strongholds of this brood. There was no report from Putnam county and they were probably not abundant there. The northern portion of Dutchess county is another stronghold of the brood, as they were found in numbers extending back nearly fifteen miles from the river. In the southern portion of Ulster county the Cicadas were in large numbers at Wallkill, ten miles from the Hudson, and at other places nearer the stream. The insect was found in force in the southern portion of Columbia county, at Hillsdale at a point about ten miles from the Hudson. In Greene county it was not observed far from the river. It was abundant on the Forbes Manor grounds at Bath-on-Hudson in Rensselaer county, and in Albany county it occurred in a number of places, but plentifully in only a few. So far as known it was not seen north of Troy.*

In New England it was reported from localities in the vicinity of New Haven, Southington, New Britain, Farmington and Winsted, Connecticut, thus extending its range north nearly across the State to the Massachusetts line.

* It doubtless occurred north of this locality but no account of its presence was received.

In New Jersey they were observed in every county in the state, according to Dr. Smith, although it was only in the eastern portion that they were abundant. They were the most generally distributed in Bergen, Hudson, Essex, Union and Morris counties. From Pennsylvania reports of its presence were received from Tunkhannock and Blue Mountain.

Distribution of the variety Cassinii.

In response to the inquiry instituted by me in a circular distributed in June, 1894 (republished in my 10th Report, pp. 420–425) of the occurrence of the above-named variety, a few replies only were returned, their small number doubtless not indicating the absence of the variety, but more probably their non-recognition by the ordinary observer. None were observed at Nyack, Bangall or Hillsdale. A few were seen by Mr. Livingston at Clermont, and at Clarksville, Mr. Bagley reported about an equal number — *Cassinii* being rather the more numerous.

Time of Appearance and Continuance of the Brood.

The regularity of the time of the appearance and disappearance of this insect is remarkable when its long term of life is considered.* Both in this and in the adjoining states of Connecticut and New Jersey, it was quite true to its appointed time — the first examples of the perfect insect being seen the week following the 20th of May.† The peculiar cry of the male which has been often described, was first heard late in May in some places, and in others not until June 15th, and continued until July 1st in some localities, and in others until the 16th, from individuals which were the last to mature. None were reported as having been seen after the 20th of July. Thus the entire time during which living adults were to be found hardly exceeded two months.

Pupæ were first seen by Miss Emily Morton, of New Windsor, in the early part of March and during April as they dug their way through the soil of a green-house on the heights of Storm-Kill mountain.

The Cicada Chambers.

The interest aroused by the advent of this brood was greatly augmented by the discovery of a number of places in this State of their peculiar clay

* As an exception to this marked regularity, Dr. Riley has stated: "The Periodical Cicada frequently appears in small numbers, and more rarely in large numbers, a year before or a year after its proper period."

† The actual time of appearance is governed to a certain extent, not only by temperature, but largely by the character and condition of the soil. At New Haven it was observed that they issued earliest on the rocky heights where there were but a few inches of stony soil, and the latest to appear came from the moist ground of a fruit garden.

mounds built as an extension to the underground burrow (Pls. X, XI). Only two other instances of their occurrence prior to this have been given by writers, to be noted hereafter, and but one example was known in any collection — in that of the National museum at Washington, deposited there over twenty-five years ago.

The distribution of these above-ground chambers and the causes leading the larvæ to construct them, can not be satisfactorily explained. Their occurrence under widely different conditions, and the theories advanced to account for their building, renders it desirable that their localities be given so far as known.

Their Abundant Occurrence in New York.

To Benjamin Lander, of Nyack, N. Y., belongs the credit of having discovered and studied on South Mountain, near Nyack, by far the largest tract of ground thickly dotted with these chambers that had ever been observed. The total area was estimated by him at about sixty acres, with five to twenty-two of the structures to the square foot. Those to which his attention was first drawn, occupied a small tract of woods that had recently been burned over. Subsequent visits extended the area far beyond this tract, and included ten acres of open land which had been wooded in 1877. Other localities of the chambers, varying in their extent, were also found by him at Nyack, Upper Nyack, South Nyack, Grandview, Piermont, and on the top of the Palisades near Alpine. Several of these areas had been burned over. Mr. Lawton, superintendent of schools at Nyack, found the chambers in small numbers on a slight terrace in his yard, and although hundreds of the insects came up in other portions of the yard, no chambers were built. Quite a number were found at West Point; at New Windsor, Miss Morton observed them in the grass and in the rows between the garden plants. A few, which were about two inches long and nearly horizontal, were reported from Johnsville. They were also seen at Marlboro in the woods, and probably further search would have revealed others. In the sandy soil of the woods along the river at Poughkeepsie, the ground was thickly covered with them. At Bangall they were found under the leaves in the woods among three times as many uncapped holes: several acres were dotted with four to ten holes to the square foot. At Athens, in one locality, the soil was not much over two feet in depth where the chambers occurred, while in another locality covered with bushes, no rock could be found at a reasonable depth. Mr. Brooks of Athens had noticed the chambers in his apple orchard in great numbers when cultivating it. The clay was then dry and would come up in quite large pieces holding the chambers, but they did not appear much above the surface. Mr. H. Van Slyke found on May 15th, the chambers very abundant at New Baltimore, distributed over a fifty-acre lot from which the brush and small growth had been burned about three weeks before. Over much of the ground, there were about eight to ten to the square foot, while in places, nearly three times as many could be counted in the same space. Frequently they crowded one another, and from three to five had been fastened together in their building. Very few of any height were built erect: most of them curved slightly just above the ground, and in many instances the cavity toward its end was nearly horizontal. They varied in height from 1½ to 3½ inches; in breadth from 1 to 1¼ inches; general height 2 inches; diameter inside ⅝ inch, rarely ½ inch. (Pls. X to XIII.)*

About 80 examples of these interesting structures, representing their peculiar forms and varied material, are in the State Collection, from the following localities:

North Fakins, Knox Co., Missouri; Rahway, N. J.; the following New York localities; Rural Cemetery near Albany, Bath-on-Hudson, New Baltimore, New Scotland, Athens, Poughkeepsie and Nyack.

In New Jersey they were reported to Dr. Smith from several localities. At Port Elizabeth a recently burned tract of 100 acres was covered with the buildings. They were also found on the Orange Mountains back of Montclair, on the Palisades above Fort Lee, at Closter, Demarest, Cresskill, Englewood and New Durham. The occurrence of the above-ground chambers was not reported in Connecticut.

Construction of the Chambers.

The chambers are constructed by the pupæ with soft pellets of clay or mud brought up from below and pressed firmly into place. On examination it will be seen that they are well rounded and firmly and rather smoothly compacted within, although the marks of the claws of the pupæ are plainly to be seen. Leaves and sticks are often incorporated in the outer portions of the walls. Mr. Lander, of Nyack, has recorded that in one corner of his garden, open towers only of about one inch in height were built with no attempt at roofing them over. It would be interesting in this case to know whether or not the process was suddenly interrupted by some nocturnal prowler devouring the little builders. In this connection may be noted the

* These plates are views taken for me at this locality through the kindness of Mr. W. W. Byington, of Albany.

interesting observations of Mr. Lawton on the repairing of injured chambers. He found that in every case, except one, the pupæ repaired them soon after the injury by bringing up pellets of mud and roofing over the broken portion about half an inch from the top. The repairs were begun on one side and gradually extended over the opening horizontally, there being no attempt to form a dome-shaped roof. Some of the chambers which had been broken off at 12:15 P. M., were found with a few pellets in position at 12:45, and three hours later the opening was entirely closed over. At one time a pupa was caught with a pellet of mud in its claws.

When the time for the final transformation has come, the pupa makes its way out of the chamber through a rounded hole made by it near the top, of a size barely sufficient to admit its passage.

The Purpose of the Chambers.

Most of the habits of animals are of direct advantage to them, or else they may be explained as the persistence of some formerly useful, but which under changed conditions are no longer of value. The Cicada buildings were first found on low wet soil after heavy rains, and the natural inference was that they were constructed for the purpose of escaping excessive moisture or flooding. In 1894, they were first noticed on tracts recently burned over, or in places where the soil was comparatively shallow. The early spring had been unusually warm, and the theory was advanced that these structures were reared to protect the insects from the heat — the elevation and slope of the land in many cases rendering the earlier theory untenable. Unfortunately for this explanation, the pupæ persisted in building their above-ground chambers where the soil was far from shallow — under the leaves in woods not recently burned over, and in other places where the ground would not become unnaturally heated. It should also be remembered that the pupæ had only to descend to a moderate depth if uncomfortably warm, and that in open fields, at least, the above-ground chambers would be much warmer on a sunny day than a subterranean burrow. Moreover, their occurrence, sometimes almost covering large tracts, and again alternating with open burrows or disappearing altogether, renders a broad generalization concerning their purpose extremely unsafe.

It may be, as suggested by Mr. Lander, that the above-ground chambers are the work of those coming to the surface earlier than the proper time for their final change, as they were probably built in April or early in May, while the imago did not appear as a rule until the latter part of

May or early June. If the insect spends a week or more in the vicinity of the surface, it is manifest that a burrow capped with one of the chambers would be more secure than an open one. There are a number of causes that might hasten this upward movement; *e. g.*, the amount of water in the soil, a greater supply of food nearer the surface, a restlessness of the insect as the time for its emergence approaches — often observed in other insects, etc. The building of chambers at the surface may not be so exceptional as at first appears. There are several records of their being found in limited numbers under fallen leaves in forests, and slightly above the surface in cultivated fields — in the latter place hardly noticed until disturbed by the cultivator. It is probable that they would have been found in many other localities than those recorded, had search been made. Their being so often reported in 1894 on tracts recently burned over may be entirely owing to their ready exposure to the eye in such localities.

First Notice of the Chambers.

The earliest notice that we have of these Cicada chambers is that of observations made by Mr. S. S. Rathvon, of Lancaster, Pa., which were communicated to Prof. Riley and published by him in his *First Report on the Insects of Missouri*, accompanied by figures of a chamber received from Mr. Rathvon. Prof. Riley mentions his having previously found them in a field being plowed near St. Louis, Mo. The only other published notice of the chambers prior to the widespread interest excited by their occurrence in many places in the State of New York in 1894, appears to be one by Prof. J. S. Newberry, who in 1877 had his attention called to their discovery in a cellar in New Jersey, and nine years later published an account of them in the *School of Mines Quarterly*, vol. VII, 1886, pp. 152–154. As the communication is an interesting one and not easily accessible, it is given herewith:

Uneducated Reason in the Cicada.

In 1877, a colony of the seventeen-year locusts (*Cicada septendecim*) appeared at Rahway, N. J. During the interval between the appearance of that and the preceding generation, the town had been extended, and some houses had been erected where forests or fields existed before.

One of these houses — that belonging to Mr. Alonzo Jaques — was constructed on the site of an old orchard, and had a shallow cellar. This cellar was kept closed till about the time of the advent of the Cicadas; the door was then opened, and the bottom of the cellar was found to be thickly set with mud-cones or tubes, from six to eight inches high, an inch to an inch and a half in diameter, each of which had been formed by the pupa of a Cicada that had emerged from the earth beneath the cellar. Finding a dark chamber, and apparently desiring to work up to daylight, the Cicadas had taken the moist clay and of this formed pellets with which the tubes were built up, apparently with the purpose of bridging over the vacancy and thus reaching the surface.

These facts appeared to me so interesting that I procured a large number of the tubes, and I had the first report verified by the written testimony of the owner of the house and several other well-known citizens of Rahway.

The document sent me with the tubes has remained in my possession to the present time. It is dated June, 1877, and reads as follows:

"These cones were erected by the pupas of the Cicada in the cellar of a house belonging to Alonzo Jaques, Rahway, during parts of May and June, 1877. They were built in an unfloored cellar of a house constructed about eight years ago in an old orchard. The cellar was dug to about the depth of a foot in red clay, and the bottom covered by a slight layer of debris, sand, sticks, etc. The cellar was perfectly dark during the construction of the cones, the only opening being shut. The locality is a dry one, the house being situated on a rise of ground, and about a quarter of a mile from the nearest water — a ditch dry in summer. These cones were not seen in the course of erection, but when the cellar was opened, about the time the locusts made their first appearance, the whole cellar bottom was covered by them. The tops of all were closed, but on breaking some of them the pupas were seen both in the hole in the ground and in the cone.

"After the cellar had been opened and left so, they appear to have stopped building and to have made holes in the tops of the cones for their exit. These cones were a great curiosity to the people of Rahway, and many came to see them, declaring them something entirely new in their experience."

(Signed) A. E. Crow,
Alonzo Jaques,
W. B. Devrie,
M. L. Crow.

In the facts cited above we have evidence of the exercise of intelligence in the Cicada, and a judicious adaptation of means to an end in circumstances that it would seem must have been without precedent in the experience of that or any preceding generation; and, therefore, for which no education of ancestors could have given a preparation. It is possible that the pupa of the Cicada is sometimes embarrassed in its ascent to the surface, by water, by too wet or too dry sand or mud, but it is hardly possible to imagine circumstances where the construction of a tunnel would be necessary.

In the earth, caves of any considerable size rarely or never occur, since surface water is constantly flowing through all superficial materials, and filling cavities with transported matter. Caves often occur in rocks, but the Cicada has no power to penetrate rock, and lives in earth near the surface.

Perhaps some of those who have made the habits of the Cicada a study, can suggest a school in which they could have received the training that fitted them for the engineering work they attempted in the case under consideration; yet, though I have studied the habits of various colonies of the Cicada with some attention, I am quite at a loss for any explanation of the phenomena that will bring them in the scope of the theory according to which all our organs and faculties are the result of formative influences progressively developed through a long line of ancestry.

In whatever way the problem shall be solved, it has seemed to me of sufficient interest to warrant placing the facts on record.

Are the Successive Broods Dwindling in Number?

The long term of years elapsing between the appearance of a brood renders it difficult to obtain satisfactory answers to this question from more than a few localities. The following are confined to localities within the State of New York:

At New Windsor they were reported fully as abundant in 1894 as at the two preceding visitations in 1860 and 1877. They were much more abundant at Hillsdale and in greater numbers at Johnsville than at the former appearance. Mr. Frederick Clarkson reports them less abundant in Westchester county, while at New Brighton and Livingston they were much more numerous than he had ever seen them, the ground being a network of holes in many places. At Nyack they were perhaps not as plentiful as in 1877, although 80 holes to the square foot could be counted in places, and at Rock City they were equally abundant. There were about the same number in 1894 as in 1877 at Clermont, Claverack, and Marlboro, and not so many at Barrytown. They were evidently losing ground at Heath, for they were fewer in 1894 than in 1877, and then not so numerous as in 1860. One report gives not so many at Clarksville in 1894, while another states that they covered more space but were not so plentiful where they appeared as in 1877. None were reported from Tarrytown although they were said to have appeared there in 1877. Mr. Nathan Banks looked for them several times, without detecting any indication of their presence, in a piece of woods near Westbury, Long Island, where they were seen in 1877. The observations of James Angus communicated to me by letter, on their occurrence in Woodlawn Cemetery, New York, are of interest as indicating in a marked manner the effect of cultivation on this insect. No Cicadas were found by him in the improved parts of the cemetery, except under one large white oak tree, although they occurred in the unimproved portions. In preparing the land for interments it was trenched to a depth of at least six feet, except, presumably, in the vicinity of this tree, and here the insects thrived, as was evidenced by the thousands of pupal shells which could have been raked together beneath its spreading branches.

This Cicada appears, as a rule, to be found in the greatest abundance on wooded heights, as the Palisades on the Hudson and similar localities, —its numbers decreasing on the lower grounds and back from the river. At New Haven, Conn., none were seen on a damp spot of about an acre in extent in the midst of a numerous colony. At Poughkeepsie, N. Y., they were most abundant in low swampy places, and very abundant directly on the shores of the river. The insect probably can not live in soil constantly saturated with water, although it may thrive in wet soils, and this difference may possibly exist between the wet locality at New Haven and the swampy places in the vicinity of Poughkeepsie. An idea of the abundance in which it appeared in certain localities may be gained from the following notes. At Nyack they occurred "in millions; the ground in many places was honeycombed with holes, and the cast pupal cases could be gathered by the peck." They completely covered the ground in some places at Rock City, and often the holes from which the pupæ came were but half an inch apart. At Annandale six of the cases might frequently be counted on a single leaf. At New Windsor, according to Miss Morton, when the insect was most abundant its noise was bewildering, and continued day and night, only intermitting for an hour or two after sunset, and commencing again with the rising of the moon (*in litt.*). At Clermont, Columbia county, the noise was almost deafening when at its height, according to Mr. Clermont Livingston, and it was heard at night after the moon rose. The Cicada was also heard in other localities on moonlight nights.

It is natural that the number of Cicada should vary from generation to generation, as other species of the insect world are known to do, and that the territory occupied by them, in consideration of the clearing of forest lands and cultivation, should be subject to continual fluctuation. So although this brood was not found in 1894 at several places where it was seen in 1877 and occurred in diminished numbers in others, yet the positive evidence of their presence in much larger force at some, and in at least equal strength to their former advent in many other places, would seem to militate against the conclusion that this brood was dying out. That it was not recorded within forty miles of its extreme northern extension in 1843 given it by Dr. Fitch (Schuylerville), may be entirely owing to no special effort having been made for its detection along the upper Hudson.

Damages by Oviposition.

The main, if not the only serious damage inflicted by this insect is that caused by its deposit of eggs in the twigs of various trees, — the amount of harm resulting from the puncturing of twigs for food is not known. The oviposition is largely in forest trees — in oaks, hickory and chestnut. Among cultivated trees the peach, apple and cherry suffer the greatest injury. The eggs may be found in almost all trees and shrubs, excepting those of the pine family; they are occasionally placed in cedar twigs. In 1894, the period of oviposition extended from about the first week in June to near the middle of July, but most of the eggs were probably deposited during the last ten days in June and early in July. The injury to the trees appeared to be mainly mechanical, resulting from the numerous slits in the twigs, forming almost continuous lines, pierced for the reception of the eggs. The damage to large trees, as a rule, was not serious, although some broken twigs and dead leaves gave them an unsightly appearance. Young trees were injured the most, and in some cases they were nearly ruined.

The reports received from various localities in 1894 concerning the injury wrought by this insect varied widely in character. In a number of places little or no damage was reported. At New Windsor, where it occurred in great abundance, Miss Morton reported that many limbs of small trees were killed, and in a few instances very little was left of the tree. Mr. H. D. Lewis is authority for the statement that at Annandale, thousands of thrifty young trees were virtually ruined by this insect. That this would naturally be the result of excessive oviposition, will appear from the following:

At Hillsdale, N. Y., in a twig nine inches long and one-fourth of an inch in diameter at its larger end, seventy slits were counted, — each slit containing about twenty-four eggs, or 1680 for the entire number. The Cicadas injured young hickories so greatly at Highland Falls as to render them unfit for hoop poles. In some localities the woods were said to appear as if fire had run through them. As a general rule, however, the damage by this insect was not great. Young trees undoubtedly suffered greatly in localities where the insect abounded, and the larger ones were severely pruned, but in most of the latter, the injury was more in appearance than in reality, — the pruning not proving very injurious, although at the time the dead leaves gave an impression of permanent harm.

Serious Results Reported From Cicada Stings.

Stories of the injurious and deadly character of the sting by this insect were widely circulated and firmly believed by many. A boy at West Point, George Pavek, was reported to have been bitten June 19th on the hands and face and to have died in a few hours, — medical aid proving of no avail. Subsequent investigation and a letter from the father of the lad, proved the story to be utterly false.

A school-girl, whose name was given, was reported to have been stung in the back of the neck by a Cicada that flew into the school-room: she was taken home in a carriage and died in great agony the following morning. This story had even less foundation than the preceding, as it could not be traced to any reliable source, and the name of the person was not known in the locality where it was said to have occurred.

Mr. H. D. Lewis, of Annandale, N. Y., was reported to have been stung so severely as to necessitate the amputation of a finger. His reply to the inquiry made of the truthfulness of the report, was as follows: "Allow me to say that the report of my being stung and the amputation necessary was pure invention, as I still retain the allotted number of bodily members unimpaired."

The story of a swarm of locusts attacking and killing a horse near Jacksonville, Pa., at the foot of South Mountain, is also another newspaper report deserving of no credence.

During the last advent of the Cicada in the Hudson river valley, hundreds and possibly thousands of persons handled the insects. Many school children amused themselves by playing with them. After investigating the newspaper and other reports of fatalities and injuries inflicted by their sting, and mailing nearly one thousand circulars throughout the region visited by the Cicada, in which special inquiry was made in relation to persons stung by it, only one instance of the kind was reported, and even in this there was reason for doubting that the slight wound had been inflicted by a Cicada. From the above, in connection with other investigations, there is good reason to believe that the insect is incapable of inflicting a dangerous or severe sting, and that the fatalities ascribed to it in the past are pure and simple inventions.

Natural Enemies.

A Cicada year is a time of unusual feasting for many vertebrates in the locality where it occurs. Cats and dogs eat the pupæ as they emerge from the ground. Skunks, ground-hogs and grey squirrels have been observed feeding on them, and it is probable that several other quadrupeds avail themselves of this abundant food-supply so easily obtained. Domestic fowls of all kinds eat them greedily,— in some places they were known to remain in the woods the entire day feeding on them. They are eaten by most of the insectivorous birds. Robins are said to prefer them to strawberries, and the crow devours them in preference to corn.

The English sparrow was observed to feed on them continuously in some places, while in others the occurrence was rather rare. Dr. J. B. Smith has recently stated: "This bird seems to have an intense hatred for the insects, attacking and pulling them to pieces in the most wanton manner. Near the large cities where the sparrows are numerous, entire broods have already been destroyed." Other birds that may be named as feeding on the Cicada are: the cuckoo, king-bird, oriole, sparrows, cat-birds, thrushes and ground-bird. Even the common land turtle was tempted to include the pupæ in its brief bill-of-fare.

The only insect enemies that were seen to attack the Cicadas were species of ants. They probably did not often molest the living, but contented themselves with preying on the dead or dying.

The fungus, *Massospora cicadina*, was found destroying the insect in widely different localities. At New Windsor, N. Y., many old males were found infested. The same conditon was reported at Nyack and at Clermont; at the latter, it was thought that possibly a few females were similarly affected. The infestation was also observed at Bay Chester and Clarksville, N. Y.; it was reported from New Jersey, in many instances at Morristown, and in a few at New Brunswick. The fungus was not found at New Haven, Conn. Failure to learn of it in other localities, by no means implies its absence, but merely that it was not seen.

Preventives of Injury.

It is practically impossible to prevent the Cicada from ovipositing in the twigs of trees, unless they are small and their value would warrant the expense of enclosing them with fine netting or light cloth so as to exclude the insect during the egg-laying period.

Since the greatest injury is done to young trees, much loss could be avoided by refraining from setting out new stock for the two or three years preceding the time for the appearance of a brood. This would be of special importance in the vicinity of forests, or on land which had borne a growth of trees at the previous advent of the insect that had suffered from its attack. In such localities it would be well not to prune older trees the spring before the appearance of the Cicada, unless the pruning be made so severe, as to leave no slender tips to serve as an invitation for the insect's oviposition.

Pemphigus rhois (Fitch).

The Sumac-Gall Aphis.

(Ord. HEMIPTERA: Subord. HOMOPTERA: Fam. APHIDIDÆ.)

FITCH: in Month. Journ. N. Y. St. Agricul. Soc. for Aug., 1866, p. 73 (described, as *Byrsocrypta rhois* with remarks).
WALSH: in Proc. Entomolog. Soc. Phil., vi, 1866, p. 281 (referred to *Melaphis*).
PACKARD: Guide Study Ins., 1869, p. 524, fig. 523 (brief mention).
WALSH-RILEY: in Amer. Entomol., i, 1869, p. 108, fig. 89 (brief mention, in Illinois and New York).
THOMAS: 8th Rept. Ins. Ill., 1879, pp. 152-153, fig. 28 (brief mention).
LINTNER: 3rd Rept. Ins. N. Y., 1887, p. 142 (from Schenectady); in Country Gent., lix, 1894, p. 686 (brief account); 10th Rept. Ins. N. Y., 1895, p. 503 (abstract of preceding, all as *Melaphis*).
OESTLUND: Bull. 4 Geolog. and Nat. Hist. Surv. Minn., 1887, p. 23 (bibliography, description, remarks).
SMITH: Cat. Ins. N. J., 1890, p. 451 (listed).
RILEY-HOWARD: in Insect Life, v, 1892, p. 145 (tannin in gall).

This insect is rarely seen, except by those curious enough to cut open one of the galls that it forms on the leaves of sumac. If the examination be made in September, it will be found tightly packed with particles of white flocculent matter which are the cast skins (exuviæ) of the lice at their successive moltings, hundreds of yellow-green wingless aphides, with wing-pads upon their sides (the pupal stage of the insect), and a smaller number of matured winged forms. A little later all will have become winged.

This insect was referred to the genus *Byrsocrypta* by its describer, Dr. Fitch, in 1866. Shortly thereafter Mr. Walsh made it the type for the new genus *Melaphis*, but upon insufficient grounds, according to Mr. Oestlund, who has recently placed it in the genus *Pemphigus*.

Description of the Gall and Immature Aphides

The galls have been described by Dr. Fitch as follows:

Resembling little round balls of different sizes, the largest measuring an inch in diameter, their surface uneven and slightly knobby in places, and covered with fine erect white hairs; their color pale buff-yellow or greenish-yellow, and on the side exposed to the sun bright crimson-red. Attached to the leaf by a narrow neck, opposite which, on the upper side of the leaf, is a thickened wart-like elevation, or sometimes higher conical protuberance, which is also covered with erect white hairs; and the leaf itself is partly withered, and turned red or yellow. Cavity inside large; in the smaller galls filled with small, oval, pale dull yellow lice of different sizes, their eyes black, their feet and antennæ white, the larger ones measuring 0.03 in length, and some of these larger ones thinly covered with a very fine pruinose powder, resembling mold; some having small scales or rudimentary wings, showing them to be pupæ; their cast skins thickly interspersed among them, resembling white meal; the larger galls with only the walls of the cavity covered, and crowded with similar lice.

Exception should be taken to Dr. Fitch's comparison of the galls to "little round balls of different sizes." All that have come under my observation are elongated, and decidedly pyriform in shape, as may be seen in figure 1 of Plate XIV, which fairly represents quite a number of others in the state collection. It is probable, however, that examples of rounded forms may at times occur, if we may judge from the peculiarly shaped one (almost semi-globular) represented by Walsh-Riley in the figure given by them, and reproduced by Dr. Thomas in the 8th Missouri Report, and also by Dr. Packard in his "Guide to the Study of Insects."

Description of the Imago.

Winged female, 0.06 in length, and to the end of wings 0.10; pale dull green or yellowish-green; head and antennæ black; base of thorax blackish, and its anterior part light yellow; legs pale; wings hyaline, but not clear and glass-like, their veins black, the third one abortive nearly half its length, the stigma salt-white; abdomen commonly thinly covered on the back with fine pruinose matter, its middle rather deeper green; antennæ shorter than the thorax, thread-like, four-jointed, the first joint slightly the shortest, and the second joint rather the longest. (Fitch.)

Mr. Walsh has taken exception to the above description, in the following criticism:

Dr. Fitch's description of the winged female of this species applies only to immature specimens extracted from the gall. After they have been out some time, the legs and the whole body, except the collar which becomes very pale brown, turns to a decided black; and the stigma then is not "salt-white," but pale dusky with a whitish reflection.

Life-History and Food-Plants.

The life-history of the species, so far as known, may be briefly summarized as follows: The growth of the gall commences in the spring, when it may be found occupied by the wingless mother louse in company with her progeny in their larval stage. The occupants multiply rapidly, increasing largely in number until during September, when the gall matures and gives forth the colony, all becoming winged eventually.

The same gall occurs on the *Rhus glabra* and the *Rhus typhina*. In a note published in Insect Life (*loc. cit.*) it is stated that the galls of this insect on *Rhus glabra* contain nearly as much tannin as the ordinary

Cynipid gall from China and Japan, viz. from 60 to 70 per cent, or about three times as much as is found in the foliage. Thus it would appear that the irritation of the tissues by the insects causes a concentration of the tannin in the affected parts.

Distribution.

The galls of this insect are apparently not of common occurrence, or possibly it should be said, they are not frequently observed, since they are rarely if ever found on sumacs standing where they are exposed to the sun.

They have been recorded from New Jersey, and from several localities in New York, Illinois, and Minnesota. The species probably has a much wider, though local, distribution. According to Dr. Fitch, it was rare in New York, for in describing it in the year 1866 he states that he had not met with it during the nine preceding years, although he had diligently searched for fresh specimens, and was compelled to fall back on those gathered in 1857 for its description. Examples in the state collection from which the figure was taken were received on September 7, 1886, from Schenectady, N. Y., and others from Clinton, N. Y., were received in September 1894. They have not come under my observation in the field.

Gossyparia ulmi (Geoff.).

The Elm-Tree Bark-louse.

(Ord. Hemiptera : Subord. Homoptera : Fam. Coccidæ.)

Geoffrey: Histoire Abrégée des Insectes, i, 1762, pp. 512–513 (described, as *Coccus ulmi*).

Howard: in Insect Life, ii, 1889, pp. 34-41, figs. 1-5 (general account).

Jack, J. G.: in Garden and Forest, ii, 1889, p. 461, fig. 129 (at Boston, Mass., life-history, remedies); in id., iv, 1891, p. 184 (distribution, injuries, remedies).

Lintner: 6th Rept. Ins. N. Y., 1890, p. 189 (at Marlboro and Albany, N. Y.); 10th do., 1895, p. 519 (abundant at Ghent, N. Y.); in Country Gent., lx, 1895, p. 425 (on willow at Loudonville), p. 585 (identified); in Bull. 6 New Ser., Divis. Entomol., U. S. Dept. Agricul., 1896, pp. 60-61 (distribution in the state); 11th Rept. Ins. N. Y., 1896, p. 280 (abstract of C.-G. notice), p. 287 (from Loudonville, Albany, and Catskill, N. Y.).

Perkins: Insects Inj. Amer. Elm, from 11th Rept. Vt. St. Bd. Agricul., 1890, pp. 81-87, figs. 61-64 (general account).

RILEY-HOWARD: in Insect Life, ii, 1890, p. 351 (?*Colastes* a parasite of); in id., v, 1892, p. 51 (occurring at Brighton, Mass.).
CRAW: in Bien. Rept. Cal. St. Bd. Horticul. for 1893-94, 1894, pp. 90-92, 2 figs. (in California, description and remedies).
COCKERELL: in Entomolog. News, vi, 1895, p. 325 (at Agricul. Coll., Mich.); in Canad. Entomol., xxvi, 1895, p. 31 (listed); in Bull. Ill. St. Lab. Nat. Hist., iv, Art. xi, 1896, p. 324 (listed, synonymy).
HILLMAN: Bull. 28 Nev. St. Univer. Agricul. Expt. Stat., 1895, pp. 3-8, figs. 1-3 (account of in Nevada).
LOUNSBURY: Bull. 28 Hatch. Expt. Stat. Mass. Agricul. Coll., 1895, pp. 23-26, figs. 13, 14 (brief account of in Mass.).
KIRKLAND: in Bull. 2, Ser. of 1897, Mass. Crop Rept. for June, 1897, pp. 35-37, fig. 5 (distribution in Mass., remedies).

The sad condition of the shade-trees in many of our larger cities, is exciting considerable attention and especially is this true where the elm-leaf beetle, *Galerucella luteola*, has become familiar through its defoliation of numerous elms, the recent destruction of many fine trees in the Hudson river valley, and the doomed condition of thousands of others. As if the long list of insect pests preying upon the foliage or burrowing within the bark and sap-wood of the elms was not sufficiently extended, another species has recently come over from abroad and is rapidly extending its range, and fast making itself a public nuisance from its blackening the foliage and branches and also the side walks beneath with its vile excreta.

Introduced from Abroad.

The elm-tree bark-louse, *Gossyparia ulmi* (Geoff.), like a large number of our most common and injurious insects, is an introduced species. The precise manner and time of introduction into this country are not known and probably will never be definitely ascertained. It was first brought to the notice of the U. S. Department of Agriculture in 1884 through Mr. Charles Fremd, of Rye, Westchester Co., N. Y., who at that time complained of the elms in his nursery being troubled with thousands of a red-looking mealy bug. The insect (represented in figure 2 of plate XIV) had probably been brought over on some nursery stock several years prior to its discovery at Rye. This importation is another illustration of the ease with which insects can be introduced from other countries on nursery stock.

History of the Insect.

This bark-louse was not determined at the time it was received by the U. S. Department of Agriculture from Mr. Fremd, nor in other sendings of the same by Mr. J. G. Jack, from Cambridge, in 1887 and 1888. In the autumn of 1888, it was discovered in several localities in the City of Washington. The following year a more complete series of its stages having been obtained from Mr. Jack, it was identified at the Department with the European *Gossyparia ulmi.* In July of the previous year (1888) it had been received by me from Marlboro and Albany, N. Y., and observed by Professor Perkins at Burlington, Vermont. It was also detected about this date in New York City by Mr. Henry Edwards, and in 1890 it was sent to Washington from Brighton, Mass. Some young trees at Palo Alto, California, were seriously affected by this insect in 1893. The next year it occured abundantly at Ghent, N. Y. In 1895, Prof. G. C. Davis found it numerous on the elms of the Michigan Agricultural College, and badly infested trees were reported by Prof. F. H. Hillman at Carson City, Nevada. About this time it made its appearance at Amherst and Brookline, Mass. The present year it was received by me from Catskill, and observation has shown it to be quite largely distributed in the vicinity of Albany and Troy in this state.

Its Distribution.

It will be seen from the above that this insect is now known to occur in six States in the Union besides the District of Columbia. In Massachusetts it appears to be extensively distributed over the state, as published in a recent notice of the insect by Mr. Kirkland. It is quite probable that it has already been introduced in the adjoining states of Rhode Island and Connecticut. From the occurrence of the pest at Burlington, Vt., there is little doubt but that it will soon invade New Hampshire and Maine, if it has not already done so. It is known to occur in several localities along the Hudson river valley from the City of New York to Troy. In the upper portion of this district, the insect has been found so abundant and generally distributed that the same condition will probably soon be reported for the lower Hudson.

The other recorded occurrences of this insect indicate a wide distribution for it in the future,—ranging from the Atlantic to the Pacific and, at least, from about the latitude of Washington, D. C., to near the Canadian border.

Injuries by this Pest.

It is impossible to estimate even approximately the damage caused by this insect in its eastern distribution, associated as it largely is with the destructive elm-leaf beetle.

Both at Boston, Mass., and at Carson City, Nev., its operations have been very injurious to the vitality of the infested elms. The trees in Albany and Troy have suffered severely from the combined attacks of the elm-leaf beetle and this scale insect. The many trees that have recently died, were probably killed mainly by the beetle, but many are now suffering severely from the work of *Gossyparia*. In the early part of June the secretion of honey-dew from the insects on a badly infested tree was so abundant as to keep the walk beneath constantly wet and in almost a slimy condition. One could stand under the trees and see and feel the continual shower of the tiny drops. The injurious nature of the work of the insect was more plainly evident in September, when its presence could be detected at a glance from some distance, by the blackened foliage and limbs of the infested trees—the copious secretion of the coccids on the leaf and branch having furnished the proper medium for the growth of the blackening fungus, *Coniothecium saccharinum* Peck. Thus the elm-leaf beetle and *Gossyparia* working on the same trees, transformed many from beautiful ornaments to hideous monuments of insect devastation. In this City and in Troy, *Gossyparia* seems to prefer the English and Scotch elms, although it occurs in limited numbers on the American elm. In both of these cities this pest is so generally distributed that it will largely aid the elm-leaf beetle in the destruction of our European elms, unless earnest effort be speedily made for the preservation of our favorite shade trees.

Description of the Insect.

It is only the adult females that, as a rule, attract the attention of the casual observer. They may be seen clustered along the under side of the smaller limbs and resembling, in a general way, a growth of lichens. The full-grown viviparous females just before giving birth to their young, are about 0.1 inch long, oval in outline, and with ends slightly pointed. They are surrounded with a mass of a white woolly secretion which also partially indicates the segmentation along their margin (Pl. XIV., figs. 2, 5). At this period the females are full of eggs which give a reddish stain when crushed.

The young are easily recognized on the infested limbs and leaves as dark-eyed yellow specks, being less than 0.5 mm. or $\frac{1}{50}$ of an inch in length. They are of an elongated oval form, rounded anteriorly and tapering posteriorly to a pair of pointed processes, each bearing a long and a short seta. Each segment of the body is indicated by a lateral spine; there is a row of six around the anterior border of the head, and a double row down the middle of the back. The growing young become darker and finally assume a yellowish-red color. Each segment becomes covered with spiny processes secreting wax. The general form of the young larva is retained (Pl. XIV, fig. 4). The antenna of the female before impregnation, is composed, like that of the young, of six segments, the second and third being the longest and the fourth and fifth shortest. The antenna of the immature male has six nearly equal segments and a longer seventh.

The oval cottony-like cocoon of the male is represented in figure 3, of Plate XIV. The presence of the insect within may be known by its two long protruding anal filaments.

The male will rarely be seen by most observers. It is a delicate two-winged creature of a reddish color, with rather large antennæ for so small an insect. It moves slowly over the limbs with a clumsy air. It is not easily disturbed and rarely takes to flight. An interesting feature is the occurrence of two forms. The earlier to appear,—the pseudimago,—is characterized chiefly by wing-pads in the place of normally developed wings. A few days later the perfect males with fully expanded wings come forth. Although the pseudimago is incapable of flight, it can probably perpetuate its kind, as it has been observed in coition.

Life-History.

This insect is the most conspicuous in the months of April, May and June, as the females are then about full-grown and are preparing to give birth to their young. Their active yellow progeny make their appearance in the latitude of Albany early in July. They move rapidly over the bark for a time and then settle along the veins of the leaves, principally the midvein, and in large numbers on the greener tips of the twigs. A few may be found in the crevices among the old females. They remain in these positions until into September or later, when many desert the leaves and establish themselves on the bark of the twigs for the winter, although it appears that numbers do not take this precaution in time, but fall with the leaves and are scattered by the winds. Many of the latter must perish, although a few may live to establish colonies in new localities. The winter is past in the immature form, the insects being about two-thirds grown, and protected by a whitish excretion from the numerous processes covering the dorsal surface. At the first warm weather in the spring, the wintered individuals show signs of activity. Early in April the females molt for the last time and the males form their cocoons. At this time many travel some distance before selecting a suitable place on which to settle. This is especially true of the males, as their snow-white cocoons are more rarely found in the center of a mass of the females than at the ends of dry twigs and other places unsuitable for the opposite sex. An abundant secretion of honey-dew occurs from the time the insects resume their activity in the spring until near the time that the young appear. The males remain in the pupa state for a few days only. A few pseudimagos emerge first (about six days after pupation), which are followed a week later by the perfect males. These soon perish after pairing,—the young not appearing until over two months later as indicated above. Soon after pairing, there is a marked difference in the features of the female. Her form changes from elliptical to oval, the secretion of the wax is more copious and is mainly from the lateral spines instead of from both lateral and dorsal as during the early autumn.

Means of Distribution.

The comparatively recent introduction of this pest and the establishment of its colonies in distant states, show very clearly how great a factor the shipment of nursery stock may be in the distribution of injurious insects. The rapid spread of this insect in eastern cities where it has obtained a foothold is surprising, and must be largely attributed to other means. It was not discovered in Albany until 1889. In the short space of seven or eight years it has spread to a large number of trees in all parts of this city and of Troy, where it is so generally distributed that perhaps three-fourths or even a greater portion of the elms are infested to some extent by it. It is by no means easy to explain how this spread was effected unless through the agency of birds. That notorious public pest, the English sparrow, has undoubtedly been an important agent in its distribution. It is but the work of a moment for the active young to crawl upon the foot of a bird touching the limb, and leave it at any later time. Many infested trees are so isolated, that there must be some such means for the conveyance of the wingless forms from one tree to another. It is possible that some of the immature insects falling with the leaves in the autumn may survive the winter and found colonies in new localities to which the leaves are carried by the winds ; but this means of distribution would at best be quite limited and uncertain, and by no means could account for the spread of the wingless female throughout so many states in less than a score of years.

Natural Enemies.

No natural enemies of this coccid have been observed preying upon it in this country, so far as known to me. Professor Perkins mentions the occurrence of a number of hibernating lady-birds, on infested trees, the most numerous species being *Adalia bipunctata*, and suggests that they might possibly feed upon it. The lady-birds were very common in Albany in the summer of 1897, and were noticed in large numbers on trees infested with various species of plant-lice, but none were observed actually attacking, or in the immediate vicinity of, the *Gossyparia*. Many flies and other insects were seen about infested trees, but they were evidently attracted by the honey-dew, and could not therefore reasonably be considered enemies of this insect.

Remedies.

Perhaps the best remedy for this pest is spraying with kerosene emulsion or a whale-oil soap solution. The insecticide should be applied either in the early spring just after the hibernated forms have molted or soon after the young make their appearance. Late in the autumn the insects are so well protected that a solution of four times the normal strength would be needed for killing them. It might be preferable to treat the trees at this time, as the insects may then be directly reached in the absence of leaves, although a stronger solution would be necessary than earlier in the year. Small trees have been effectually cleaned by going over them with a stiff brush. The brush would be made more effective by dipping it in either kerosene emulsion or a whale-oil soap solution from time to time. It may possibly be found that a heavy stream of cold water thrown directly on the insects would reduce them to harmless numbers, if repeated several times during the season. Where convenient, this, from its simplicity, might be preferable to other methods.

Neuronia pardalis Walker.

(Ord. NEUROPTERA : FAM. PHRYGANIDÆ.)

WALKER: Cat. Sp. Neurop. Ins. Br. Mus., Pt. 1, 1852, p. 7 (description).
HAGEN: Neurop. N. Amer., 1861, p. 250 (description from Walker); in Proc. Bost. Soc. N. H., xv, 1873, p. 293 (from N. H.); in Beitr. kennt. Phrygan., 1873, p. 394 (description and remarks); in Psyche, i, 1875, p. 96 (rarity).
HARRIS: Entomolog. Corr., 1869, p. 333 (description).
BANKS: in Trans. Amer. Entomolog. Soc., xix, 1892, p. 362 (listed).

An example of this insect, was taken in Keene Valley, N. Y., in June, 1896, which, so far as known, is its first capture in the State of New York. Mr. Howard Notman, its fortunate collector, has kindly sent a colored figure of the insect, from which the accompanying illustration has been taken. It is apparently a rare species. Dr. Harris has recorded two examples of it captured near the Great Moniadnock mountain in New Hampshire. Dr. Hagen has given "Nova Scotia (Redman)" as its habitat in his enumeration and description of the eight North American recorded species. Mr. Banks has added Canada and Labrador to its localities.

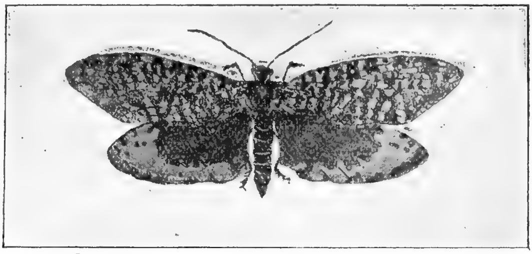

Fig. 7. — NEURONIA PARDALIS. (After Notman.)

At a meeting of the Cambridge Entomological Club in October, 1874, Dr. Hagen mentioned among the rare captures for the year, an example of this species, of which he remarked: "The only nearly related species live in Japan, the northern part of Europe, and in Liberia. They have the peculiarity to fly very high; this specimen was taken on top of a stage coach."

The following is Dr. Harris' description of the insect:

Body dark brown, antennæ, with the upper part of the head and thorax, black, the latter having two abbreviated fulvous lines; upper wings brown, with numerous large, rounded, tawny spots in rows between the nervures; hind wings brown, with a broad, tawny, tranverse band near the tip, and attaining the margin at the anal angle; base spotted with tawny yellow upon and behind the anterior edge; head beneath, with the palpi, coxæ, anterior thighs and tibiæ and bases of the intermediate and posterior thighs, fulvous.

Leptodesmus sp.?

Thousand-legged Worm Infesting Green-houses.

(Class MYRIAPODA: Ord. CHILOGNATHA: Fam. POLYDESMIDÆ.)

A gentleman in charge of some private greenhouses in Kansas City made complaint of "a pestiferous, repulsive pest" which is proving very injurious, and which it has not been possible to control. Accompanying the specimens sent he has written:

We have used ammonia — one tablespoonful to four quarts of water, soapsuds, and slacked lime. We have taken off the pots from the benches in this particular house and covered them with powdered lime — then put on two inches of cinders and replaced the pots, and still the worms come, lying under each pot on top of the cinders. The benches were also cleaned and flooded with boiling water, and even steamed with a hose attachment. Can you tell me what the species is and how to eradicate it? One of the greenhouses contains three beds of earth that was mixed with sheep manure from stock yards here, by a florist employed. They are everywhere in this house, and nearly everything planted in beds is dead or dying; but begonias, geraniums, colias, heliotrope, etc., in pots, are doing well in spite of the pests sticking to the bottom of the pots."

The greenhouse pest of the above communication proves to be, upon examination of the specimens sent, one of the numerous species of "thousand-legged worms" that occur in the United States. Those that usually come under observation have rounded, cylindrical bodies, as seen in the family Julidæ. Those received, are flattened and spreading out at the sides, where the numerous short legs with which they are furnished have somewhat the appearance of a fringe (Pl. XV, fig. 1).

Description of the Millepeds.

Most of them are about three-quarters of an inch long, of a reddish-brown color, and are apparently full-grown, while others are about one-half inch in length and whitish. The head bears six-jointed attennæ sparsely clothed with coarse setæ (Pl. XV, fig. 3), and the body of the male 30 pairs of legs,—a pair on the first, second, fourth, and seventh, and two pairs on the fifth, sixth, and eighth to the eighteenth segments inclusive; the last two segments legless (apodal); the female has 31 pairs of legs, there being two pairs on the seventh segment; the hinder angles of the segments are acute. Repugnatorial pores surrounded by slight swellings occur on segments 5, 7, 9, 10, 12, 13, 15–19 inclusive. The smooth convex dorsal plates with only a slight transverse sulcus are characters of the genus *Leptodesmus*, to which this form is referred. At the bottom of the transverse sulcus there is a minute tuberculate ridge.

The lateral carinæ are yellowish, feebly sulcate with two minute serrations, the anterior one bearing a small seta (Pl. XV, fig. 4). The rhomboidal gnathochilarium is represented in fig. 7 of plate XV. The copulatory legs of the male are abruptly flexed and terminate in four slender, curved processes (Pl. XV, fig. 6), which are nearly colorless, and vary slightly in form in different individuals.

In the event of this being a form new to science, it may be known as *Leptodesmus falcatus*, in allusion to the hook-like shape of the first process of the copulatory legs. This species was also found swarming in soil containing house plants in Albany, N. Y., the following season.

The Allied Genus Polydesmus.

It is evidently closely allied to the genus *Polydesmus*, of which a common form in Europe is *Polydesmus complanatus*, or "the flattened millipede" (fig. 8) — represented by Curtis and other writers as being one of the most destructive of its kind, feeding upon the roots of wheat, onions, pansies, and several garden products. Dr. Fitch, in his 10th Report on the Insects of New York, has given a detailed account of the habits of one of the "flattened centipedes" which he regarded as identical with the European *complanatus*. It seems, however, to be different, for that species has not been recognized as yet in our country. It is thought that the form that Dr. Fitch wrote of (without any accompanying description) may have been the *Polydesmus Canadensis* Newport,— figured and briefly described by Dr. Packard in his *Guide to the Study of Insects*, page 677, and referred by Bollman to *Polydesmus serratus* Say. He represents it as "crawling everywhere over the damp surface of the ground by night, in search of the nicest, daintiest food it could discover and withdrawing into the crevices under chips, stones, and similar situations during the daytime." The underside of cucumbers lying on the damp ground were often almost covered with them and the skin much eaten. The roots of onions when lifted were found eaten entirely off by them—completely arresting the growth of the bulb. From finding many of the worms in the stalks of cabbage distorted with warty swellings and cracks, Dr. Fitch was led to believe that they were the cause of the disease known as "anbury" or "club-foot" in cabbage.

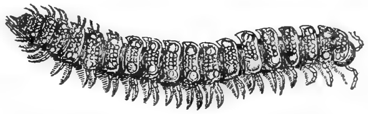

FIG. 8.— POLYDESMUS COMPLANATUS, slightly enlarged. (From Brehms Tierleben.)

Study of American Myriapoda Desired.

The Myriapoda, a class embracing the centipedes and millipedes, have not been given much study in this country, and therefore comparatively little is known of them, either scientifically or in their economic relations. Many of the millipedes feed only on decaying vegetable matter and are, therefore, of minor economic importance. Of those recognized as injurious to vegetation from attacking living plants, we are still without knowledge of such approved methods of dealing with them as will ensure protection from their varied forms of attack — especially when so severe and general as above reported in the Kansas City greenhouses. To meet such an emergency, we can only give a few remedies that have been recommended, and suggest some methods which give promise of being aidful if not entirely efficient.

Remedies.

Lime has been represented as a remedy by several writers, yet it has not apparently been of particular service in the present infestation. John Curtis, the eminent author of "Farm Insects," states that soot spread over the surface of the ground will drive the plant-feeding millipeds away, and also recommends spreading old cabbage leaves as a bait for attracting them, when they may be killed with hot water.

As they are mainly nocturnal feeders, many can be killed by lifting the pots and sprinkling diluted or pure kerosene on the worms gathered beneath, or wherever they may be seen on the benches or elsewhere. The kerosene may be diluted by shaking it briskly in a pot, or better still by making it into a strong emulsion. Pyrethrum and powdered hellebore might each be experimented with as a contact insecticide, either in its powdered state or mixed with water.

Probably the best results would be obtained by the use of traps or baits. Small pieces of board laid on a damp surface would be attractive as hiding places. Dr. Fitch states: "On raising up a chip or fragment of board that happens to be lying anywhere in the garden, you will probably find lurking under it a dozen or it may be fifty of these worms."

The traps would be much more efficient if made more attractive by placing beneath them slices of potatoes, turnips, or carrots. In England, slices of mangolds have proved to be one of the best baits that could be employed. If the baits were poisoned by dipping them into a Paris green mixture, it would not be necessary to visit them so often for the collection of the worms.

I think it probable that the infestation of the greenhouses has come from the piles of manure brought into them, as millipeds are known frequently to abound in manure, and are believed to breed in it. If on examination they prove to be present in large numbers in the manure, some efficient measure that may suggest itself should be taken for destroying them in it, and the manure should be removed to some distance from the houses.

The following thorough measures proved, as might be expected, an effectual means of ridding the greenhouses of the pests. (See *Garden and Forest*, v, 1897, p. 348):

In the spring we removed all plants from the greenhouses, also all wooden benches, and everything but the bare brick walls and the glass roofs. The floors had been concreted. We burned sulphur in liberal quantities three times a week for several weeks. Then we dusted all interiors thoroughly with hellebore, and in the fall, just before replacing plants in the houses, we coated all interiors with whitewash. Since then we have not found a single one of these unpleasant pests.

Kansas City. J. G. C.

The above-mentioned treatment should exterminate almost any pest to be found in a greenhouse. Such a fumigation might well be given greenhouses that are empty or nearly so during the summer as a preventive to the undue abundance of any injurious animal or plant form the coming season. Then if a little care be exercised when the house is filled in the autumn, not to introduce any pests, very little trouble should be experienced in keeping the plants in a healthy growing condition.

APPENDIX

(A)

NOTES ON SOME OF THE INSECTS OF THE YEAR IN THE STATE OF NEW YORK.*

The year has been characterized by the absence of attacks of the usual severity of a considerable number of our common insect pests—particularly those that infest our fruit trees. I do not recall a year before the present one in which reports have not been received by me of abundance of the apple-tree aphis, *Aphis mali* Linn., and of injuries feared from it. The eye-spotted bud-moth, *Tmetocera ocellana* (Schiff.), which has become so destructive to orchards in the western counties of the State, has hardly been heard from. No abundant presence of the apple-leaf Bucculatrix, *Bucculatrix pomifoliella* Clemens, has been reported to me, nor of the apple case-bearer, *Coleophora Fletcherella* Fern. The apple-tree tent-caterpillar, *Clisiocampa Americana* Harris, has been less injurious than in preceding years. The hop-vine aphis, *Phorodon humuli* (Schrank), made its appearance late in the season—in August, in portions of Madison and Oneida counties, and the blackening of the leaves from deposit of honey-dew excited some alarm, but it is not believed that serious harm has been done.

So far as my observation has extended—confirmed also by the observation of several collectors and others,—with a few notable exceptions, the year has also been remarkable for a scarcity of insect life. Some short excursions made in the vicinity of Albany specially for collecting, were without any satisfactory results. My Adirondack collections were unusually limited. Apparently not one-fourth of the usual number of insects were abroad (exceptions to this were the common house-fly and grasshoppers). Mosquitoes, the gray-gnat (*Ceratopogon*) and the black-flies (*Simulium*), were among the rarities, even in the month of July. The scarcity of butterflies was particularly noticeable, and was remarked upon by others than entomologists. Not a single *Papilio Turnus* was seen nor any of the other Papilios, except one *Asterias*. No Graptas were taken,

* Read at the Eighth Annual Meeting of the Association of Economic Entomologists at Buffalo, N. Y., August 22d, 1896, and published in Bulletin 6 New Series, U. S. Department of Agriculture, Division of Entomology, 1896. A few additions have since been made to the paper.

when in former years hundreds could have been captured. The Argynnids were very few and mainly *Atlantis*. *Feniseca Tarquinius*, for which Keene valley is a noted locality, was not seen. *Colias Philodice* was comparatively rare, while *Pieris rapæ* was abundant in the fields and about the blossoms of the burdock. The presence and capture of several examples of *Pieris oleracea* was welcomed as evidence that our once familiar native species had not been entirely driven away by the hosts of the foreign invader. In part compensation for the absence of so many of our diurnals, the beautiful "red admiral," *Pyrameis Atalanta*, was uncommonly abundant in the last week of July and in early August.

The night-flying species — the moths — were also very few, and it was only possible to secure a few of the attractive Plusias that abound at these high elevations; but among them were several examples of the resplendent *Plusia balluca* Geyer.

In each of the other orders was there an equally poor representation of the species commonly met with—quite noticeable in the families of the Cicindelids, Coccinellids, Cerambycids, in the *Bombylidæ* and *Syrphidæ*, in the dragon flies, and many others.

What particular climatic conditions had resulted in so marked a reduction in the usual abundance of insect life is beyond our knowledge. It would be interesting to know if any other class of the animal kingdom was similary affected, and if it also extended to the flora.

The following are brief notices of some of the insect attacks that have come under observation:

Tenthredo rufopectus (Norton).

An example of this saw-fly was received May 25, from Mr. Thomas Tupper, of Corning, N. Y. It operates in the stems, after the manner of, and often in association with, the current-stem girdler, *Janus integer* (Norton). It had been common in his garden for many years past, but by cutting off and destroying each wilted tip last year as soon as seen, he had nearly checked its operations.

The insect appears to have an extended distribution. Norton gives it from New England, New York, Pennsylvania, and Illinois. Cresson, later, gives United States and Canada. It has been taken in a number of examples in Canada — at Ottawa and vicinity, between June 5th and July 1st. In my collections made at Schoharie, N. Y., it occurred as late as July 18th.

Datana integerrima Gr.-Rob.

The walnut trees in Bellport, L. I., have been almost entirely stripped of their leaves by the caterpillar of this species, according to reports received from Dr. H. G. Dyar, of New York city.

This is one of the most common of our Datanas, and its larvæ are often found assembled in large companies on the hickory. They also feed on walnut (*Juglans*), beech (*Fagus*), oak, and occasionally on willows and apple.

The Army-Worm.

The notable entomological event of the year has been the occurrence and the ravages of the army-worm, *Leucania unipuncta*, over the greater part of the State — from its eastern to its western borders, and from its southern to nearly its northern boundary. It has been authentically reported from 55 of the 60 counties of the State. Its extension and the injuries committed by it are believed to be greater than had ever before been recorded in the State. When it appeared on Long Island and in Westchester county in 1880, although serious harm was done to the crops invaded, it was limited to the southeastern portion of the State, although spreading over some of the New England States, New Jersey and Pennsylvania.

Its habits have been similar to the many recorded occurrences elsewhere, unless that in many instances its operations were first observed in rye fields. From these it spread to oats, to timothy, and corn. Clover has been reported as eaten by it, and peas to a limited extent. Grass, of course, was consumed in its travels.

Of its abundance it may suffice to state: In many places they occurred in millions. Roadways crossed by them were "blackened" by their numbers. They "covered fences" and it has been said that they covered sides of buildings. The noise made by their feeding could be heard after nightfall. The clothing of a person standing for a short time in an infested field needed frequent brushing and picking over to remove them. The sight of their marching armies was said to be "nauseating."

Of the many preventives employed to prevent their ravages—as heretofore, plowing furrows with a perpendicular side toward the field to be protected from invasion, was the most effective and the one more generally resorted to. Attempts to save fields of barley, oats and timothy when once infested, were of little avail.

The earliest notice of the insect within our State, came to me on July 1st, when it were found on corn near Albany. This was followed on the 2d inst., by examples sent from Cambridge, Washington county; and for the week thereafter, reports followed closely and thickly of army-worm ravages in several of the eastern counties, and later, from southern and western parts of the State.

Larvæ received and collected by me were full-grown, and entered the ground for pupation as early as July 4th. Two changed to pupæ on the 9th on the surface of the ground in the box with the earth given them. On the 23d the moths commenced to emerge, and on the same date some of its parasites, *Winthemia 4-pustulata*, also made their appearance. Only a few parasites were disclosed. Their eggs had not been observed on any of the larvæ that I had examined, while in the western part of the State they have been reported as not at all uncommon.

The Wheat-Head Army-Worm.

The wheat-head army-worm, *Leucania albilinea*, has been reported from the town of Morley, in St. Lawrence county. I was informed under date of July 22d, that the caterpillar, identified from examples sent me, was doing much damage in barley fields. Its operations were shown, 1st, in the awns of the barley having to a great extent fallen, or more probably, been cut off: 2nd, a great number of the heads were cut off between the head and the next joint below. In one instance where the crop had been a most promising one, it was estimated by the owner, that two-thirds of it had been destroyed. The injury had not been sudden or rapid as in the work of *L. unipuncta*, but had been under observation for some considerable time. The barley-heads lying on the ground were subsequently eaten out, leaving only the husks or chaff remaining: this, it was thought, was done by the caterpillars.

A feature noticed in the work of this insect, was, that the leaves of the barley were not eaten—the first to be consumed by the army-worm, but that with the exception of the severed head, the plant was left in all its freshness and healthy appearance.

Eufitchia ribearia (Fitch).

This insect, generally known as the "gooseberry span-worm," from the preference shown by the caterpillars for that plant, was reported in very great numbers, during the latter part of May in a garden in Pine

Plains, Dutchess county, N. Y., where it stripped the leaves of both gooseberries and currants and threatened the destruction of the bushes. It had been noticed for a few preceding years, and had been steadily increasing. This season it was beyond control either by hand-picking or jarring, and was proving a more serious pest than the currant-worm, as hellebore powder had little if any effect upon it.

Although this insect is represented as common by most of our writers, and according to Dr. Packard, "is everywhere abundant in the Northern States, flying in gardens and resting on the leaves of currant and other plants," it can not be numbered among the more destructive garden pests of the State of New York. The above is the first instance in which the attention of the State Entomologist has been called to the injuries of the caterpillar. Nor can it be common on our wild currants or gooseberries, for, to my surprise, in referring to the State Collection, the moth is represented in a single example taken in Keene Valley on July 21st, 1895.

Apparently the insect abounds in a locality for a few years and then diminishes or entirely disappears. It was more numerous, according to Dr. Fitch in 1847 when it was described and named by him than in any of the intervening years to 1857 when he again wrote of it. During this latter year, it proved very injurious to gooseberries and currants at Paris Hill, Oneida County, N. Y., during the third year of its presence.

The Canker Worm.

The spring canker worm, *Anisopteryx vernata* (Peck), which is quite local in the state and seldom very injurious, has this season been committing serious depredations in scattered localities. The present year, Mr. E. J. Preston has sent under date of May 21st, examples of the caterpillar of various sizes, with some of nearly full growth. He represents them as skeletonizing the foliage in several of the orchards in his immediate neighborhood. Efforts had been made to stay their ravages through Paris green spraying. When used in several orchards by a person employed who was familiar with spraying methods, a mixture of one pound of the green and four pounds of lime to 200 gallons of water, did not seem to kill a worm. The same in 150 gallons of water was also ineffectual. A third spraying with 100 gallons of water was next tried, the result of which had not been reported.

It would seem from the above, provided that the Paris green was of the standard purity, that the canker worm is almost as resistant to the effects of Paris green as is the larva of the gypsy moth.

Mr. Preston refers to the observed habit of the caterpillar, which has been frequently noticed elsewhere, of dropping from the leaves when they have been nearly all consumed, and hanging by a thread until carried by the wind to some neighboring tree, or else dropping to the ground.

To the orchardists of Amenia the canker worm is popularly known as the "fire worm," from the appearance of the leaves after all their green has been eaten away, as if they had been swept over by fire.

The canker worm has also been reported from Moreton Farm, Monroe county, and from orchards in Wayne county, as quite common, and from several localities in Western New York. The seasonal conditions have apparently been favorable for its multiplication.

Cacœcia rosaceana (Harris).

Cacœcia rosaceana (Harris), known as "the oblique-banded leaf-roller," which feeds on an unusually large number of food-plants, has been quite abundant and destructive in apple orchards. It has been sent to me from several localities in Eastern and Central New York, as having been very injurious not only to the foliage and the blossoms but later in the season to the young fruit into which it ate rounded holes averaging one-third of an inch on the outside and larger within, and often extending to beyond their center. They attacked the fruit as soon as it had set, and continued until it had attained nearly an inch in diameter. The injury had been quite serious in the orchard of Mr. Morris Tompkins, of Germantown, Columbia county. The moths were known to him from having reared them from the caterpillars, and on June 13th, such numbers were drawn to light at night that apprehension was felt of the work of a second brood. Walsh and Riley have recorded as a habit of the caterpillar its gnawing off the rind of green apples, but I do not recall mention of its destroying the fruit by eating large holes into the interior.

Another caterpillar of larger size—of about an inch in length of a pale green color and marked with white lines and dots—is also chargeable with eating into the fruit, after the manner of the Cacœcia. I failed to rear the examples that were sent me, but it is not improbable that it may be *Nolophana malana* (Fitch). It appears that *C. rosaceana* may be in part, controlled by jarring. State Botanist Peck brought on the 18th of May, several of the larvæ which he had taken from his plum trees in jarring for the plum curculio. From one small tree, twenty larvæ fell upon the sheet underneath.

A Cecidomyid in Choke-cherries.

The galls of a Cecidomyid larva on choke-cherry, *Prunus Virginianus*, were brought by State Botanist Peck, from Bethlehem, N. Y., on May 28th. The larvæ emerged and entered the ground, but none of the flies have made their appearance.

In Keene Valley, in former years, I have found this cherry very abundantly galled by apparently the same insect, in the month of July. Many larvæ were disclosed from them, but in the several attempts made to obtain the imago, all have met with failure.

The present year not a single galled cherry could be found in the localities in Keene Valley where in other years they had abounded.

These galls have been studied by Prof. Geo. F. Atkinson, of Cornell University, in connection with a fungus attack which he found to be usually associated with them — named and described by him as *Exoascus cecidomophilus* (see Bull. 73, C. U. Agricultural Experiment Station, September, 1894). It was not ascertained by him if the larvæ attack the fruit before or after the attack of the fungus. It was thought that the larvæ attack and deform fruits which are not affected by the fungus. In this he was probably correct, as I have no recollection of the fungus presence on the galls collected by me in Keene Valley.

This Cecidomyid has not as yet been described, although it has been observed by several entomologists.

Euphoria Inda (Linn.).

The larvæ of *Euphoria Inda* (Linn.), formerly known as the Indian Cetonian, were found in large numbers beneath chip manure at Menands, N. Y., in the latter part of June. From their general appearance and from their occurrence in manure, they were believed to be the "muck-worm," *Ligyrus relictus* (Say). Examples were brought to me within the manure inclosed in a box. Not long thereafter, they were found to have eaten all of the decayed portion, leaving only the bits and pieces of chips and a large quantity of rounded pellets of their excrementa. These, together with additional ones obtained, were transferred, on July 30th, to a larger box with an ample supply of food. The box was, opened from time to time, until the 8th of August, when two *Euphoria Inda* were resting on the surface. Examination of the contents, gave the following: Two perfect beetles within their cells, one of which was on the point of emerging. Another cell gave a beetle, uncolored, having just transformed from the pupa. The remaining cells (5) contained pupæ.

The species not being recognized in its larval stage, no examples were retained for the State Collection, nor description made of it, but several of the pupæ were preserved in alcohol. I have not found any description of the early stages of this insect, nor of its larval habits. Of the latter Dr. Thomas has written : "the larvæ, probably, like those of other known species (of Cetonians), live in rotten wood, as the perfect insects are often seen flying over chip yards, probably in search of a convenient nidus for their eggs" (4th Illinois Report, page 91). From the above, taken in consideration with the occurrence of the larva at Menands, it may be inferred that chip manure is its favorite habitat.

Do the larvæ feed also on growing vegetation? State Botanist Peck from whom the larvæ were obtained, had applied some of the manure to a few hills of corn in his garden. The following day one of the hills was noticed to have been cut down, as if by cut-worms. Upon digging around the stalks, two larvæ of the Euphoria were discovered, but no cut-worms, from which it would seem probable that the grubs had committed the injury.

The Elaphidion Oak Pruner.

The oak pruner, *Elaphidion villosum* (Fabr.) is not, I believe, of frequent occurrence on apple trees, but during the first week of June, its operations were very noticeable in an orchard in Voorheesville, Albany county, where a large number of twigs and branches had been thrown to the ground by it. Some of the branches brought to me were from three-tenths to seven-tenths of an inch in diameter. Each contained the mature and active larva, within a closed cell in its burrow, prepared for pupation.

The maple-tree pruner, *E. parallelum* Newm. (regarded by many as identical with the preceding species) was very abundant in early June in the maples bordering the avenues in the grounds of Governor Morton, at Ellerslie, in Dutchess county. Not a maple was seen which had not a score or two of the recently fallen pruned branches lying beneath it, although previous gatherings had been made and destroyed.

The Asparagus Beetle.

The asparagus beetle, *Crioceris asparagi* (Linn.), is continuing its spread in the central and western counties of the State. In my Ninth Report, reference is made of its appearance at Geneva, Ontario county in the year 1884, and at Rochester, Monroe county in 1892. On June 2d of the present year (1896), Mr. A. P. Case of Vernon, Oneida county, sent to me asparagus twigs bearing numerous eggs of the beetle, and shoots eaten by the larvæ. He writes: — "The insect has appeared since Saturday last (May 30th) on all of the asparagus beds here, where they have never before been seen. Every sprout is covered with the worms, and the new seedling shoots are alive with the full-grown worms, and newly hatched ones are burrowing into the stalks. The tops of the young shoots are alive with the mature worms which eat them off as they appear. The crop is worthless for this year." During the meeting of the Association of Economic Entomologists, at Buffalo, a further western extension of the insect within our State was brought to my notice, in examples given me by Mr. Ottomar Reinecke of that city which were collected by him August 20th from wild asparagus growing in the outskirts of the city.

[On June 2d, 1897, information was received of its abundant presence in a garden at Geneseo, Livingston Co., where it was attacking the young shoots as they appeared above ground, and destroying the crop.]

The Ash-grey Blister Beetle.

The ash-grey blister beetle, *Macrobasis unicolor* (Kirby) was received (June 9th) from New York city, where it was reported as feeding destructively on a locust hedge. The young and tender leaves at the end of the branches had been eaten over the entire extent of the hedge of about 600 feet in length. They were driven away or killed when the pyrethrum powder recommended for them, was applied.

Examples of the same insect came June 25th from Factoryville, N. Y., where they were rapidly destroying the leafage of potato vines.

The Chinch Bug.

A correspondent from Almond, Allegany Co., writes that this insect *Blissus leucopterus* Say, is very thick on his new seeding and has ruined his pastures, and that it has destroyed his meadows for the past 4 or 5 years. They were working in the greater part of his 300 or 400 acres of land. Mr. Van Duzee, in his collections in Erie and Niagara counties the present year, has met with only a few scattered individuals of the species.

The San José Scale.

The San José Scale, *Aspidiotus perniciosus* Coms., has apparently found the climatic conditions unsuited to its establishment in all except the extreme south-eastern part of our state. Its existence in a few localities has been reported to me, but in each instance another scale has been mistaken for it. At the Kinderhook locality where it was first discovered in the Hudson river valley, it has been nearly exterminated. Recently its presence was suspected by the owner of the orchard, Mr. Morrell, where it had been found abundantly two years ago, but on examination, the scale proved to be the rather closely resembling one, *Aspidiotus juglans-regiæ* Comstock. An examination of the orchard showed no living San José Scale, but later, a single living specimen alone on a twig, was brought to my office by Mr. Morrell.

A neighboring orchard in Kinderhook was reported as badly infested with the scale. On examination in July, by Mr. E. P. Felt, my assistant, the scale was found in abundance on plum trees of apparently ten or twelve years' growth, but upon perhaps twenty trees that were carefully examined, not a single living scale was found. The trees had not been treated for the scale, and it is therefore probable that the insect had been winter-killed. How long they had been upon the trees, or the source of the infestation, was not learned, but the age of the trees would indicate that the pest had not been introduced on nursery stock. The orchard was within one fourth of a mile of that of Mr. Morrell, and it is highly probable that it had been carried from there upon birds or insects.

The scale has also been reported to me recently (in August), from another locality in New York, in the valley of the Wallkill river—a tributary of the Hudson river. A few fruit-trees in an orchard in Middletown, Orange county, are stated to be infested with the scale—the trees having been received from a New Jersey nursery. Inquiry was promptly made of the owner of the orchard of the extent of the infestation with proffer of assistance if needed, but no reply having been received, it is probable that the infested trees were promptly destroyed, and that the spread of the insect was not feared.

The Oak Kermes.

The peculiar oak-kermes, *Kermes galliformis* Riley (Pl. V, fig. 1), which bears so marked a resemblance to a gall as to be mistaken for it by everyone not acquainted with it, may not be rare when one knows where to look for it, but it has always been a rarity in my own experience. One of my correspondents, Mr. W. R. Walton, of Middletown, N. Y., has been fortunate in his collection of it and has kindly contributed a number of examples to the State Collection. He also has been successful in breeding from it the beautiful Lepidopterous parasite, *Euclemensia Bassettella* (Clemens), with which it is so frequently infested and of which he has made excellent colored drawings in its several stages (Pl. V, figs. 2–7). From Kermes taken from scrub oak in the latter part of December, he obtained the moth toward the last of the following June. The larger number of the mature Kermes were found to be infested by the parasite.

The Elm-Tree Bark-Louse.

Gossyparia ulmi (Geoffrey), an European Coccus, feeding on most of the varieties of the European and American elms, was first noticed in this country at Rye, Westchester county, N. Y., in June of 1884. (See Howard in *Insect Life*, ii, 1889, pp. 34–41). Examples of it were brought to me from Marlboro, Ulster county, in July of 1888. Since that time, it appears to have become distributed in different portions of the State, and to have planted itself in several localities in the vicinity of Albany. In May and again in June, it was brought to me from Loudonville, Albany county, and in June of the same year, from two places in the city of Albany, and also from Catskill, Greene county, 40 miles to the southward.

In June of the present year, Mr. J. B. Washburn, brought a limb of elm from his grounds at Delmar, Albany county, bearing dense patches of the Coccid. It was blackened to a degree that indicated the abundant presence of the insect the preceding year. The tree — a young one — of about three inches diameter of trunk, was infested both upon the trunk and the limbs. Other elms upon his grounds were not infested. The scales were apparently about full-grown, but no young had yet been given out.

A large number of trees in the city of Albany, are at the present time (in August), showing severe and injurious attack from this insect. The leaves are blackened by their secretions, and some of the branches whitened by their abundant presence. Their larvæ, about half-grown, are to be seen in large numbers in the crotches of the smaller twigs, on the lower surface of the leaves, and in the crevices of the bark. The infested trees are mainly the Scotch elm, *Ulmus montana*.

The insect is also quite generally distributed in Troy — six miles to the north of Albany, where in combination with the attack of the elm-leaf beetle on *Ulmus montana*, it is threatening destruction to many of the trees. It also occurs at Menands and Watervliet, between Albany and Troy. The infested trees can be recognized at a distance by the blackened appearance of the limbs and foliage.

PHYTOPTUS ? PRUNI (Amerl.).

Leaves of a Chickasaw plum, received the middle of May from a correspondent in Muncy, Pa., had numerous mite galls scattered over their surface, on both their sides. On the lower surface they are of an elongate purse-like form, and give out from their sides some short white hairs resembling mould: on the upper surface they are rounded and completely covered with longer white threads. Within the galls, a powerful microscope showed a minute transparent four-legged mite — the architect — apparently in an early stage of growth. The mite, if we may judge from the characters of the gall that it produces, is identical with an European species, known as *Phytoptus pruni* Amerl., and which has not, we believe, been previously detected in this country.

(B)

ENTOMOLOGICAL ADDRESSES.

THE MOSQUITO.

[Read before the Dana Natural History Society of Albany, May 14, 1887.]

Strange as it may seem, the common objects in nature surrounding us on every side and ever at hand, are those of which we frequently know the least. Day after day throughout our lives many, if not most of us, pass along the streets without knowing the nature of the stones we tread upon, the names of the trees that throw their grateful shadows over our pathway, or of the birds or insects that fly around us. If the cultivated mind may find "sermons in stones, books in the running brooks," surely volumes of intense and absorbing interest are to be found in the interpretation of the vegetable and animal kingdoms, in their infinitely varied forms, their complicated structure, their wonderful transformations and peculiar habits: and how much do we lose from our inattention to these common objects — the almost constant presence of which before our eyes is a perpetual invitation to their observation and study, and a rebuke for their neglect.

I have chosen for my topic of this afternoon paper, one of these common objects—a very common insect, with which, perhaps, you may think yourselves sufficiently familiar, while, in reality, knowing next to nothing of it. And if I shall succeed in showing you that the mosquito, perhaps the most universally obnoxious of our insect pests, possesses many attractive features and has its beneficent uses in nature, you may feel inclined to extend to it henceforth some degree of toleration, and even to honor it with a little attention. Yet I shall not expect that even the enthusiastic members of the Dana Natural History Society will be wrought up to such a state of ecstasy in its contemplation that they will adopt the sentiment of a distinguished naturalist of the past century—"it is impossible to behold and not admire the amazing structure of the mosquito's sting: one undergoes with pleasure a puncture that enables us to observe how this wondrous piece of mechanism works."

The Common Name.

Mosquito is a Spanish and Portuguese word, and is probably the diminutive of the Spanish *mosca* fly. Its orthography varies, it being given by Webster as m-o-s-q-u-i-t-o, m-u-s-q-u-i-t-o, m-u-s-k-e-t-o. For the last phonetic mode of spelling, I have a decided preference, and would gladly see it adopted were it not that the orthography approved by Webster of m-o-s-q-u-i-t-o, is sanctioned and sustained in its employment as the specific name of one of the species of the genus *Culex*, and scientists do not feel at liberty to change a single letter in a specific name once given and accepted, except under a few prescribed conditions. Another mode of spelling with which we sometimes meet, is m-o-s-c-h-e-t-o, the authority for which I do not know.

The common name, as is often the case with unscientific names, does not define the insect intended. The insects which in the United States are known as mosquitoes, are popularly known in England and also written of, as gnats. By some writers, the blackfly — the terror of the Adirondack tourist in early summer, has been claimed as a mosquito, while in reality it belongs to a family — the *Simulidæ* — quite removed from the *Culicidæ*. The Portuguese, in Brazil, are said to apply the name to a small species of Simulium or black-fly.

Its Place in Classification.

The mosquitoes and associated gnats belong to the order of Diptera, or two-winged flies, and to the family of *Culicidæ*, so named from its principal genus, *Culex*. This family from the high degree of development of its mouth parts, has been placed near the head of the Diptera, as are the *Cicindelidæ* or tiger beetles at the head of the *Coleoptera*. The principal characteristic of the family, is its long and slender beak or proboscis, nearly half as long as the insect, appearing as a simple organ, but really composed of several pieces, peculiarly fitted for their function of forcing their way into the flesh and drawing blood therefrom.

The mosquito, is not, as its popular name would seem to imply, a single species. There are a number of distinct and well characterized species, which have their special haunts, different degrees of annoyance, and different seasons of the year devoted to their forays. Even in that season when the entire insect world out of doors is generally supposed to be indulging in its sleep of months preparatory to its spring opening and summer campaign, we are not left wholly without representation of this intrusive family, for the winter months may bring us occasional visits — fortunately they are rare — from *Culex hyemalis*, the winter mosquito.

All of those which are grouped in the family of *Culicidæ*, may properly be regarded as mosquitoes, as they are closely allied in structure and in habits.

Number of Species.

Although exceedingly numerous in individuals, occurring at times in localities in swarms so immense that they have been mistaken for clouds or smoke, the *Culicidæ* are not very numerous in species. In a catalogue by Mr. Walker, formerly of the British Museum, published in 1874, one hundred and fifty-eight species from all parts of the world are given. Of these, the North American species comprise about one-fourth of the number, for in the last published catalogue, that of Baron Osten Sacken, in 1878, forty-two species are recorded as belonging to North America, arranged in the five genera of *Megarrhina*, *Culex*, *Anopheles*, *Aëdes* and *Corethra*.* The specific names that designate many of these have a merit that does not always attach to our scientific nomenclature — that of being appropriate and characteristic. For example, we find the following names in the list of species of Culex, each one of which we may presume, has been bestowed after experimental test of its fitness, as they lead us up the gamut by harmonious gradations from the initiative *Culex punctor*, to *pungens*, and on to *stimulans*, *perturbans*, *provocans*, *impatiens*, *implacabilis*, *excitans*, *excrucians*, and culminating in *Culex damnosus!* The last is applied to the notable "gallinipper" of the southern swamps, which is said, but I do not vouch for the truth, to be capable of boring with its proboscis through a leather boot.

It is not probable that in the numbers above given, we have an approximation to the real number of species. The family, for some reason, has been but little studied. When I applied a short time ago to the gentleman who is the best authority that we have among us on the Diptera, for the names of a few of our more common species represented in my collection, he was unable to determine them for me. Another of our distinguished entomologists who enjoys a brilliant European reputation from his long residence in Europe could not decide the question which I propounded to him—does *Culex pipiens* of Europe, the type of the genus, occur in North America, to which it has been credited.

Distribution.

Every known part of the globe has its peculiar species of the mosquito. They are endowed with power to resist any degree of cold and to endure extreme heat. They particularly swarm in the tropics where they often

* Dr. L. O. Howard, in a paper published the present year (1896), has recorded twenty species of mosquitoes belonging to the United States, which had been examined by D. W. Coquillett, of the Division of Entomology at Washington, accompanied with a list of ten additional species, which had not been examined for verification. (See *Bull.* 4, *New Series*, *U. S. Dept. of Agricul.*, *Division of Entomology*.)

render life a burden. In the frozen regions of the north where winter reigns, their numbers have been compared to a snow-storm when the flakes fall thickest, or to the dust of the earth. There are localities which they are entitled to claim as their own, for explorers have been driven back in agony from the attempt to penetrate them. To other localities they have given name, as to Mosquito, a township in Illinois; Mosquito, a village in Newfoundland; Mosquito Creek in Indiana, another of the same name in Iowa, and still another in Ohio; and the Mosquito Country of Central America. In certain districts of Louisiana and other of the Southern States, their abundance diminishes by one-half the value of the plantations. Those who have traveled in summer on the lower Mississippi or in the Northwest, have experienced the torment which these frail flies can inflict: at times they drive everyone from the boat, and trains can sometimes be only run with comfort on the Northern Pacific railroad by keeping a smudge in the baggage car and the doors of all the coaches open to the fumes. "The bravest man on the fleetest horse dares not to cross some of the more rank and dark prairies of Minnesota in June" (Riley). The marsh lands of New Jersey and portions of Long Island, you will remember are particularly noted for their abundance, and the frequenter of the Adirondacks knows of their powers of annoyance, as they compel him if particularly sensitive to their sting, to seek relief in flight.

It would seem that our English cousins have much less to endure from this tormenting pest than we, for Professor Westwood has written: "The mosquito is far more annoying in its attacks upon the inhabitants of America than our European species is to us; it is there requisite to have their beds inclosed in a curtain of fine gauze to defend the sleeper from their attacks." The Rev. Mr. Kirby, in his delightfully fascinating work entitled "Introduction to Entomology," after a graphic recital of the torments endured in various parts of the world from the mosquito's poisonous sting, and the inferential conclusion that it were "a lesser terror that the forest should resound with the roar of the lion or the tiger than with the hum of the gnat," closes with this pæon of gratitude: "With what grateful hearts ought the privileged inhabitants of these happy islands to acknowledge and glorify the goodness of that kind Providence which has distinguished us from the less favored nations of the globe, by what may be deemed an immunity from this tormenting pest!" Evidently the fogs of England and London smoke are not agreeable to the mosquito.

Means of Protection.

In that portion of the world which we occupy, and in the localities where this insect occurs in annoying numbers, comparative immunity from its attack is attainable by the use of mosquito nettings, but there are countries where these luxuries are not procurable, nor would their employment afford the desired protection. The inhabitants of some of the districts of Brazil, at certain seasons, can only obtain sleep at night by burying their bodies several inches beneath the sand, and covering their heads with a thick cloth. On the west coast of Africa the natives swing their hammocks from elevated posts with fires burning beneath them to repel the insects with the smoke and heat. In Guiana the poorer classes find a degree of protection in covering their bodies with paint and varnish. Russian soldiers in the neighborhood of the Crimea resorted to sleeping in sacks as a protection, but this served only as a palliative of the unendurable torments to which they were subjected by the attacks of the insatiable blood-suckers of that region. In Lapland, a writer states, that it is impossible to eat or sleep or keep a light burning in the hut without constant fumigation, and the additional resort to a coating of the exposed portion of the person with rein-deer cream, rancid fish-oil and tar.

For the benefit of those whose summer wanderings may lead them into the haunts of the mosquito, under circumstances when heavy gloves and veils and nets may not be conveniently worn, I would state, that when the annoyance becomes too serious to be longer borne, protection may be procured by making oneself disagreeable to the mosquito through means not quite so pronounced as that to which the Laplander resorts, but by applying to the hands and face a small quantity of oil of tar combined with a little carbolic acid. This is, perhaps, the best application that can be used, as a preventive of mosquito attack under conditions above named.

Severity of the Bite.

The effects of the bite vary greatly in different persons. There are those who are scarcely affected by it, and indeed are rarely bitten, either by this insect, the bed-bug or the flea, although in situations exposing them to attack and with their companions suffering from the infliction. I have no explanation to offer for the attractiveness of some persons for these pests and the reverse in others, but it would seem that it might result from some peculiar emenation from the person, as no attempt is made to draw the blood or pierce the skin of those exempt from attack.

While in some, only a slight and brief irritation follows the bite, in others, the well-known itching sensation becomes intense, and is accompanied with serious inflammation and swelling which may be continued for several days. Again, the resultant effect of the bite often depends upon the general condition of the system at the time, and upon the particular portion of the person where it is received. I do not know of any fatal result attending the bite of a single mosquito, but we have a well-authenticated instance where death ensued as the consequence of the sting of a hornet inflicted in the scalp of a bald head.

When the occasional mosquito, which we find a trial, is multiplied a thousand-fold, the wounds against which the victim is powerless to defend himself, become a most serious matter. The swollen hands almost lose their service; the bloated face scarce admits of recognition. Mortification of the limbs has ensued, rendering amputation necessary, and cases are recorded where death has resulted. Professor Jeager relates that on one occasion when traveling on the banks of a river in Russia, his servant was driven to such a degree of madness by his sufferings from the dense cloud of mosquitoes in which they were enveloped, that he was only prevented from shooting himself as an escape from his misery, through the united strength of two athletic Cossacks.

The severe stinging sensation and subsequent inflammation and itching of the bite, is owing to a poisonous fluid injected into the wound through the proboscis at the time of its insertion to affect the blood and cause it to flow more readily. This opinion, advanced by Reaumur long ago, was for a long time held as probable. Very recently, however, it has been verified, by Dr. Macloskie, of Princeton College, New Jersey, in the discovery of two poison-glands, the duct through which it is conveyed into the hypopharynx and the escape of the fluid, in oily globules from an aperture near the tip of that organ which is subapical like that in the rattlesnake's fang, so as not to weaken or impair the delicacy of its point.

Of the effects of this poison, and the reason for believing in its existence before it had been demonstrated, Dr. Dimmock, has written as follows: "After having experimented a large number of times with the living mosquito, I am convinced that there is use made of a poisonous saliva; for, when biting, if the mosquito fails to strike blood, which it often does on parts of the back of my hand, although it may have inserted its proboscis, nearly full length, in from one to six directions in the same and withdrawn it, yet, in such cases, if no blood be drawn, no more effect is produced upon my skin than is produced by the prick of a sharp needle — a red point appears only to disappear in a few hours. Certainly there has been as much tearing of tissues in such a case as the above mentioned, as there is, when Culex settles on a place rich in blood, and, with a single probing, draws its fill. The amount of poisonous effect upon me, as proved by numerous experiments, is in direct proportion to the length of time the Culex has occupied in actually drawing blood. The above-mentioned facts would indicate a constant outpouring of some sort of poisonous fluid during the blood-sucking process."

Palliatives of the Bite.

Various applications have been recommended and are employed to alleviate the effects of the bite, such as vinegar, lavender water, salt and water, spirits of camphor, ammonia, etc. Pressing the puncture and forcing out some of the blood, and with it the injected poison, has also been prescribed, but beyond doubt the best method that may be adopted is the following: When the bite is first felt, resist the natural impulse to crush the creature and stoically endure the trifling pain, while you add to the stock of your entomological knowledge by critically observing the extreme delicacy and the entire *modus operandi* of the performance, particularly noting the disposition made of the sheath while the contained case of instruments are being buried in the flesh. A brief period of forbearance will suffice to fill the abdomen of the skillful phlebotomist to its utmost capacity—the gradual enlargement and the deep purpling of which through its thin and distended walls you may watch. The fill obtained, the lancets will be leisurely withdrawn and repacked in their case, and with the prolonged draught taken through them most of the injected poison will have been withdrawn. If you are not able at this juncture to say with Sterne's Uncle Toby, " go, poor insect, the world is wide enough for you and me," then, if your study has failed to repay you, revenge yourself in her death as she assays with her stolen burden to fly slowly away. If you terminate her existence while the lancets are buried in your flesh, their barbed ends together with most of the poison will remain in the wound to irritate and exact of you the penalty of a wasted opportunity and an unscientific proceeding. You might, at least, if you feel that you have no contribution to make to Madame, intimate to her by a gentle touch of the finger, that it would be quite as agreeable to you if she would present that little bill somewhere else. A million lessened by one, would aid but slightly in the extermination of the species in your immediate vicinity.

The Female only, Bites.

I would not be thought as reflecting in the slightest — even through innuendo — upon the gentler sex — "Heaven's best gift to man" — without whose presence Eden was incomplete; but a proper treatment of my topic and inexorable science demands of me the statement to which the use of the feminine pronoun has been leading me up and preparing the way, to wit: all the annoyances, pains, tortures, which the world endures from the mosquito, is solely chargeable upon Madame Culex. I cheerfully admit that the natural taste of Mr. Culex may be equally blood thirsty, but alas, poor creature! he has been left without the means of gratifying a sanguinary desire. He is, therefore, compelled to forego the exquisite relish of the royal repasts in which his consort finds so great delight, and be content with the juices of plants and the nectar of lilies, and of other flowers to which he is particularly addicted. He has not been favored by nature with that delicate and complicated piece of apparatus which is so admirably adapted, as has been graphically expressed, to being driven "through crushed and bleeding capillaries, shrinking nerves and lacerated tissues." With a becoming humility, therefore, he rarely visits us in our apartments, or even obtrudes his presence upon us when we seek his haunts; and few of us know of the branching plumes, fit for a knight, that adorn his front and make him far more beautiful than his unpretentious mate.

The Biting Organs.

By this time you may desire to be told something of the character of the biting organs of which the effects have been related to you.

Let me preface by stating that the mouth-parts of insects consist, normally, of six pieces, viz., four lateral pieces consisting of a pair of upper jaws denominated *mandibles*, a pair of lower jaws named *maxillæ* (which in biting insects that feed on solid matter move horizontally), an upper lip known as the *labrum* and the lower lip, the *labium* — these two covering the mouth from above and beneath. Some of these bear appendages which need not at the present be referred to. These organs, of course, are greatly modified in the different orders of insects, to adapt them to the different methods of taking their food — whether fitted for gnawing or tearing in pieces solid substances, as in the beetles — transformed into a sucker with expanded disc for sipping its food as in the house-fly — extended into a long, flexible tube coiled up in a spiral when at rest, for drinking the nectar from the bottom of tubular flowers, as in the butterflies, or forming a long, firm, jointed proboscis for thrusting into plants or animals through which to draw their juices, as in the Hemiptera or bugs. These parts exist in all insects, although at times some of them may be but rudimental. The mouth-parts of the female Culex represent all of these typical parts of different insects, and in the formation of its proboscis, two other organs unite (as in most of the Diptera) which are the pharyngeal sucking organs, named the *epipharynx* and the *phyopharynx*.

It therefore appears that the proboscis of the mosquito, which in its normal condition seems but a single piece, upon dissection or close examination is found to consist of seven distinct pieces—eight pieces in reality, but two so combine as to form one. Some authors have stated the number of pieces at four, five, or six, but there certainly are as many as seven in *Culex pipiens*, *C. ciliatus* and *C. rufus* which have been carefully studied, and it is not probable that the number will be found to differ in other species when examined.

These pieces are shown in the accompanying figure. The upper piece, pointed and gradually tapering from the base to the apex, is the *labrum-*

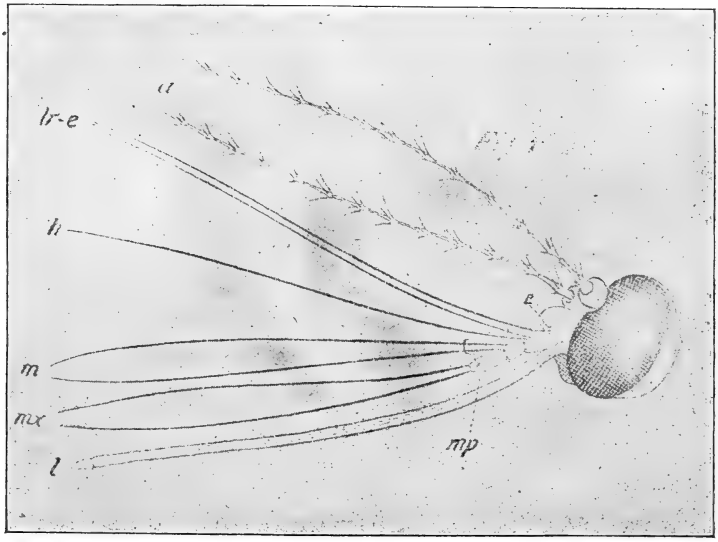

Fig. 9.—Mouth parts of the mosquito, lateral aspect. (After Dimmock.)

epipharynx, made up by the close union of the *labrum* and the *epipharynx*. Below it is the *hypopharynx*, a linear, lanceolate, transparent plate, having a longitudinal rod (appearing as if tubular in some species) traversing it in the middle, through which, it is thought, the poisonous fluid which we have referred to is conveyed into the wound. With these two pieces pressed together, a channel is formed through which the blood passes as it is pumped up by the sucking-bulb, located in the head. The mandibles are the most delicate of the mouth-parts, consisting only of thin, linear-lanceolate blades of transparent chitin, slightly tapering in their width from their base outwardly. The existence of very fine serrations on their upper part (about forty-two on each) has lately been announced.*

The *maxillæ* are tapering, transparent blades of chitin, thickened on its upper edge and apparently toothed or serrated at the tip. Careful observation with a powerful microscope shows them to be not serrated at the edge, but the apparent teeth—about fifteen near the tip of each, are really papillæ placed on the upper surface of the blade. Aided by these papillæ, the service performed by the maxillæ is doubtless to draw the other mouth parts into the skin, as a slow gliding motion may be observed in first one and then in the other as all the parts are gradually buried. They are provided with muscles appropriate for the purpose.

The *labium* is the largest of the mouth-parts. It opens along its upper side in order to receive the other parts and to serve as a sheath for holding and protecting them when not in active use. When the proboscis is to be inserted, it acts in this manner: Its tip, consisting of two lobe-like appendages called *labellæ*, is closely pressed upon the surface. At once it is seen to bend backward or downward at the middle, releasing the contained parts—the setæ—which are held firmly together as they are driven into the flesh, guided and kept in place by the above named *labellæ* serving as a pair of fingers for the purpose. As they penetrate deeper and deeper, the labium or sheath bends more and more until when they have been buried to nearly their entire length — from having been at first elbowed, it is now bent double beneath the body.

The operation as above described is an exceedingly interesting one to watch. The labium is easily recognizable in any female mosquito that you will examine, appearing as a long projected beak, nearly as long as the abdomen, clothed with dark colored scales, and extending in front of the two delicately feathered antennæ given out from between the two large black eyes.

The relative position of the mouth-organs which I have briefly described, and the manner in which they are arranged in the sheath, may be

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***American Naturalist*, xxii, 1888, p. 884.

understood from an examination of the accompanying figure, which represents a transverse section through the proboscis of the female at about its middle.*

The labium is seen wrapping itself nearly around the other parts. Above it lie the two maxillæ, partly inclosing the parts above it. Above them are the two mandibles, and above these, centrally, is the hypopharynx, with its thickened, middle, supposed saliva, channel. Above this is the labrum-epipharynx — the epipharynx of an omega-form, having the labrum closely attached to it. With the labrum-epipharynx slightly brought from its position as shown for convenience in the figure, so as to rest on the hypopharynx, the channel for the passage of the blood, as has been described, is formed. In the continuation of this sucking-tube into the head, "in the posterior part of the head, it is enlarged in a large pumping-organ, which forces the imbibed fluid backward into the œsophagus and stomach" (Macloskie).

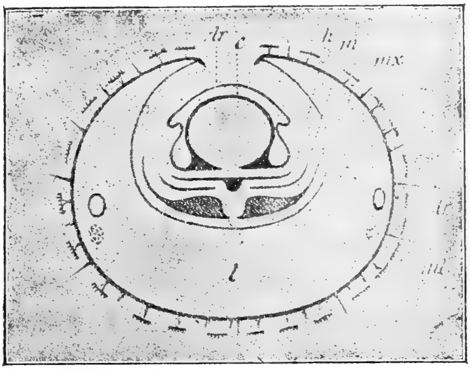


Fig. 10.—Mouth parts of the musquito, cross-section. (After Dimmock.)

Uses of the Mosquito.

I have spoken of the mosquito as the most universally annoying of all our insect pests. Why then, it may be asked, was it created, and does it serve any possible good in the economy of the world?

The naturalist, as his acquaintance with nature becomes more extended, and the range of his studies widens so as to open up to him an insight into the interdependence of all animated nature, is led to accept the belief that nothing was made in vain, and that not a single one of the typical forms now in existence could be withdrawn without breaking the chain that binds all nature together in one harmonious (if properly interpreted) whole. This belief brings to him a faith that compels him to accept as of use whatever object owes its existence and preservation to the hand of its Creator and Guardian, although in his limited knowl-

* This and the preceding figure are copied from Plate 1 of *The Anatomy of the Mouth-parts and of the Sucking Apparatus of Some Diptera*, by George Dimmock, Boston, 1881.

edge, he may not be able, in all cases, to assign the purposes for which it was made.

Do not misunderstand me. I do not object to the destruction of noxious animals when our lives are endangered by them, nor to a very great reduction — even to the extreme extent of our ability — of the overwhelming numbers in which some of our insect enemies present themselves, depriving us of comfort, withholding from us luxuries, and robbing us of material wealth and at times of the necessities of life. To such a reduction, my studies and labors as you know, are being constantly directed. But it is only against excessive numbers that the economic entomologist contends — an excess that did not exist when first "God saw that all was good" — which could not exist under the operations alone of the laws of nature, but which do exist as the result of the unnatural, excessive, and often improper demands of our present form of civilization and society. Briefly, it is right and proper to restrain; it would be wrong, we think, had we the power to utterly exterminate.

But to return to the question. We do know one purpose which the mosquito serves, and one of considerable importance in a sanitary point of view. It serves to purify standing waters and to a great extent to lessen their malarial influences. The natural habitat of the larval mosquito is the stagnant water of our miasmatic swamps. The entire food of the creature from its birth to its maturity is believed to consist of the decaying vegetable matter which is here found in abundance, together with other impurities which it draws from such waters. Its agency in the purification of standing water may be easily shown. If during the summer months two barrels of rain-water be placed side by side — the one open to the atmosphere and the other covered with a thin netting, the following result will be obtained: The open one, after a few days has elapsed, will be found to abound with the larvæ and the pupæ of the mosquito, and its water sweet; the other, the netting of which prevented the visits of the mosquitoes for the deposit of their eggs, and consequently without larvæ, will have become foul and offensive.

We need not refer to an important role which the insect in its superabundance plays, as food for fishes, since that is but in accordance with a seemingly universal rule controlling all of the lower orders of animated nature, viz., "eat and be eaten."

In view of this general law, seemingly fraught with so much suffering, how fortunate it is, we may remark incidentally, that many of the lower orders which are doomed to a perpetual sacrifice to the Moloch, appetite — insects, for example — have organisms so constituted that they are almost without a consciousness of pain. Thus the rapacious dragon-fly — the hawk of the insect world — would quite as readily eat its own abdomen, as actual experiment has shown, could it conveniently be brought within range of its powerful jaws, as to indulge in its favorite and ordinary mosquito diet.

Newspaper authority — not always the best in matters of science — has lately (last year) given us another mosquito "boom," in the announcement of the discovery that the Cuban mosquito was about to signalize a great advance in the science of Therapeutics — to serve no less a purpose than an effectual preventive of the fearful disease of yellow fever. The method of protection was simple in the extreme. A bottled mosquito must be applied to the person of a yellow fever patient and permitted to imbibe a little of his blood. Transferred, after a few hours, to the arm of the individual to be protected, the virus received would be conveyed with or through the proboscis, and a successful and complete vaccination against yellow fever will be accomplished.

The Mosquito as a Filaria Host.

If the above be only a fanciful conception of some "newspaper man," as it possibly may be, the fact that the mosquito may communicate disease, or aid in its distribution, rests on a scientific basis. Some recent anatomical investigations of a species known as *Culex mosquito* inhabiting tropical regions, have shown it as serving a most unexpected purpose in acting as an intermediary host in the life-development of a thread-like worm,—a species of *Filaria*. This hæmatozöon, bearing the name of *Filaria sanguinis-hominis*, is found in its immature or larval stage in the blood of persons afflicted with elephantiasis and some of the allied diseases which are endemic over the more thickly populated tropical portions of the world.

Before the filariæ can undergo their full development they have to enter some other organism quite different from that occupied by their larvæ. The female mosquito above named (and probably other species also) acts as the host in this instance. As she drinks the blood of the diseased person, she imbibes with it the larval filariæ. Within her abdomen they undergo further transformations. Six distinct stages have been recognized within her. As she returns to the water for the deposit of her eggs—with her death occurring soon after oviposition, the filariæ which she bears in their perfected stage, are consigned to the water. In drinking the water, the parasites are received into the human stomach, from which they pass to, and enter, the lymphatic vessels, and by their presence, under suitable conditions, produce the painful, loathsome, and often fatal disease of elephantiasis. (See Science, for May 18, 1883, i, pp. 419-420, for an extended notice and illustration.)

The Mosquito Perhaps One of the Ten Plagues of Egypt.

Professor Westwood, of London, an eminent entomologist, and the author of a volume on insects of such exceeding value that it is known as "The Entomologist's Bible," has endeavored to show that the mosquito was the insect that composed the "swarms of flies" that were sent upon Pharaoh and his people as one of the *ten plagues of Egypt.* In evidence of this, he cites the expression "swarms of flies," and remarks: "We are sure that every one who has seen a swarm of gnats at eventide, will perceive the aptness of the expression, supposing the Egyptian fly to be a species of gnat, or in other words, the mosquito. We next read of their making their way into the houses, which shall be full of flies. This is also precisely the habits of the *Culicidæ.*" The distinguished Doctor of Science (like an eminent Doctor of Divinity of our own city), evidently favors "a reduction of the miraculous in the Bible to the minimum," and a non-resort to a miraculous interpretation of such phenomena as may be explained by natural causes; for he finds the fullest corroboration of his view of the mosquito being the plague insect, in the fact that the land of Goshen, in which the people of Israel dwelt, was to be exempt from the swarms of flies that invaded the land of the Egyptians. The latter, he remarks, was subject to a periodical overflow of the Nile — a condition most favorable to the production of mosquitoes; while the land of Goshen, was not overflowed and was a sandy soil entirely unsuited to the mosquito, and even at the present time, a favorite place of refuge for cattle from its attack.

Others, who have written of this plague, entertain different views — among which, Rev. Mr. Kirby, finds strong evidence of its having consisted of cockroaches. Opinions might differ as to which would be the greater plague.

Eggs of the Mosquito.

The transformations of the mosquito, to which we now pass, are of much interest, as I hope to be able to show you.

While the eggs of a large proportion of our insects, either from their form, color-markings, sculpture, or manner of deposit, offer many attractive features, those of the mosquito possess special and unusual interest from the singular disposition made of them.

The individual egg is of an elongate-oval form, rather pointed at the upper end, broader at the lower. They are deposited in a mass, on the surface of the water, in the form somewhat of a boat, and left to float freely about. The little egg-boat, not exceeding a tenth of an inch in length, yet bearing nearly a hundred lives, is built in the following manner: The insect takes her position on some object in the water—a floating leaf or stick it may be—holding to it by her anterior legs, while her long abdomen rests on the water with its tip slightly elevated. Crossing her posterior pair of legs (which are much longer than her body) behind her in the form of an x, she places an egg in a perpendicular position at the point of crossing—the inner point, nearest the tip of her abdomen: this forms the keel of the boat. To this two eggs are next attached in the form of a triangle. The eggs are coated with a glutinous matter, causing them to adhere closely and firmly to one another. Successive additions are made to these in a gradually enlarging outline, as regulated by the angle or curve formed by the legs. When the boat is about half built, the legs are uncrossed and placed side by side underneath for better support, and in this position the remaining portion of the boat is completed in a symmetrical form, although unaided by the eye and only guided by the delicacy of touch. When finished, the supporting legs are withdrawn, and the tiny craft is launched, and left to be driven about hither and thither by the winds, yet ever drifting securely, without the slightest risk of sinking to the bottom or of being overturned. For experiment's sake, you may place one in a basin of water and pour gallons of water on it, without being able to overturn it. You may even thrust it by force to the bottom of the vessel, whence, as soon as released, it will rise to the surface, right side up and not holding in its concavity a particle of fluid. It is a veritable life-boat.

The Larval Mosquito.

The eggs hatch ordinarily in from two to three days, dependent, of course, on the temperature of the water. The larvæ that they produce are familiar to all who have been in the habit of using rain-water during the spring or summer months which had been exposed to the open air for a few days. Children living in the country often know them under the appropriate names of "wigglers" or "wrigglers," drawn from their peculiar jerking motions as they come to the surface of the water to draw in a supply of air and to hang motionless, head downward, for awhile, or with the same motion descend to the bottom to feed. They have a distinct rounded head with mouth-parts, antennæ and ciliated appendages, an enlarged thoracic region, and a long ten-jointed abdomen, slightly tapering, with each segment bearing bundles of hairs. From the eighth abdominal segment a long tubular organ is given out, ending in a star-like structure bearing a number of ciliæ. This is its organ of respiration—all the air that it receives being supplied to the tracheal vessels only through this opening. The terminal joint of the abdomen bears five conical plates which are used in its locomotion.

The Pupal Mosquito.

After several moltings, while they rapidly increase in size, the larvæ enter upon their third stage of existence, in assuming the pupal stage. At this time they present an uncouth aspect. Their thoracic region has become greatly enlarged, and in front of it are grouped, in separate cases, the legs, wings, mouth-parts and antennæ. They still continue in an active state, unlike the quiescent pupal condition of many insects, and even many other Diptera — but they are incapable of feeding. A striking and interesting change has taken place in their breathing apparatus. They suspend themselves from the surface of the water, as before, for respiration, but the air is now taken in through two horn-shaped organs proceeding from the upper part of the thorax. Before, they hung head downward; now, as they have made a material advance in development, more fittingly, head upward.

In about two weeks, usually, from the deposit of the eggs, the pupal stage is completed, and the insect is prepared to enter upon its final state, a perfect, winged insect. With so brief a period required for its development, you will perceive that there is ample time for several generations of the insect during the spring and summer months.

The Final Development.

The pupa having fully matured, it rises to the surface of the water where it floats with its thorax elevated above the surface. Exposure to the air dries the exposed portion, and, aided by movements within, it splits along the middle line, and the head and thorax of the inclosed insect are thrust out. Slowly the wings, legs, other organs and abdomen are drawn forth through alternating muscular extension and contraction—all the while balancing itself in an upright position with the utmost care, for the problem of how to maintain the center of gravity when elevated so high above its frail and unstable base must necessarily be an exceedingly difficult one—it would seem to be an impossibility. The slightest excess of lateral deviation, either from defective instinct or from a current of air, is at once fatal. The float—a mere transparent film—with its occupant, is thrown upon its side; the wings are wet and no longer serviceable, and the new life just opening, is ended. This fatality is common—indeed it is represented as the rule—the contrary, the exception. Each such occurrence, although a tragedy, need not evoke our sympathy although so oft repeated. Food is thereby furnished fishes and other living forms, and there will always be quite as many mosquitoes left as are required for sanitary uses.

With those that are so fortunate as to escape this perilous evolution, a short time suffices for the expansion of their wings through the entrance into their veins of air and blood, and to dry and fit them for flight. Just the manner in which the pupal-case is abandoned, is not definitely known; it may be with the feet resting upon its edge; or it may be as represented in some illustrations, that, carefully preserving its equilibrium, the insect bends forward and rests with its fore-legs on the water—a moment passed, perhaps, in admiration of the delicate form mirrored therein—when the wings are spread, and with their rapid vibration of five hundred beats a second emitting music though familiar yet not sweet to human ears—it launches forth into its new element, in quest, as it may be, of nectar, or of blood.

The mosquito is gone! Are you not glad, for with her flight ends my paper.

[Those who would like to consult some recent publications and studies upon this interesting insect are referred to the following:

HOWARD: in Bull. 4 N. Ser., U. S. Dept. Agricul., Division of Entomology, 1896, pp. 9-24, figs. 1–4.

LUGGER: 2nd Rept. Entomol. St. Exper. Stat. Minn., 1896, pp. 182–195, figs. 152–158.

OSBORN: Bull. 5 N. Ser., U. S. Dept. Agricul., Division of Entomology, 1896, pp. 25–30, figs. 1, 2.]

A PLEA FOR ENTOMOLOGICAL STUDY.

[Read before the Agassiz Association of the State Normal College, Albany, May 18, 1894.]

The Association which I have the honor and privilege of addressing, I have the right to believe, from its connection with an institution which, in the annals of education, has won an enviable reputation for the careful, systematic and thorough training it aims to give to all its pupils — is not only desirous of promoting to the extent of its ability investigations in various departments of Natural History, but that it is also able to do excellent work and render good service toward this desired end.

I therefore esteem it a privilege to appear before you to-day, and ask your earnest co-operation in that department of study in which I am specially interested, and to which so large a portion of my life has been devoted. I appreciate, to some degree at least, the almost infinite extent and variety of the Museum of Nature. On every hand and in every direction, objects of interest invite our observation and study. Excluding what lies beyond the sphere upon which we dwell — there are the rocks to which we owe our basis for study, and their contained fossils, telling of the forms that peopled this globe eons of ages ago; the vegetable world instinct with life and beauty and wonderful processes of growth and development, and crowned with the dignity of being the agency through which alone, directly or indirectly, existence is possible for each and every mammal, bird, reptile, fish, insect, myriapod, crustacean, worm, mollusc, protozoan — of all the myriad living forms that people our globe.

In each of the several classes of the mineral, vegetable and animal kingdoms, there is abundant work for the earnest student. There are collections to be made; elements, form and structure to be studied; habits to be observed; preparations for study and for preservation; comparisons to be instituted, forms new to science to be detected and illustrated; descriptions to be drawn and published, and name and systematic place to be given to each and every one.

Why, then, should I make a special plea for the study of the Insect world? I would not presume to do so, unless I felt that I could give you sufficient reasons for making the claim; of these, I offer,

I. The Mental Discipline that the Study Affords.

This should especially commend it to the young student, where the intellectual faculties are to be developed and strengthened, and the mind guided and formed into proper habits of observation, thought and expression. To these ends, I believe entomological study to offer better discipline than the study of mathematics or the classics to which so much time is devoted and far beyond what may, by any possibility, in a large majority of students, be of any material practical importance.

But why may this be accomplished through the study of the insect world, better than by some other branch of natural history? We answer: because of the greater number of objects that in a given time may be brought together for study — the insect world presenting, as it does, by far a larger number of species than all the other classes of the animal kingdom combined. With this almost boundless number of species, it follows that there must often be but minute differences between them, not perceptible but through careful comparison, and often demanding the microscope for their detection. It is impossible that any one who has made a collection of insects of considerable size — separated them in their usually accepted seven orders, named such as he has been able to with the literature at his command or by comparison with other scientific collections, and arranged them systematically in proper cases, in their families, genera, species, and varieties — could have done this without having greatly strengthened his faculties of observation, comparison, discrimination, memory, and having acquired habits of study, industry, delicate manipulation, order, neatness, precision, and the like, which shall serve him in whatever position in life he may be placed, and cling to him to his life's end.

II. The Facilities for Entomological Study.

The entomologist, if unable to search for his material — we will not say, if not caring to seek it, for a lazy naturalist would be an anomaly — may have abundant material come to him unsought. As he walks the street, "the shard-borne beetle with its drowsy hum" flies in his face or alights upon his clothing; the moth sits at rest upon a tree-trunk or fence-paling as if asking for admiration and capture; the caterpillar drops upon him by its silken thread from an overhanging branch, or exposes itself as it travels over the sidewalk, to his meditative downcast gaze. Rapt in study in the seclusion of his room, the sudden thrust of the sharp lancet of *Stomoxys calcitrans*, causes its capture and invites examination of the curious projecting blood-sucking apparatus which, without critical observation, seems the only difference between it and the harmless common house-fly; or, curiously plumed creatures of delicate forms and colors, attracted by the light upon his study-table, will flit over his paper to mar his penmanship and perhaps end their life in a bath of ink, as they are doing at this present while writing of their obtrusiveness.

The invalid, who may be held a captive within his home through physical weakness or other infirmity, during the months when the insect world holds its hey-day in the fields and forest, may still make ample collections for study and enrichment of his cabinet even within the confines of his chamber. Should the year be favorable for insect life (the years vary greatly in this respect), at least five hundred species could be taken by him. Does this surprise you, as an indoor collection for a single year? I believe it a moderate estimate. To many of you, perhaps, all the flies of our window seem alike, or the smaller forms are regarded as the young of the common house-fly. Yet I would engage that from the windows of a single room of one's house, during the months of March to November inclusive, there could be taken one hundred species of Diptera alone.

Insect collections are easily made, and with simple and inexpensive material. For our ordinary walks in the requirements of business or study, the "cyanide bottle," that comparatively recent invention, yet now regarded as indispensable to the collector—is all that is needed for securing most of our insects. To the cyanide bottle, of a size convenient to be carried in a pocket, should be added a small tin box for inclosing caterpillars or other larvæ, with some of their food if desired to rear them. For field excursions, we would multiply our bottles and boxes, and add a suitable net, a pin-cushion with insect pins of two sizes, and a box hanging from a button or belt in which to pin the collections.

III. The Interest Attaching to the Study.

I dare not urge this topic as I feel to do, for fear that you would receive what I might say as the extravagance of enthusiasm. If not prepared to accept the assertion, that in no department of natural history can you find so much to interest you, and to interest you so deeply, as in the study of insects, their transformations and their habits, then, if willing to test the truth of the assertion, will you please accept for guidance the following program:

Get the cocoons of some one of our larger silk-spinning moths, of the family of *Bombycidæ*,—let them be, if you please, of *Attacus Promethea*, which you may find at the present time upon your lilac bushes, infolded in dried-up leaves of last year's growth. Before you cut the cocoons from the twigs (you can hardly tear them off by hand) first observe the silk extending from the cocoon, enveloping the leaf-stalk and then encircling the twig, binding the leaf securely to it, and holding it there during the falling of the other leaves and through all the winter's storms. Inclose the cocoons in a box of sufficient size to admit of the expansion of the wings of the moth and some freedom of motion when it comes from its cocoon. On some morning in the month of June, (earlier if they have been kept in a warm apartment) if your cocoons contained living pupæ, you will find that the moths have emerged, and deposited a large number of eggs, cementing them to the sides of the box. Note the regularity of form and size of the eggs, each with its yellowish spot upon its somewhat flattened upper side. When two or three weeks thereafter, the eggs commence to hatch, with a magnifier in hand, watch the enclosed caterpillars eating their way out of the shells, always at one side, and through a somewhat oval hole.

Transfer them carefully to some tender leaves of their food-plant, and observe their social habit of grouping themselves side by side like soldiers on parade, and their manner of eating. After you have watched them for a week, and noticed perhaps with fear of the result lest it should betoken incipient disease, their fasting for a day or two, you will find them materially increased in size and in a new dress of light green with bands of yellow, bordered with black, and rows of white-bristled tubercles studding their body. This is their first molting, or casting of their skin to admit of increased growth. Four or five times you may observe a similar molting, followed each time by a new and more beautiful garniture. As the caterpillar approaches maturity you will surely be compelled to regard it as a beautiful creature, with its creamy pruinescence, its bands of dark blue tubercles on each ring, its four rich coral-red horns on the front of its body and a yellow black-ringed one at its other extremity. Carefully observe the row of spiracles or breathing pores upon the sides of the body through which the air is admitted to the tracheal vessels, and the peculiar structure of its many-hooked clasping legs. It is indeed a wonderful creature,— not "a worm" as ordinarily stigmatized, but a being which its Creator has dignified with the possession of eight times the number of muscles that are to be found in the human body; and in every way worthy of your study and admiration. When through your watchful care, your little colony have attained their growth, to your great relief from providing them with an adequate supply of their daily food, do not fail to have your eyes upon them as they throw out the first threads that are to bend the leaf in shape for enfolding their cocoons, preparatory to passing to their pupation. The leaf may hardly be more than marked as the chosen one, before you may see the busy spinner leaving it, and commencing to cover the leaf-stalk with a firm envelope of silk, which, when completed, will be stronger than you can break without forcible pulling. You will now be given a favorable opportunity as the caterpillar's head sways from side to side, to note the two silken semi-fluid threads emitted from the pair of projecting spinnerets beneath the mouth, but uniting and drying at once in a single thread. The intelligence that leads the caterpillar next to bind securely the enveloped leaf-stem to the twig by throwing band after band about it, and in the event of the twig being a delicate one and liable to be broken off, then, in addition, securing the twig by the process above mentioned to its parent stalk — can not fail of amazing you. Do you think it simple instinct, working in one unvarying line inherited from its ancestors, and incapable of adapting itself to different or changed conditions? Then try the experiment that I once made, and learn your error. When all of this preparatory work has been completed, each lashing examined over and over again, and finally pronounced all right by its artificer — then with a sharp blade of your knife, quietly and neatly sever the leaf-stalk just where it is bound to the twig and, replacing it with accurate adjustment, insert a fine insect pin to hold it in place. You will not have long to wait before the spinning of the cocoon will be arrested and a reconnoitering expedition commenced. Your treacherous work is discovered as soon as the point is reached. The situation is at once taken in — the danger, the necessity of meeting it, and how best to do it, fully comprehended. You may not read in the microscopic eyes of the caterpillar, the successive phases of anxiety, alarm, distrust, annoyance, anger, resolve, triumph, but you may see him apply himself to the task of lashing anew the foot-stalk to the twig and thus bid defiance to your perfidious pin, around which he throws his silken threads, until the severed stem is stronger than before. What else is this than reason!

The shaping and formation of the cocoons will be of interest to watch, until the thickening walls have hidden the larva from your view. During the winter, you may sacrifice one or more of the number by making sections of them, that you may observe the structure of the double cocoon — one within the other, with the intermediate loosely-threaded non-conducting air-chamber, and the contained pupa, with its wing, leg, and antennæ-cases folded upon its breast, and the cast-off caterpillar skin compacted in a pellet behind it.

Your study of this life-history will not be fully carried out to its proper completion until, in the following spring, you can see the moth emerge from its cocoon. A strange looking object will it seem in your eyes, as with a brisk movement of its legs, it clambers upward to some position where its unexpanded wings may hang downward, limp and wet, over its back. Watch the gradual but rapid expansion of the wings, as they grow before your eyes — the two membranes of which they are composed steadily distending as the circulation from the body is forced into the veins that lie between. The innumerable wrinkles of the membranes are smoothed out; the scales that are implanted in them also increase in size, until within perhaps half an hour the wings have assumed their full development, and display their perfect ornamentation, in patterns resulting from the combination of nearly half a million of individual scales — the most delicate imbrication that may be found in nature, and far surpassing any thing that art can produce.

If not deterred by my long recital you will undertake what I have proposed—to follow out the life-history of one of our silk-worms, and having done so, if you do not find that the study has been one of surpassing interest, leading you to further study of the kind, and wedding you to entomology—then you have been given or have acquired a nature that I can not comprehend.

IV. The Practical Importance of the Study.

It is universally conceded that Agricultural pursuits form the basis of National prosperity, and that upon the products of the soil our existence is dependant.

The existence of the insect world also depends upon vegetable life: hence arises that constant antagonism of man to the insect world, which becomes so intensified when through his agency as a cultivator of the soil, there results excessive multiplication of injurious species preying upon crops which he deems essential to him.

Every crop grown is exposed to their attack. It has been estimated that there are upon an average, six species of attacking insects to each known plant. From their minute size and the secrecy of their depredations, we can not fence them out, as we do our large domestic animals. Probably there is no cultivated crop which is not lessened by one-tenth through insect injury. Often there is a diminution in yield of one fourth; frequently of one-half, and at times there is a total loss, as when during the prevalence of the wheat-midge, forty years ago, entire fields of wheat were left uncut in New York and other of the wheat states, and for a term of years wheat could not be grown. In one year, in our State (1854), the loss from this tiny insect was calculated at fifteen millions of dollars. Illinois suffered in a single year, in its wheat and corn crops, to the amount of seventy-three millions of dollars, according to estimate, from the ravages of the chinch-bug (*Blissus leucopterus*). True, these were exceptional years, but from another insect pest, the cotton-worm

(*Aletia argillacea*), annual losses to the cotton-crop of the Southern States are sustained, it has been calculated, of thirty millions of dollars.

From careful computations based upon the census returns of agricultural products of the United States, the startling aggregate is presented of an annual loss in these products of three hundred millions of dollars.

A large proportion of this loss — this onerous tax upon industry — need not be sustained — need not be exacted. It is preventable through the use of means which have been and are being indicated by those who have undertaken the study of methods of prevention and remedy. In consideration of the progress that has been made in the knowledge of insects, the discovery of insecticides and of mechanical appliances for their application to field crops, as well as to orchards and gardens, I dare to assert that the insect does not exist, the injuries from which may not be materially lessened whenever its habits and life-history have become fully known.

The need of the study of these insect depredations, the importance of it, and the absolute necessity thereof, will be more evident when we consider, next

V. The Extent of the Study.

A comparative idea of the magnitude of the insect world, as contrasted with the entire animal kingdom, has already been given you. It may enable you to form a better idea of its extent, to state, that judging from the number of species now named and described — about 330,000 (we know and possess in our collections thousands of others awaiting study), and at the rate that new species have been added to our lists within the last half-century—it will not be an extravagant estimate, if for the present, we place the probable number of species existing in the world at one million. Although this figure is largely in excess of those made by other entomologists, I believe it to be a moderate one, in consideration of the limited study as yet given to some of the orders, and the still unexplored regions of the globe — entire continents in which scientific exploration has barely commenced. Its realization would but necessitate *less than the trebling* of the at present known species, with all future time available for the work; while during the years that have followed my boyhood, the number of described species has been *quintupled.*

From a scientific point of view, each species as discovered demands description that will give it positive recognition, and assignment to its proper place in classified lists. For economic purposes, but a small proportion will require the elaborate study that shall tell us all that we need to know of them. But what patience, what persistence, what an amount of study—extending it may be over several years—is often needed for the acquisition of a single life-history. Each of the four stages under which insect life is presented to us—the egg, the larva, the pupa, and the imago, must receive its share of attention. The varied habits are to be observed and noted, under the complications frequently existing of change under changed conditions of food-plant, climate or locality.

The extent of the study will further appear from a consideration of the omnipresence of insects. As I have elsewhere written, "they abound in our homes, our gardens, orchards, fields, vineyards and forests. In the vegetable kingdom, they are found in the seed, the root, the stalk or trunk, the pith, the bark, the twig, the bud, the leaf, the blossom, and the fruit—within or upon every portion of the vegetable organism. They are parasitic on our persons and upon or within all of our domestic animals. They attack and destroy fishes and birds. They have their natural home in many articles of food. By their digusting presence and annoyance they may render our homes untenable. They burrow within our household and agricultural implements. They destroy our furniture and our clothing. They occasionally take possession of our books. No asylum is so secure that they may not intrude; no condition in life is exempt from their presence and attack."

VI. The Study has not been given its proper Share of Attention.

If you have followed me as I have attempted, in the brief time that I dare claim on this occasion, to show you the value of the Study of Entomology as a mental discipline—the facility with which it may be pursued—the interest attaching to it—its great practical importance—and the broad range that it embraces, you will, I think, agree with me, that it is very far from receiving the attention that it deserves and may justly claim. Notwithstanding the enormous losses annually sustained from insect depredations, how very few comparatively there are among us who can properly apply the familiar names of "bug," "beetle," or "butterfly." There are those whose crops are annually depleted, needlessly, to the amount of hundreds of dollars, who do not know that the caterpillar is but an immature stage of the winged moth or butterfly. This day, I find in a pretentious journal a notice of a destructive insect to this effect: "The insect appears first in the form of a small moth. In a few days, it sheds its wings and becomes a caterpillar, and a week thereafter it lays its eggs, each caterpillar producing two hundred."

In how many of our public schools and academies is Entomology given place? I do not know of one. In nearly all of our higher institutions and private schools, Botany is taught, and yet the former is certainly of far greater importance in the broad range of its economic applications. The State Normal College at Albany and the Oswego Normal School, have given excellent entomological instruction. Cornell University sustains a Professorship in Entomology, with courses of lectures, laboratory work and Museum. Lectures in course upon it are given at Harvard University, the State College of Maine, the Massachusetts Agricultural College, the Michigan State Agricultural College, Purdue University at Lafayette, Ind., the Illinois Industrial University, the Iowa Agricultural College, the Kansas State Agricultural College, and the Leland Stanford Jr., University in California. In each of these State Institutions particular attention is paid to the economic aspect of the science.

The above, with the exception of some academic instruction in other States is the sum, so far as known to me, of what is being done in our institutions of learning in this department of Natural Science.

The reason for its almost entire neglect in our schools, is, undoubtedly the want of text books adapted to the young student. It might have rivaled Botany in popularity could its collections be named with the facility of plants. But for this we may never hope. The volumes that would be required for the simple identification by means of three- or four-lined diagnoses of the known United States species of insects, would be, at least, twenty of the size of Gray's School and Field Book of Botany—a series which would certainly prove inconvenient for general class use. A reference catalogue alone of the Diptera (flies) of North America, forms a volume three-fourths the size of the one above named; and a catalogue of the known Insects of the small State of New Jersey, giving name and occasionally brief annotations of locality and distribution, fills 486 pages octavo.

We should not wait for the desired text-books, such as will enable us to name our collections, for there is much else to learn of insects besides their names, as, for example, their structure, habits, transformations, and economic value. With "Packard's Guide to the Study of Insects" and "Comstocks Manual for the Study of Insects," in the possession of the student for reference, and with the insects before him upon his table, the teacher, having qualified himself for the work, may, in a series of lectures give to his class a better foundation for future study than could be acquired from books alone.

I lately had the privilege of attending one of the Lowell Institute Free Course of Lectures on Zoölogy, at Boston, given to the teachers of the Public Schools. Each of the about three hundred teachers in attendance had upon his or her table a box containing a half-dozen representative species in the order of Neuroptera, and a vessel of water in which were some macerated specimens with which to study structure. The lecture was further illustrated by diagrams and charts upon the wall. I was delighted with the lecture, and with the promise that it gave of the good to result, when these trained teachers would form centres of similar instruction to other classes elsewhere.

In conclusion, if my plea for entomological study shall meet its desired response in inducing some of you to become faithful laborers in this broad field, where so large an amount of virgin soil is to be upturned, so much tillage is required, and such abundant fruit to be gathered — then, let me further ask of you, not to rest contented to gather for yourselves alone, but that from your superabundant stores you may make large contribution to others. Emulate the example of him whose honored and revered name your association bears. Ever find your greatest incentive to study, not in that it enriches yourself, but that you may impart to others. So gather from Nature's exhaustless stores and so distribute that your fellow-men shall be made the better, wiser and happier from your having been permitted to serve as Nature's interpreters.

More of honor than regal crown can bestow is in that single word, chiseled on a glacial block borne from beyond the seas to mark, so fittingly, the grave of Agassiz at Mount Auburn — TEACHER.

(C)

LIST OF PUBLICATIONS OF THE ENTOMOLOGIST.

The following is a list of the principal publications of the Entomologist during the year 1896 — thirty-eight are named — giving title, place and time of publication, and a summary of contents.

On the Girdling of the Elm Twigs by the Larvæ of Orgyia leucostigma and its Results. (American Naturalist, xxx, January, 1896, pp. 74–75 — 17 cm.)

Its annual depredations in Albany; a new form of attack noticed in 1883, viz., girdling of the tips of the twigs; cause of the girdling; the girdling operations of a second brood of the Orgyia in August, 1895; a second brood not previously recorded in Albany; a feature shown in the twigs girdled by this brood; no similar girdling seen on any other of the Orgyia food-plants.

[Republished in pages 124–126 of the Eleventh Report.]

Wire-Worms in Corn. (Country Gentleman, for February 20, 1896, lxi, p. 144, c. 1—18 cm.)

Wire-worms reported as injuring corn seriously at Mullica Hill, N. J., the previous year. Buckwheat and mustard crops as preventives of wire-worms. Kainit possibly a remedy, although it gave unsatisfactory results at Cornell University. Baits of poisoned clover for the beetles recommended; midsummer plowing for destroying pupal cells and their occupants; rotation of crops; keeping fields in sod but a year or two at a time; thorough cultivation in autumn.

A Solution for Killing Worms. (Gardening, for March 15, 1896, iv, p. 199, c. 2—5 cm.)

Replying to an inquiry of a solution for killing worms, grubs, etc., in potted plants and on benches of greenhouses, several are named, as pyrethrum water (½ ounce to two gallons of water), quassia water, tobacco water, mustard water, and lime water. Vegetable solutions would be less liable to injure the roots of the plants.

The Apple Maggot, *Trypeta pomonella*. (Gardening, for April 1, 1896, iv, p. 218, cols. 2, 3 — 21 cm.)

The insect is stated to ruin annually in Western Massachusetts the fruit of several varieties of apples; inquiry is made of remedies. Reply is given that preventive measures must be mainly relied on. The parent insect flies from early July until frost, — the females depositing their three to four hundred eggs singly beneath the skin on all parts of the apple. The eggs hatch in four or five days; mining habits of larvæ; they naturally pupate under ground. Destroying fallen fruit at once, using decoy trees for receiving the eggs, compacting the soil beneath trees or stirring it frequently, is recommended.

Apple Maggot. (Country Gentleman, for April 2, 1896, lxi, p. 270, c. 3 — 13 cm.)

It is reported as doing much damage to young apples in Fond du Lac county, Wisconsin; spraying is proposed. In reply, it is stated, that arsenites are of no value against this insect [*Trypeta pomonella*]; a good coating of the fruit with the Bordeaux mixture might prevent oviposition. General failure of the crop would probably reduce the numbers of the fly the following year, as it is sluggish and would hardly fly far. It can also breed in wild haws and crab apples. Best remedies: destruction of fallen fruit and using decoy trees. Arsenical spraying should not be neglected because of comparative exemption from insect attack.

The Cheese Skipper. (Country Gentleman, for April 9, 1896, lxi, p. 293, c. 2 — 28 cm.)

In response to inquiry, the meat-skipper is identified as the one found in cheese, viz., *Piophila casei* (Linn.). The perfect fly hibernates, appearing in warm weather in spring to oviposit; duration of stages. Long known only in cheese; in recent years infesting meat; losses caused in packing houses. Skippers reported from Moorefield, W. Va., on salted meat in January. Remedies: storing these products in darkness; excluding the flies. The work of the skippers does not produce ill odors or putresence.

[Extended in pp. 229–234 of this Report (xii).]

Scale Insects. (Gardening, for April 15, 1896, iv, p. 234, c. 1 — 14 cm.)

Scales on apple trees from Milwaukee, Mich., are identified as *Mytilaspis pomorum* and *Chionaspis furfurus*. Remedies are, cutting down when badly infested; for moderate attacks spray with kerosene emulsion reduced with nine parts of water when the young insects appear, or else from the middle to the end of May, for the latitude of Michigan.

The Southern Corn-Root Worm. (Country Gentleman, for April 30 1896, lxi, p. 353, cols. 2, 3 — 40 cm.)

"Bud-worms" which had nearly destroyed a field of corn in Fauquier Co., Va., are "the twelve-spotted Diabrotica," *D. 12-punctata* (Oliv.). The closely allied northern corn-root worm, *Diabrotica longicornis* (Say), is more destructive in the Northern States. Characters of the two species are given. The southern beetle is sometimes common North, and is a well-known pest of squashes, melons and cucumbers. The larvæ attack the corn just beneath the surface and cause wilting of the central leaf. Infested fields should not be replanted. No effective remedy is known.

Thousand-Legged Worms Infesting Greenhouses. (Gardening, for May 1, 1896, iv, pp. 251, 252, cols. 2, 3, 1—47 cm.)

Thousand-legged worms are reported as abounding in greenhouses at Kansas City, Mo., and not controlable by ordinary applications. From examples sent, the Myriapod is briefly described and identified as one of the flattened millepeds near to *Polydesmus complanatus* of Europe, which has not been recognized in this country. *Polydesmus Canadensis* is probably the species found to be so injurious by Dr. Fitch in this country. Many of the Myriapods feed only on decaying vegetable matter. Soot is said to drive them away. Kerosene or a strong kerosene emulsion will kill them; pyrethrum and hellebore might be tried. Baiting with chips, slices of carrots, etc., recommended. Removal of the manure in the house in which they may have bred is advised.

[Extended in pp. 300–303 of this Report (xii).]

A Handbook of British Lepidoptera. By Edward Meyrick. (The Nation, lxii, May 14, 1896, p. 385, cols. 2, 3—33 cm.)

In a review of the above work, its comprehensiveness, completeness, and general excellence is commended. It contains descriptive text of 2061 species. Analytical keys for the determination of the higher groups so complete have rarely if ever been given Its new system of classification is noticed, based on the author's study for years, of the Lepidoptera of the World. The system is so revolutionary as to be almost startling, but it is presented as a natural one, as based on resemblances resulting from traced community of descent. It is in accordance with the views advanced in Darwin's "Origin of Species," and has apparently been so carefully elaborated that in all probability it will have to be generally accepted by American Systematists. From the intimate relationship of the Lepidoptera of Great Britain and of the United States, the volume will be almost indispensable to American Students of Lepidopterology.

Elm-Leaf Beetle. (Country Gentleman, for May 14, 1896, lxi, p. 386, c. 3—6 cm.)

Examples sent with inquiry from Gaylordsville, Conn., taken on an attic window, are identified as *Galerucella xanthomelæna*, now *G. luteola*. They had doubtless just wakened from their winter's sleep in the attic and when found were seeking to escape to the elm for feeding and subsequent oviposition.

The Harlequin Cabbage Bug. (Gardening, for May 15, 1896, iv, p. 266, cols. 2, 3—26 cm.)

Insects destructive to cabbage and cauliflower in Tracy City, Tenn., are the harlequin cabbage bug, *Murgantia histrionica*. Its northward spread from Mexico is noticed, also its habits, and method of destroying it by drawing the early insects to mustard, cabbage stumps and sprouts for convenient killing, and by crushing the eggs.

A Plum Mite. (Country Gentleman, for May 21, 1896, lxi, p. 406, c. 2—16 cm.)

Leaves of a Chickasaw plum from Muncy, Pa., are deformed with galls showing on both surfaces of the leaf, produced by a gallmite which is seen under a powerful glass. Judging from the character of the gall, it is identical with that of *Phytoptus pruni* Amerl., which has not been previously detected in this country. For the destruction of the mite, hand-picking and burning the infested leaves early in the season, and winter spraying with kerosene emulsion are recommended.

[See page 318 of this Report (xii).]

The "Fire Worm." (Country Gentleman, for May 28, 1896, lxi, p. 431, cols. 3, 4—12 cm.)

The canker-worm, *Anisopteryx vernata* (Peck), is defoliating orchards in Amenia, N. Y., where it has previously been abundant. It is proving quite resistant to Paris green, and one pound of the green to 100 gallons of water has been required for killing it. Its habit of dropping from the foliage and being carried on its thread by the wind to other trees is noticed. It is known in Amenia, as the "fire worm," as the trees after the infestation, look as if they had been swept by fire.

[See pages 311–312 of this Report (xii).]

On the Girdling of Elm Twigs by the Larvæ of Orgyia leucostigma and its Results. (Proceedings of the American Association for the Advancement of Science — Forty-fourth meeting, held at Springfield, Mass., August–September, 1895. May, 1896, p. 156— 5 cm.)

A brief abstract of the paper under the above title was published in the American Naturalist for January, 1896. See page 347 of this Report.

Fruit Tree Aphides. (Country Gentleman, for June 11, 1896, lxi, p. 466, cols. 3, 4—12 cm.)

Some black aphides on cherry from East Hartford, N. Y., are identified as the cherry-tree aphis, *Myzus cerasi* (Fabr.), and the green ones on plum as *Aphis prunifoliæ* Fitch. The former is a common and widely distributed pest, while the latter is much less so. Spraying the plant-lice with whale-oil soap solution or strong tobacco water on their first appearance is effective. After the leaves curl, the spray is not effective. The Syrphid larvæ found preying on the aphides would probably soon destroy them all.

[Kill the Larvæ of the Elm-leaf Beetle.] (Albany Evening Journal, for June 24, 1896, p. 4, c. 4—16 cm.)

The larvæ of the first brood are now descending for pupation, and by killing them with hot water or kerosene, the ravages of the second brood may be largely prevented. This method is simple, while general spraying is impracticable. Infested trees—confined almost entirely to European elms, are indicated by small spots on sidewalks ordinarily left by the larvæ trodden under foot. The American elm in Albany is so far exempt from attack.

[Extended in pages 253-264 of this Report (xii).]

[Report on the Work of the Gypsy Moth Committee after an Examination made in June, 1893.] (The Gypsy Moth, *Porthetria dispar* (Linn.)— A Report of the Work by E. H. Forbush & C. H. Fernald [June], 1896, Appendix D, pp. xxxii–xxxv).

The pages cited contain (in part) a report made by the N. Y. State Entomologist, following an examination, at the request of the Committee, of their operations. As the result of the examination of the field and office work, and at the Insectary, nothing was found to criticise. Liberal appropriations by the State Legislature and a continuance of the work of the Committee were recommended. Two suggestions were offered, viz.; that the entire service of the Entomologist, Prof. Fernald, be secured, if possible, and that the cultivation of parasites be entered upon and vigorously prosecuted, somewhat on the plan of which an outline is given. Possibly by this means only, can extermination of the moth be effected.

The Elm-tree Beetle in Albany (Albany Express, for July 1, 1896.)

Gives the progress of the insect up the valley of the Hudson river since its appearance at Newburg, N. Y., in 1879, until its invasion of Albany in 1892; also, its slow spread in Albany and best methods for its destruction.

Rose Bugs. (Gardening, for July 1, 1896, iv, p. 311, c. 2 —11 cm.)

A correspondent, Mrs. Chrisman, states that rose-bugs may usually be traced to a hatching ground, where they could be killed by the application of a few sacks of salt. The editor requests comment on the above. It is given to the effect that the correspondent has undoubtedly been successful in tracing the rose-bugs in her neighborhood to a common hatching ground in a swamp, and draining the locality is suggested as a remedy for the continued breeding. Salt, as suggested, may prove effectual, and it would be well to experiment with it.

Tenth Report on the Injurious and Other Insects of the State of New York for the Year 1894. Albany, 1895. [Issued July 8, 1896.] Pages 297, plates 4, figures 24. (Forty-eighth Report on the New York State Museum, for the year 1894. Albany, 1895, pp. 297, plates 4, figs. 24.)

The contents are: TRANSMITTAL. INJURIOUS INSECTS, etc.: Ants on Fruit-Trees. Derostenus sp? Operations against the Gypsy-Moth in Massachusetts. Gortyna immanis, the Hop Vine Grub. Gortyna cataphracta, as a Raspberry-cane borer. Collections in the Adirondack Mountains in 1893. Sitotroga cerealella, the Grain-Moth. Diplosis pyrivora, the Pear-Midge. Notes on Sciara. Sciara coprophila, the Manure-Fly. Sciara caldaria, the Greenhouse Sciara. Phora agarici, the Mushroom Phora. Agrilus ruficollis, the Gouty-Gall Beetle. Anomala lucicola, the Light-loving Grapevine Beetle. Anomala marginata, the Margined Anomala. Diabrotica vittata, the Striped Cucumber Beetle. Dibolia borealis, a Plantain-Leaf Miner. Otiorhynchus ovatus, the Ovate Snout-Beetle. Conotrachelus cratægi, the Quince Curculio. The Seventeen-Year Locust in the State of New York in 1894. Psylla pyricola, the Pear-Tree Psylla. Remarkable abundance of Aphides or Plant-Lice in 1893. Are Aphides Eaten by Spiders? Pentatoma juniperina, the Juniper Plant-Bug. Leptocoris trivittatus, the Box-elder Plant-Bug. The Grasshopper Plague in Western New York. Julus cæruleocinctus, with Associated Potato-Scab. Mites Attacking Mushrooms. Mites Infesting Potatoes. Tyroglyphus Lintneri, a Mushroom-Infesting Mite. Phytoptus pyri, the Pear-Leaf Blister-Mite. APPENDIX. (A) THE SCORPION-FLIES; PANORPA RUFESCENS; BITTACUS STRIGOSUS. (B) LIST OF DATES OF COLLECTIONS OF LEPIDOPTERA (HETEROCERA). (C) LIST OF PUBLICATIONS OF THE ENTOMOLOGIST. (D) ENTOMOLOGICAL PUBLICATIONS OF J. A. LINTNER, 1862–1869. (E) CONTRIBUTIONS TO THE DEPARTMENT IN 1893. (F) CONTRIBUTIONS TO THE DEPARTMENT IN 1894. (G) CLASSIFIED LIST OF INSECTS NOTICED IN REPORTS I–X. (H) ERRATA (ADDITIONAL) IN PRECEDING REPORTS. INDEX TO REPORTS I–X.

The Army Worm Invasion. (The Argus [Albany, N. Y.], for July 8, 1896, p. 8, c. 3—28 cm.; the same, in part, in New York Recorder, for July 15, 1896—18 cm.; Country Gentleman, for July 16, 1896, lxi, p. 552, c. 1—24 cm.; Rome Sentinel, for July 17, 1896—12 cm.; Circular of the Department of Agriculture of the State of New York.)

The army-worm appears in Washington County, N. Y., the first week in July, and in other localities near Albany, in immense numbers and quite injurious. Crushing them and ditching to arrest their progress is recommended, also spraying narrow strips in advance of their march with Paris green. Its injuries will soon cease. None of its parasites seen as yet.

[Extended in pages 190–214 of this Report (xii).]

Wire Worm. (Country Gentleman, for July 9, 1896, lxi, p. 540, cols. 1, 2–13 cm.)

Examples sent from Hackettstown, N. J., where they have been quite injurious to corn, are identified as wire-worms and their general characters given. No entirely effective remedy for them has been found. Kainit is said to be a remedy. Salt is of doubtful value. Plowing in the autumn and attracting to baits recommended.

The Army Worm Invasion. (New York Daily Tribune, for Saturday, July 18, 1896—57 cm.)

The presence of the army worm [*Leucania unipuncta*] in eastern New York. The caterpillars unusually abundant and destructive. Lime, plaster, rolling the ground, ditching, etc., recommended. No parasites observed. Favoring meteorological conditions responsible for their immense numbers. Not likely to be so numerous another year.

[Extended in pages 190-214 of this Report (xii).]

Tent Caterpillar. (Country Gentleman, for July 23, 1896, lxi, p. 571, c. 4—5 cm.)

An example of a moth occurring in great numbers sent for identification from Baltimore, Md., was the apple-tree tent-caterpillar [*Clisiocampa Americana*]. Some particulars relating to the cocoon and the moth were given in reply.

The Army Worm. (Country Gentleman, for July 23, 1896, lxi, p. 574, cols. 3, 4—32 cm.)

The caterpillars were reported in the last week of June. The week following, many had nearly attained their growth and were destroying grains and grasses in most of the southeastern counties of the State. Ditching, rolling, spraying infested strips with Paris green, and applications of air-slacked lime, plaster, or even road dust, recommended. The most serious injury has already been committed. The moth, *Leucania unipuncta*, is not uncommon. The unusual abundance of the insect this year is due to meteorological conditions which may not prevail the coming year.

[Extended in pages 190-214 of this Report (xii).]

Cut-Worms and Borers. (Country Gentleman, for July 30, 1896, lxi, p. 591, cols. 1, 2—22 cm.)

In response to inquiry from Montclair, N. J., for remedies for cut-worms and borers it is stated that the feeding and other habits of cut-worms are so various that no one general remedy can be given. Fresh clover sprinkled with Paris green water and laid in loose bunches between the rows, or cabbage or turnip leaves treated in a similar manner, have been found quite effective. Bran mash poisoned with arsenic might be used in the same manner. Digging out the cut-worms is sure and not very laborious. The soft-soap carbolic acid wash poisoned with Paris green is recommended for borers. Common whitewash is believed to be a preventive by many.

More About the Army Worm. (Country Gentleman, for August 6, 1896, lxi, p, 606, cols. 1, 2 — 52 cm.)

The army worm [*Leucania unipuncta*], reported as injurious on many farms at Orchard Home, N. Y. Ditching was quite effective and it was found that plowing a furrow and returning in it, gave good results. Holes, 10 or 15 inches deep at intervals in the furrows, proved efficient. The wheat bran mash reported effective, the worms descending from the corn to eat it.

In reply, the precautions taken are commended, though deeper holes are preferable. The dead worms observed on the ground may have been killed by ground beetles, *Carabidæ*, or by parasitic flies

Nemoræa leucaniæ [*Winthemia 4-pustulata*]. When and where the eggs are laid and other items of life-history.

[Extended in pages 190–214 of this Report (xii).]

Snapping Bugs. (Country Gentleman, for August 6, 1896, lxi, p. 610, c. 1 — 12 cm.)

In response to an inquiry from Beaver Creek, Col., it is stated, that it has been found serviceable to attract click-beetles, or snapping-bugs to poisoned baits, from May to August inclusive. The exact time for continuance of the baits to be ascertained by the number of beetles drawn to them. Freshly cut clover, dipped in Paris green water, is perhaps, the best bait. A corn or bran mash sweetened with sugar and containing arsenic should be effective.

Blister Beetles. (Country Gentleman, for August 13, 1896, lxi, p. 624, c. 3 — 12 cm.)

Insects sent from Madison, N. J., where they had been feeding on beets and mangels, are of two species. The black one, with a narrow ash-colored margin on the wing covers, is the "margined blister beetle," *Epicauta cinerea* (Forst.), a common and destructive species at times, feeding on potato and tomato leaves; seldom continuing longer than a week. The other, "the striped blister-beetle," *Epicauta vittata* (Fabr.), is especially destructive to potatoes and is a more southern form. Lime or plaster of Paris are remedies. The larvæ of these beetles, destroy grasshopper eggs and are therefore beneficial.

Willow Butterfly. (Country Gentleman, for August 27, 1896, lxi, p. 666, cols. 1, 2 — 10 cm.)

Caterpillars, identified as *Vanessa Antiopa*, are stated to have ravaged trees on the bar [at Whitehall, N. Y.], next the Lake, to an extent that caused them to look as if dead. Their occurrence in such destructive numbers is quite unusual.

Caterpillars and Parasites. (Country Gentleman, for August 27, 1896, lxi, p. 670, cols. 1, 2 — 21 cm.)

A half-grown larva of *Ampelophaga Myron* (Cramer), from a woodbine at Port Kent, N. Y., is nearly covered with the cocoons of its common parasite, *Apanteles congregatus*. The history of the parasite is given, and also of a secondary parasitic attack by a Chalcid on Apanteles.

The Oak Pruner. (Country Gentleman, for September 3, 1896, lxi, p. 682, c. 4 — 6 cm.)

The small limbs of some hard maple trees at Baltimore, Md., are cut off by some insect, as clean, as though with a knife. The attack is identified, as, in all probability, that of the oak pruner, *Elaphidion parallelum* Newm. The insect may be kept in check by collecting the fallen branches and burning them.

The Beech-Tree Blight. (Country Gentleman, for September 10, 1896, lxi, p. 705, c. 4 — 26 cm.)

Beech leaves from Scarsdale, N. Y., are thickly infested with *Schizoneura imbricator* (Fitch). The enveloping white substance is noticed, and the honey-dew which it secretes. As the insect is difficult to reach with insecticides, crushing the collected masses is recommended.

Elm-Tree Borer. (Country Gentleman, for September 24, 1896, lxi, p. 746, c. 1 — 14 cm.)

A borer, infesting elm-trees in Peoria, Ill., is identified from the account given of it, as the elm-tree borer, *Saperda tridentata* Olivier. The best remedies for it are these: 1. Removing the dead bark over the infested portion until the insects are reached, and applying kerosene emulsion to kill them. 2. Preventing egg-laying by coating the portion of the trunk threatened with a repellant coating in which Paris green and carbolic acid are mixed.

[Extended in pp. 243-248 of this Report (xii).]

The Cecropia Moth. (Country Gentleman, for September 24, 1896, lxi, p. 746, c. 2 — 9 cm.)

A supposed vegetable growth on a grapevine, from Auburn, N. Y., is the cocoon of *Attacus Cecropia*. Features of the cocoon are given from which it may be recognized.

Imported Scale Insects. (Country Gentleman, for September 24, 1896, lxi, p. 746, c. 3 — 13 cm.)

In commenting on a statement of the recent arrival at Seattle, Wash., of a steamship from Japan, with some Japanese plants badly infested with a destructive scale-insect, the importance is urged of such quarantine regulations at that port as shall prevent the introduction of the scale insects of Japan, and also at other of our ports where plants and fruits are largely imported. The particular scale referred to above, *Diaspis lanatus*, has been in the United States for at least four years, having probably been introduced from the West Indian Islands, and is now in Florida, Georgia, and District of Columbia on peach trees. How destructive it may prove, remains to be seen.

Pea Bugs. (Country Gentleman, for October 1, 1896. lxi, p. 763, cols. 3, 4—12 cm.)

In reply to inquiry from Baiting Hollow, L. I., the life-history of the pea-weevil, *Bruchus pisorum* is given, and for killing the insect, chloroform or bisulphide of carbon are recommended.

Rose-Leaf Hopper. (Country Gentleman, for October 1, 1896, lxi, p. 763, c. 4—10 cm.)

A remedy is asked for from Port Kent, N. Y., for "a small white fly infesting rose-bushes." It is probably "the rose-leaf hopper," *Typhlo-*

cyba rosæ (Harris), and for destroying it, the following are recommended: whale-oil soap, tobacco water (made after formula given), pyrethrum powder mixed with flour, and a strong stream from a garden hose of cold water. The last, if used on the young larvæ, is a simple and effective remedy.

The Wheat Wire Worm. (Country Gentleman, for October 22, 1896, lxi, p. 826, c. 1—21 cm.)

Agriotes mancus (Say) was received from Torresdale, Pa., as having ruined potato crops. Features of wire-worms; the difficulty in dealing with them, and their life-period. Kainit or other potash salts are recommended for their destruction, also baits of poisoned clover for the beetles, and late plowing for crushing the pupæ.

Apple-Tree Borers. (Country Gentleman, for December 10, 1896, lxi, p. 949, cols. 2, 3—36 cm.)

The borers that are infesting old trees which always drop their fruit before ripening, in Pittsburg, Pa., are probably the round-headed and flat-headed borers, *Saperda candida* Fabr. and *Chrysobothris femorata* (Fabr.). The trees may possibly be saved by proper fertilizers and prevention of further attack. A soft soap and carbolic acid wash applied the last of May and renewed whenever needed, is a good preventive of egg deposit. The "Saunders Wash" of soft soap and washing soda, is highly esteemed in Canada. "Dendrolene" may not as yet be recommended for general use. Remedies, are cutting out or crushing the borers after the methods stated. For protection of young trees wrap bands of cloth or folds of newspaper around the base of the trees for a foot or more.

Notes on Some of the Insects of the Year in the State of New York. (Bulletin 6, New Ser., Divis. Entomol., U. S. Dept. Agricul., 1896 pp. 54–61.)

The year has been characterized by the unusual harmlessness of a number of common insect pests, and the remarkable scarcity of insect life with a few exceptions. Notes on the following insects are given: *Leucania unipuncta*, *Leucania albilinea*, *Anisopteryx vernata*, *Cacœcia rosaceana*, *Nolophana malana*, Cecidomyiid larva on choke-cherry, *Euphoria Inda*, *Elaphidion villosum*, *Crioceris asparagi*, *Macrobasis unicolor*, Chinch-bug, *Aspidiotus perniciosus*, *Kermes galliformis*, and *Gossyparia ulmi*.

[See pages 307-318 of this Report (xii).]

Eleventh Report on the Injurious and Other Insects of the State of New York for the Year 1895. Albany, 1896. [Issued January 21, 1897.] Pages 238, plates 16, figures 25. (Forty-ninth Report on the New York State Museum, for the Year 1895. Albany, 1897 [issued in October, 1897], pp. 245, plates 16, figures 25.)

The contents are: INTRODUCTORY. INJURIOUS INSECTS: Monomorium Pharaonis, the Little Red Ant. Ants in a Lawn. On

Arsenical Spraying of Fruit Trees while in Blossom. On the Girdling of Elm Twigs by Orgyia leucostigma. Eudioptis nitidalis, the Pickle Caterpillar. Eudioptis hyalinata, the Melon Caterpillar. Pyrausta futilalis, a Dogbane Caterpillar. Mecyna reversalis, the Genista Caterpillar. Pyralis costalis, the Clover-Hay Caterpillar. Grapholitha interstinctana, the Clover-seed Caterpillar. Antispila nyssæfoliella, the Sour Gum-tree Case-Cutter. Tischeria malifoliella, the Apple Leaf Miner. Cecidomyia betulæ, the Birch-tree Midge. Diplosis cucumeris, the Melon-vine Midge. Diplosis setigera, the Hairy Melon-vine Midge. Anthomyia sp., ? the Raspberry-cane Maggot. Anthrenus scrophulariæ, the Carpet-Beetle. Pyrophorus noctilucus, the Cucuyo. Crioceris asparagi, the Asparagus Beetle. Lina scripta, the Cottonwood-leaf Beetle. Galerucella luteola, the Elm-leaf Beetle in Albany. Galerucella cavicollis, a Cherry-leaf Beetle. Blissus leucopterus, the Chinch-bug. The San José Scale [Aspidiotus perniciosus], and Other Destructive Scale Insects of New York. Myrmeleon sp. ?, the Ant Lion. Thrips tabaci, the Onion Thrips. Schoturus nivicola, the Snow Flea. Achorutes diversiceps. Tyroglyphus heteromorphus, a Carnation Mite. APPENDIX. (A) LIST OF INJURIOUS APPLE-TREE INSECTS. (B) LIST OF PUBLICATIONS OF THE ENTOMOLOGIST. (C) CONTRIBUTIONS TO THE DEPARTMENT IN 1895. (D) CLASSIFIED LIST OF INSECTS, ETC., NOTICED IN THIS REPORT. (E) EXPLANATIONS OF PLATES. INDEX.

(D)

CONTRIBUTIONS TO THE DEPARTMENT IN 1896.

Hymenoptera.

Saw-fly larvæ, *Hylotoma pectoralis* Leach, feeding on birch, August 12th. From Mrs. H. D. Graves, Ausable Forks, N. Y.

Larvæ of the pear-tree slug, *Eriocampa cerasi* (Peck), August 18th. From R. W. Strickland, Albion, N. Y.

Larvæ of the willow apple gall saw-fly, *Pontania pomum* (Walsh), from Delmar, N. Y., August 19th. From Prof. C. H. Peck, Menands, N. Y.

Tenthredo rufopectus (Norton), imago, May 25th from currant twig. From Thomas Tupper, Corning, N. Y.

The lunated long-sting, *Thalessa lunator* (Fabr.), June 4th. From Frank Unger, Albany, N. Y.

Bracon sp. From Mrs. E. C. Anthony, Gouverneur, N. Y.

A Chalcid, *Brucophagus* sp., from the fungus *Peridermium cerebrum* on *Pinus tæda* from Auburn, Ala. From Prof. C. H. Peck, Menands. N. Y.

The large digger-wasp, *Sphecius speciosus* (Drury), from a lawn, August 16th. From James Reynolds, Poughkeepsie, N. Y.

A leaf-cutter bee, *Megachile montivaga* Cress.; *Pelopœus cœmentarius* (Drury), *Chalybion cœruleum* (Drury), and *Trypoxylon politum* Say. From Mrs E. B. Smith, Coeymans, N. Y.

Lepidoptera.

Larvæ of *Vanessa Antiopa* (Linn.), devastating willows, June 11th. From C. T. Hawley, Jr., Cambridge, N. Y.

Larva of *Thyreus Abbotii* Swainson, July 7th; larva of *Deilephila chamænerii* Harris, var., from *Œnothera biennis*, October 20th. From Mrs E. B. Smith, Coeymans, N. Y.

Larva of *Ampelophaga Myron* (Cramer), parasitized by *Apanteles congregatus*, and these, in turn, by a Chalcid, August 16th. From Mrs. D. D. Kellog, Port Keat, N. Y. The same, in the same double parasitism, August 22d, from Mrs. E. C. Anthony, Gouverneur, N. Y.

Larva of *Ceratomia Amyntor* (Hübn.), August 21st. From F. J. Riggs, Albany, N. Y.

Hypoprepia fucosa Hübn., August 8th. From Mrs. K. E. TURNBULL, Tannersville, N. Y.

Larvæ (10) of *Empretia stimulea* Clemens, August 7th, on a leaf of garden cherry. From Dr. S. A. RUSSELL, Poughkeepsie, N. Y. The same, 7 examples on cherry, August 31st, from J. F. ROBINSON, Middletown, N. Y.

Egg-belt of *Clisiocampa Americana* Harris, June 17th, of the present year. From J. S. WHITCOMB, West Somerset, N. Y.

The leopard moth, *Zeuzera pyrina* (Fabr.), June 5th. From A. H. STRATTON, Arlington, N. J.

Eacles imperialis (Drury). From Mrs. E. C. ANTHONY, Gouverneur, N. Y.

Harrisimemna trisignata Walker, and *Agrotis subgothica* Haworth, Sept. 30th. From Mrs. E. B. SMITH, Coeymans, N. Y.

The army-worm, *Leucania unipuncta* (Haworth), July 1st, from J. N. McHARG, Albany, N. Y. The same, July 2d, from S. E. SPALDING, Cambridge, N. Y. The same, July 6th, taken at Wemple, N. Y., from Hon. J. S. BAILEY, Albany, N. Y. The same, September 25th and October 2d, from H. S. AMBLER, Chatham, N. Y.

Xylina Bethunei Gr.-Rob., Sept. 30th. From Mrs. E. B. SMITH, Coeymans, N. Y.

Young apples eaten into by the larvæ of *Cacœcia rosaceana* (Harris), with examples of the larvæ, May 27th. From W. A. LAFLER, Albion, N. Y.

Examples of the currant span-worm, *Eufitchia ribearia* (Fitch), feeding destructively on gooseberries, June 5th. From LYMAN H. HOYSRADT, Pine Plains, N. Y.

The spring canker-worm, *Anisopteryx vernata* (Peck), May 21st. From E. J. PRESTON, Amenia, N. Y.

Ephestia interpunctella Zeller, the larvæ in samp, split peas, "wheat germ meal and wheatlet," September 4th. From MELVIL DEWEY, Albany, N. Y.

Pears infested with the apple-worm, *Carpocapsa pomonella* (Linn.). From Prof. C. H. PECK, Albany, N. Y.

The apple-tree case-bearer *Coleophora Fletcherella* Fernald; the apple-leaf Bucculatrix, *Bucculatrix pomifoliella* Clemens, in the pupal stage on apple twigs, September 15th. From W. A. THACKER, Walcott, Wayne county, N. Y.

Larvæ of the willow-apple Tineid, *Batrachedra salicipomonella* Clemens, feeding within the galls of *Pontania pomum* (Walsh), August 19th, at Delmar, N. Y. From Prof. C. H. PECK, Albany, N. Y.

DIPTERA.

The dog-flea, *Pulex serraticeps* Gerv. From EARL S. CRANNEL, Albany, N. Y.

Larvæ of *Cecidomyia* sp. in galled choke-cherries, May 28th, from Bethleham, N. Y. From Prof. C. H. PECK, Menands, N. Y.

The pear-midge, *Diplosis pyrivora* Riley. From Dr. J. B. SMITH, New Brunswick, N. J.

Examples of *Sciara multiseta* Felt reared from mushrooms, *S. pauciseta* Felt from potatoes, and *S. fulvicauda* Felt from decaying blackberry roots; and of *Phora abidihalteris* Felt from mushrooms. From Dr. J. B. SMITH, New Brunswick, N. J.

Chrysops sp. near *nigra*, *Scenopinus fenestralis* (Linn.), and *Pollenia rudis* (Fabr.). From Mrs. E. B. SMITH, Coeymans, N. Y.

Larvæ of *Anthomyia* sp., mining beet leaves, June 16th. From C. W. SEELYE, Rochester, N. Y.

Larvæ and pupa of *Meromyza Americana* Fitch, from stalks of wheat, quite destructive in Altdorf, Wisc., June 24th. From E. S. GOFF, Madison, Wisc.

Larvæ of a Phorid (?), infesting, in association with coleopterous larvæ, the fungus, *Clitocybe illudens*, October 1st; also, numerous dipterous larvæ and imagoes from mushrooms, Sept. 29th. From C. H. PECK, Menands, N. Y.

COLEOPTERA.

Calosoma scrutator (Fabr.), September 4th. From G. R. HOWELL, Albany, N. Y.

Calosoma calidum (Fabr.), *Silpha Surinamensis* (Fabr.), *Chalcophora Virginiensis* (Drury), *Dicerca divaricata* Say, *Aphodius* sp., *Osmoderma scabra* (Beauv.), *Monohammus confusor* (Kirby). From Mrs. E. C. ANTHONY, Gouverneur, N. Y.

Coccinella 9-notata Hübn., *Alaus oculatus* (Linn.), *Epicauta cinerea* (Forst.) From Mrs. E. B. SMITH, Coeymans, N. Y.

The twice-stabbed lady-bird, *Chilocorus bivulnerus* Muls., from mountain ash, June 1st. From A. H. STRATTON, Arlington, N. J.

Silvanus Surinamensis (Linn.), in wheat flour, August 22d. From F. J. RIGGS, Albany, N. Y. The same in samp, split-peas, flour, raisins, and dried currants, from MELVIL DEWEY, Albany, N. Y. The same in "Cerealine," from F. J. RIGGS, Albany, N. Y.

Wireworms, *Elateridæ*, from roots of corn. From C. W. SARGENT, Hackettstown, N. J.

The Pennsylvania soldier beetle, *Chauliognathus Pennsylvanicus* (DeGeer), Sept. 30th. From Mrs. E. B. SMITH, Coeymans, N. Y.

Tenebrioides Mauritanica (Linn), from Miss M. SEYMOUR, Albany. N.Y.

Living examples of the cucuyo *Pyrophorus noctilucus* (Linn), June 17th, from the Island of San Domingo, W. I. From Mrs. EDMUND H. SMITH, Albany, N. Y.

Amphicerus bicaudatus (Say), taken while boring into a species of "African tamarisk," May 25th. From V. H. LOWE, N. Y. Agricultural Experiment Station, Geneva, N. Y.

Lucanus dama Thunb., June 10th. From R. H. SHREVE, Albany, N. Y.

The rose-bug, *Macrodactylus subspinosus* (Fabr.), June 10th, on apple. From Mrs. M. B. WELCH, South Butler, N. Y.

Pelidnota punctata (Linn.). From F. J. RIGGS, Albany, N. Y.

Larvæ (10) of *Euphoria Inda* (Linn.), from chip manure. From Prof. C. H. PECK, Albany, N. Y. The same, imago, injuring pears September 9th. From JAMES HENDRICKS, Albany, N. Y.

Elaphidion parallelum Newm., June 2d, in apple branches. From J. A. HOUCK, Albany, N. Y. Pruned twigs of the same, of Norway maple (many) and of pig-nut hickory (one), August 23d. From GEORGE T. LYMAN, Bellport, Suffolk Co., N. Y.

The maple-tree borer, *Plagionotus speciosus* (Say), June 29th. From A. P. WILLIAMS, Mannsville, Jefferson Co., N. Y.

Crioceris asparagi (Linn.), in eggs, larvæ, and imagoes, June 2d. From A. P. CASE, Vernon, Oneida Co., N. Y.

Chlamys plicata (Fabr.), in eggs and larvæ, on hickory, May 23d. From W. R. WALTON, Middletown, N. Y.

Bruchus obtectus Say, February 14th. From G. M. PATTEN, Poughkeepsie, N. Y.

The ash-gray blister-beetle, *Macrobasis unicolor* (Kirby), June 19th, feeding on the honey locust. From M. T. Richardson, New York City. The same, from potatoes, June 25th, from ——— ———, Factoryville, N. Y.

Tribolium confusum Duval and *Calandra granaria* (Linn.), August 18th, infesting graham flour. From F. J. RIGGS, Albany, N. Y.

Scolytus rugulosus Ratz. (7 examples), August 13th, boring into apple and peach trees. From Prof. C. H. PECK, Albany, N. Y.

Hemiptera.

The harlequin cabbage bug, *Murgantia histrionica* (Hahn.), from cauliflower, April 23d. From E. A. Nathurst, Tracy City, Tenn.

Lygus pratensis (Linn.), from potatoes, June 22d. From D. F. Harris, Adams, N. Y.

The four-lined leaf-bug, *Pœcilocapsus lineatus* (Fabr.). From Miss L. F. Clarke, Canandaigua, N. Y.

The dog-day Cicada, *Cicada tibicen* Linn., July 31st and August 18th. From F. J. Riggs, Albany, N. Y.

Typhlocyba vitis (Harris), from grape, September 4th. From Prof. C. H. Peck, Albany, N. Y.

Pemphigus imbricator (Fitch), on beach, August 31st. From D. J. Garth, Scarsdale, N. Y.

Gossyparia ulmi Geoff., June 4th. From J. B. Washburn, Albany Co., N. Y.

Kermes galliformis Riley, from scrub oak, containing in December, pupæ of *Euclemensia Bassettella* (Clemens). From W. R. Walton, Middletown, N. Y.

Lecanium sp., thickly encrusting a maple twig, May 13th. From Selwyn A. Russell, M. D., Poughkeepsie, N. Y.

Lecanium sp. on *Prunus Simoni*, May 26th. From Lewyllen DeFreest, DeFreestville, Rensselaer Co., N. Y.

The San José scale, *Aspidiotus perniciosus* Coms. on pear, from T. C. Royce, Middletown, N. Y. The same, Nov. 28th, on apple, from Dr. Edward Moore, Loudonville, N. Y.

Orthoptera.

The mole cricket, *Gryllotalpa borealis* (Burm.), Sept. 28th. From J. W. Bayer, Saratoga Springs, N. Y.

Ceuthophilus maculatus (Harris), *Cyrtophyllus concavus* (Harris), *Amblycorypha oblongifolia* (De Geer), and *Diapheromera femorata* (Say). From Mrs. E. B. Smith, Coeymans, N. Y.

Chortophaga viridifasciata (De Geer). From Mrs. E. C. Anthony, Gouverneur, N. Y.

Periplaneta Australasiæ (Fabr.). From Ernest F. Irvin, Sinclairville, N. Y.

Periplaneta orientalis (Linn.). From Silas W. Burt, New York City.

Neuroptera.

Epiæschna heros (Fabr.), June 9th. From Mr. King, Fort Edward, N. Y.

Gomphus adelphus Selys, Sept. 30th. From Mrs. E. B. Smith, Coeymans, N. Y.

Numerous examples of a Psocid occurring in oat refuse, September 29th. From H. S. Ambler, Chatham, N. Y.

Myriapoda.

? *Polydesmus falcatus* Lintn. infesting greenhouses, February 12th. From J. G. Campbell, Kansas City, Mo.

Cermatia forceps Raf., June 10th, in the Capitol. From L. M. Lee, Albany, N. Y.

(E)

CLASSIFIED LIST OF INSECTS, ETC., NOTICED IN THIS REPORT.

HYMENOPTERA.

Tenthredo rufopectus (*Norton*), the red-breasted Tenthredo.
Tremex columba (*Linn.*), the pigeon Tremex.
Ophion purgatum *Say*, the purged Ophion.
Thalessa lunator (*Fabr.*), the lunate long-sting.
Apanteles militaris (*Walsh*), the military Apanteles.
Camponotus herculaneus (*Linn.*), a large black ant.
Formica exsectoides *Forel*, an eastern mound-building red ant.
Formica obscuripes *Forel*, a western mound-building red ant.
Formica rufa *Linn.*, the European wood-ant.
Formica subsericea *Say*, the large black ant.

LEPIDOPTERA.

Ecpantheria scribonia (*Stoll*), the great white leopard-moth.
Datana integerrima *Gr.-Rob.*
Attacus Promethea (*Linn.*), the Promethea moth.
Leucania albilinea (*Hubn.*), the wheat-head army-worm.
Leucania unipuncta (*Haworth*), the army-worm.
Eufitchia ribearia (*Fitch*), the gooseberry span-worm.
Anisopteryx vernata (*Peck*), the spring canker-worm.
Oxyptilus periscelidactylus (*Fitch*), the gartered plume-moth.
Cacœcia rosaceana (*Harris*), the oblique-banded leaf-roller.
Proteoteras æsculana (*Riley*), a maple and buckeye twig-borer.
Steganoptycha Claypoliana (*Riley*), a new maple-tree insect.
Euclemensia Bassettella (*Clemens*), a parasite of Kermes.

DIPTERA.

Cecidomyia species in choke cherries.
Sciara fulvicauda *Felt.*
Sciara agraria *Felt.*

Sciara multiseta *Felt.*
Sciara pauciseta *Felt.*
Sciara prolifica *Felt.*
Culex species, mosquitoes.
Winthemia 4-pustulata (*Fabr.*), the red-tailed Tachina-fly.
Belvoisia unifasciata *Desv.*, the yellow-tailed Tachina-fly.
Piophila casei (*Linn.*), the cheese skipper: the ham skipper.
Phora albidihalteris *Felt.*

Coleoptera.

Calosoma calidum (*Fabr.*), the fiery ground-beetle.
Lebia grandis (*Hentz*), an enemy of the Colorado potato-beetle.
Euphoria Inda (*Linn.*), the Indian Cetonian.
Elaphidion villosum (*Fabr.*), the oak pruner.
Elaphidion parallelum *Newm.*, the maple-tree pruner.
Plagionotus speciosus (*Say*), the sugar maple borer.
Neoclytus erythrocephalus (*Fabr.*), an elm, hickory and locust borer.
Saperda tridentata *Olivier*, the elm borer.
Crioceris asparagi (*Linn.*), the asparagus beetle.
Crioceris 12-punctata (*Linn.*), the twelve-spotted asparagus beetle.
Galerucella luteola (*Müller*), the elm-leaf beetle.
Odontota dorsalis *Thunb.*, a locust leaf-miner.
Macrobasis unicolor (*Kirby*), the ash-gray blister beetle.
Balaninus rectus *Say*, the smaller chestnut-weevil.
Balaninus proboscideus (*Fabr.*), the larger chestnut-weevil.

Hemiptera.

Podisus spinosus (*Dallas*), the spined Podisus.
Metapodius femoratus (*Fabr.*), the thick-thighed Metapodius.
Blissus leucopterus (*Say*), the chinch-bug.
Cicada septendecim *Linn.*, the periodical Cicada.
Pemphigus rhois (*Fitch*), the sumac-gall aphis.
Gossyparia ulmi (*Geoff.*), the elm-tree bark-louse.
Kermes galliformis *Riley*, the oak Kermes.
Aspidiotus perniciosus *Comst.*, the San José scale.

Neuroptera.

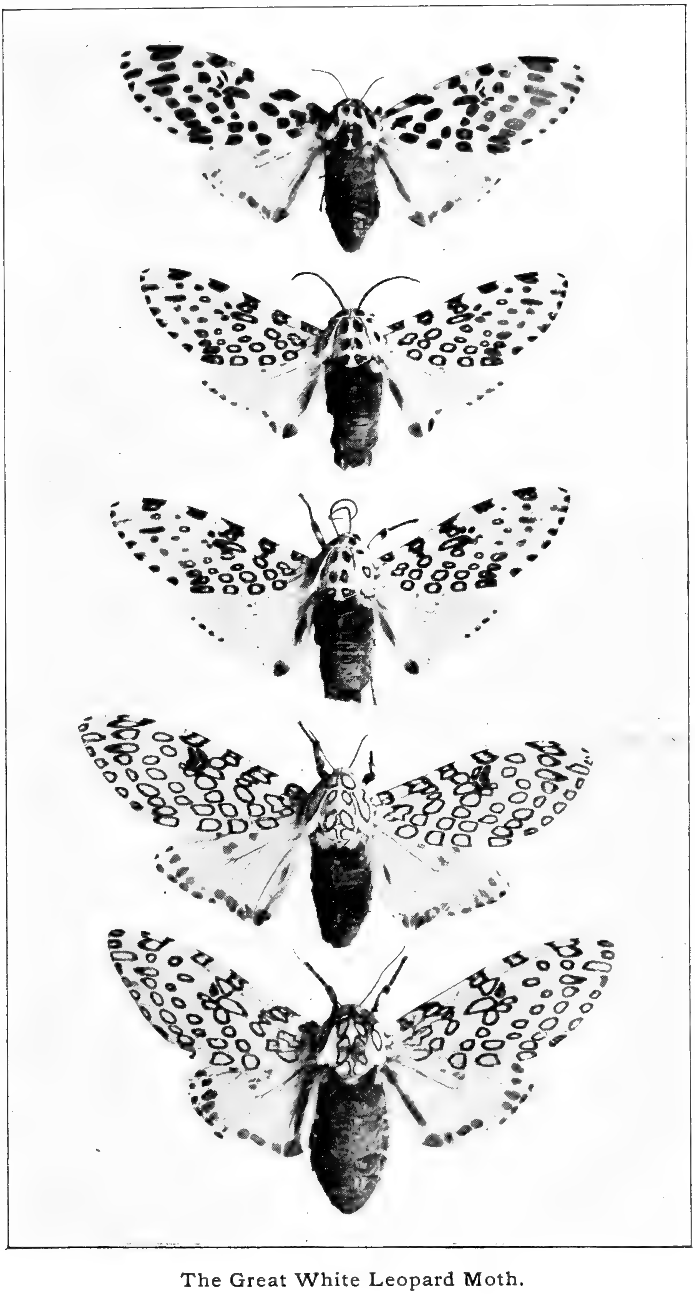
Neuronia pardalis *Walker*, the spotted Neuronia.

ARACHNIDA.

Phytoptus pruni *Amerl.*, a Chickasaw plum mite.

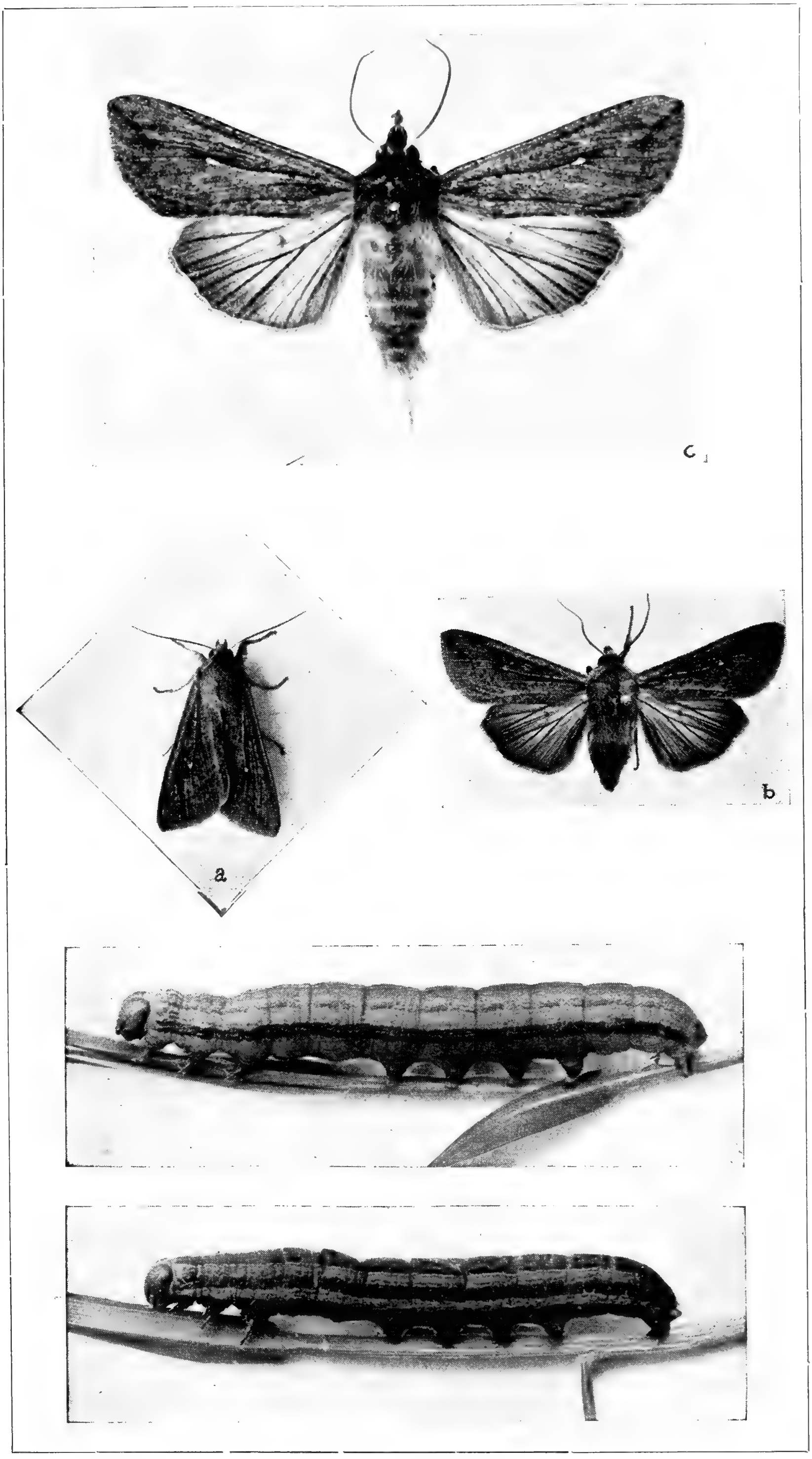
MYRIAPODA.

Leptodesmus falcatus *Lintn.*, a thousand-legged worm in greenhouses.
Polydesmus complanatus (*Linn.*), the flattened millipede.
Polydesmus serratus *Say*, the serrate Polydesmus.

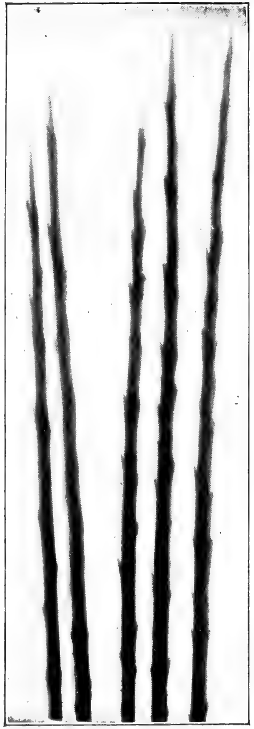


The Great White Leopard Moth.

Army-Worms at Work on Corn.



Army-Worm Moths and Caterpillars.



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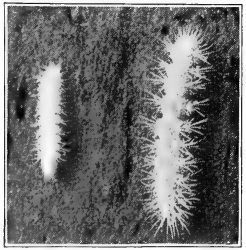

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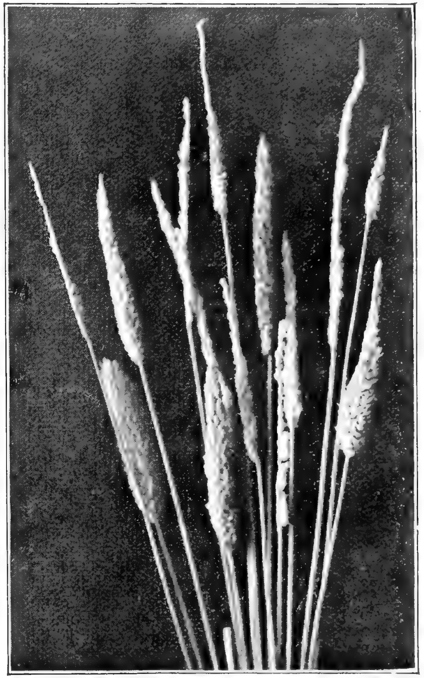

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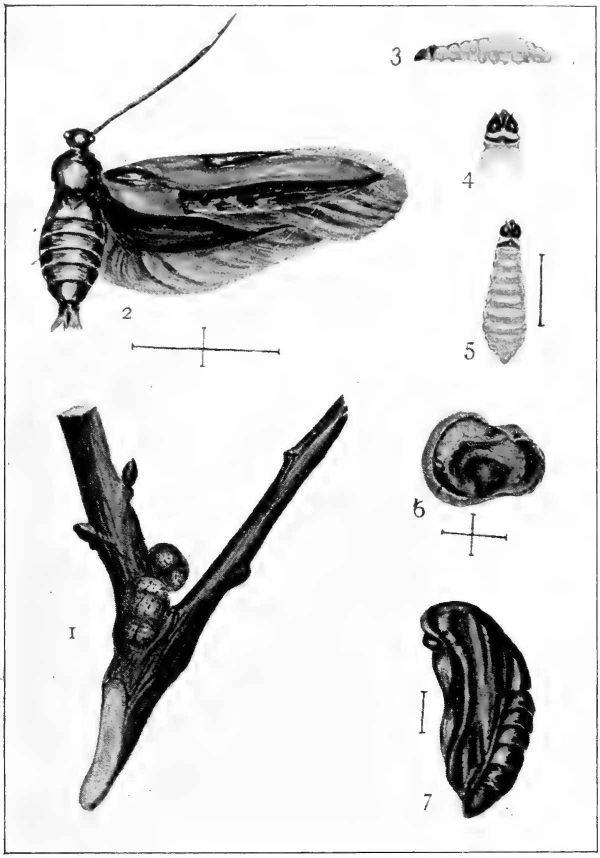
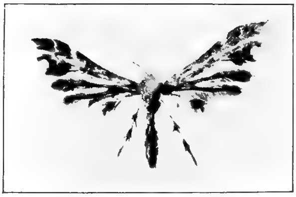
Ecpantheria Spines — Grape-vine Plume-moth — Work of Army-worm.





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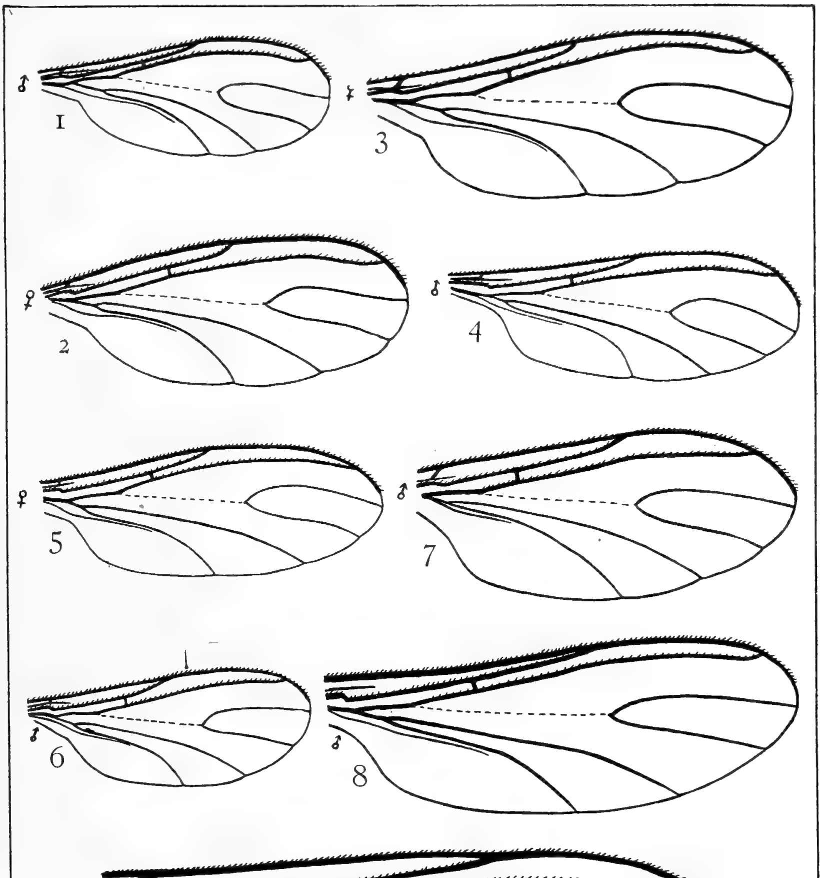
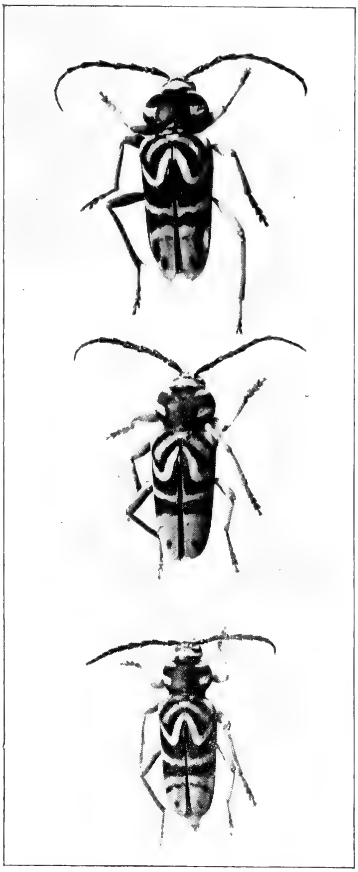
Kermes — Euclemensia — Oxyptilus.



New species of Sciara.



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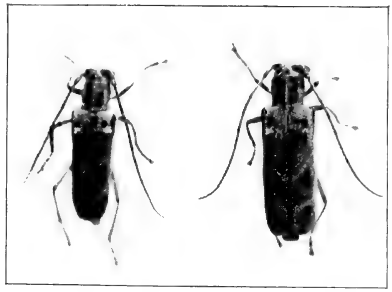

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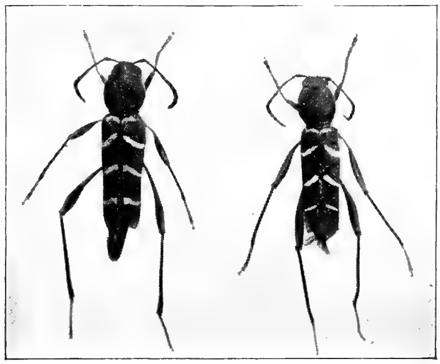

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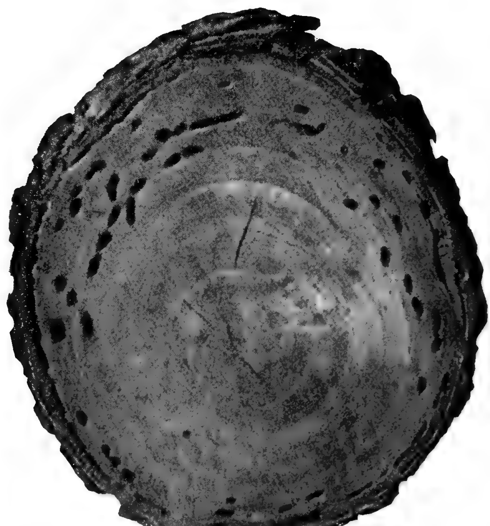

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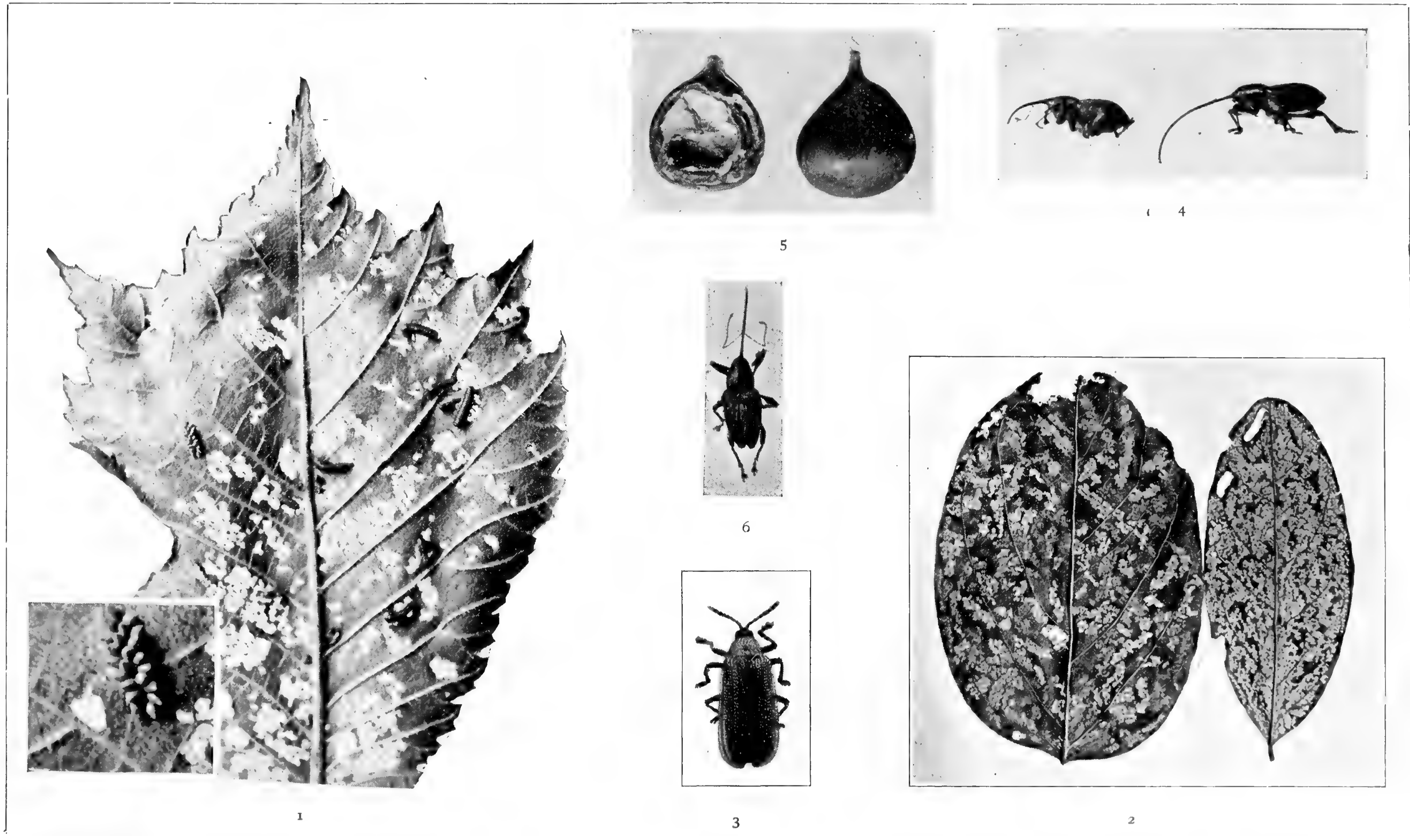
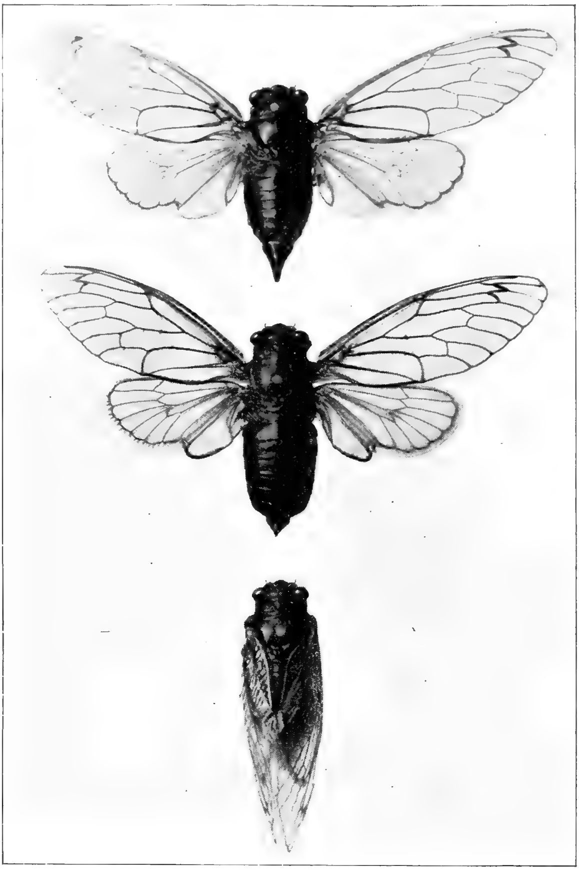
Maple and Elm Tree Borers.



Elm and Locust Leaf Beetles, and Chestnut Weevil.



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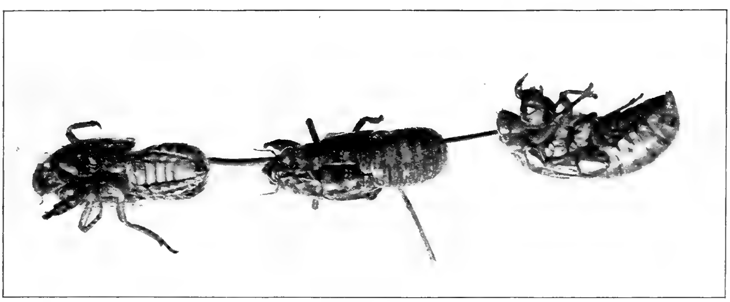

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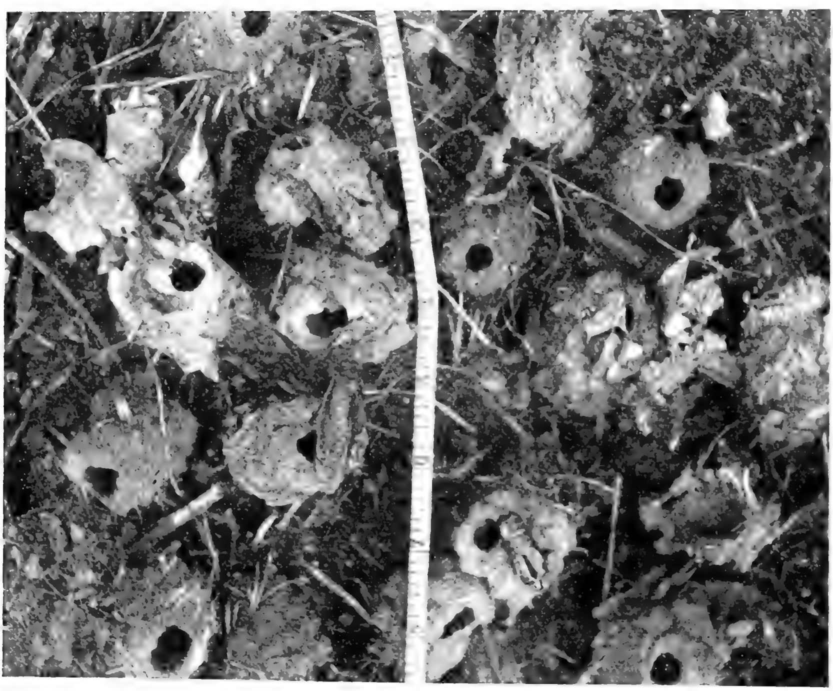
The Seventeen-year Cicada.

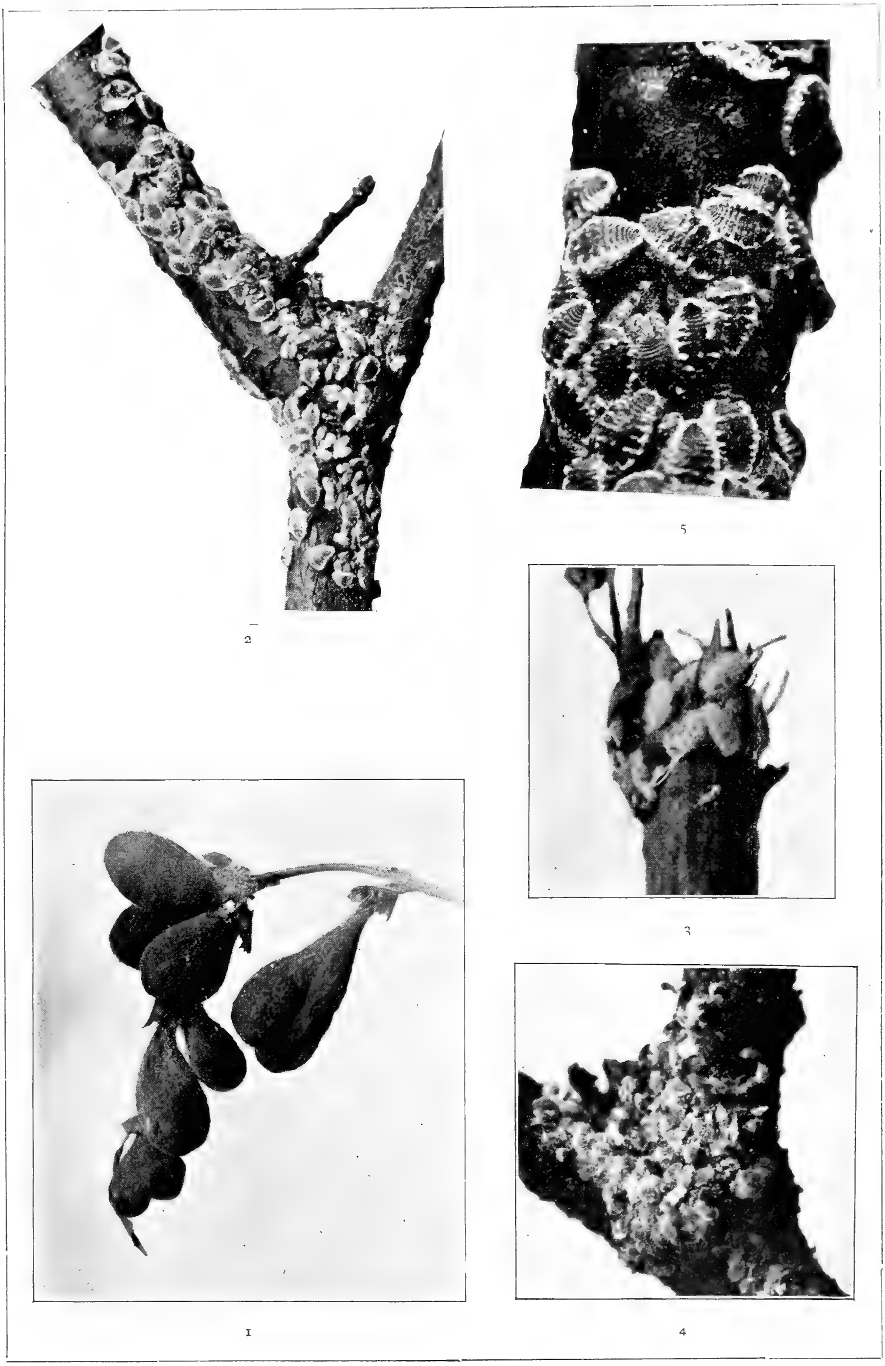


Cicada Chambers, at New Baltimore, N. Y.

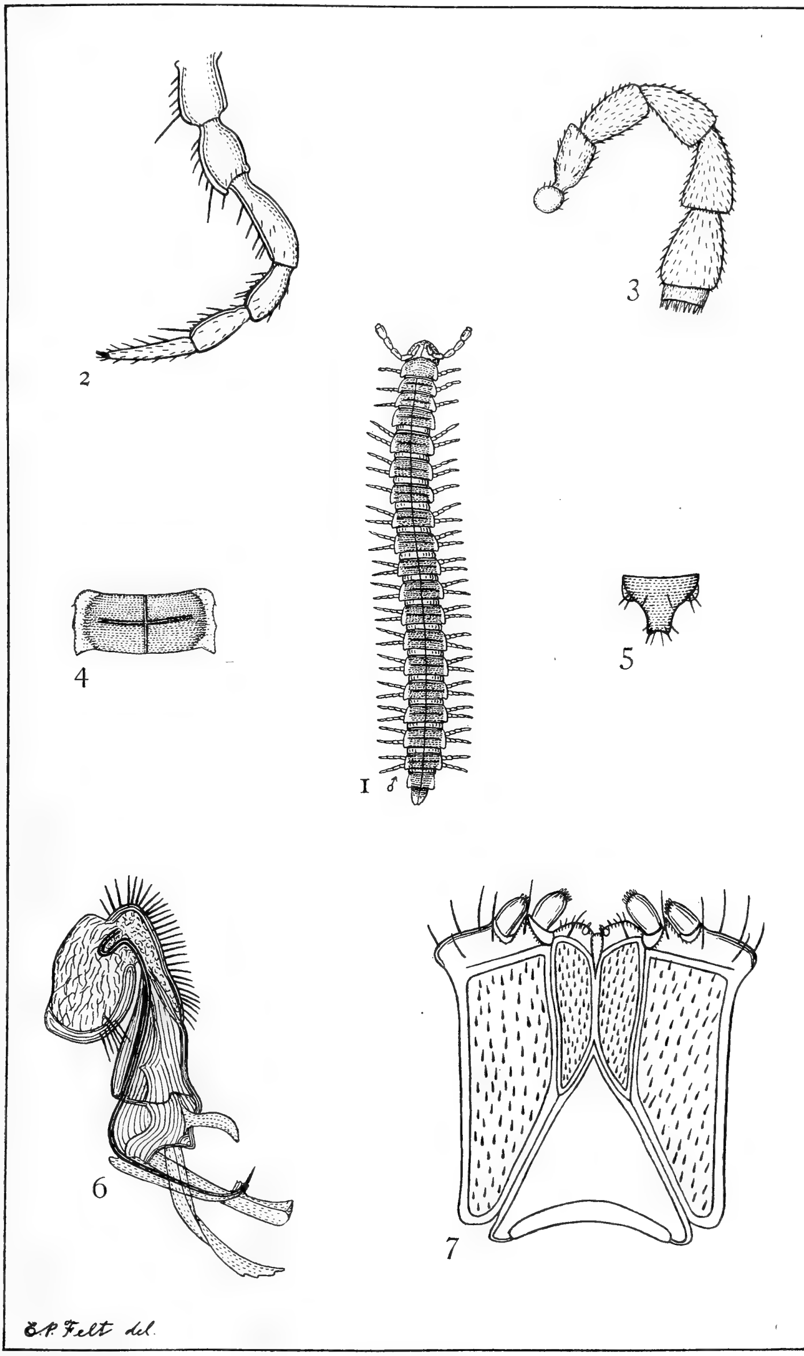
Cicada Chambers.

Cicada Chambers, at New Baltimore, N. Y.

Cicada Chambers, at New Baltimore, N. Y.



Pemphigus and Gossyparia.



Leptodesmus.

(F)

EXPLANATION OF PLATES.

Plates I, IV, V, VII, VIII, IX, XIV, are from photographs by E. P. Felt. Plates X, XI, XII, XIII, are from photographs by W. W. Byington.

PLATE I.

Ecpantheria scribonia.

The Great White Leopard Moth.

The upper three figures are males; the lowest two, females: showing the variations in maculation in this species.

PLATE II.

Leucania unipuncta.

The Army-Worm

Army-worms at work on a corn plant, nearly natural size (after Slingerland).

PLATE III.

Leucania unipuncta.

The Army-Worm.

Fig. *a.*— Moth at rest, natural size; *b*, moth with wings expanded; *c*, moth twice natural size; lower figures, light and dark varieties of army-worms, twice natural size (after Slingerland).

PLATE IV.

Fig. 1 — Larval spines of *Ecpantheria scribonia*, thirty-five times natural size.

Fig. 2.—Heads of timothy eaten by army-worms, nearly natural size.

Fig. 3.—Tips of grape vines infested with larvæ of *Oxyptilus periscelidactylus*, natural size.

Fig. 4.— Young and nearly full-grown larvæ of *Oxyptilus*, about three times natural size.

Fig. 5.— Pupæ of same, about three times natural size

PLATE V.

Fig. 1.— *Kermes galliformis* on twig, natural size.

Fig. 2.— Imago of *Euclemensia Bassettella* (Clemens).

Figs. 3, 4, 5.— Larvæ of same.

Fig. 6.— Larva within the Kermes.

Fig. 7.— Pupa (Figs. 1 to 7 from colored drawings by W. R. Walton).

Fig. 8.— *Oxyptilus periscelidactylus*, twice natural size.

Fig. 9.— The same in natural position, twice natural size.

PLATE VI.

Fig. 1.— Wing of *Sciara multiseta*, male.

Fig. 2.— " " " female.

Fig. 3.— " *S. pauciseta*, female.

Fig. 4.— " " " male.

Fig. 5.— " *S. agraria*, female.

Fig. 6.— " " " male.

Fig. 7.— " *S. fulvicauda*, male.

Fig. 8.— " *S. prolifica*, male.

Fig. 9.— " " " female (Figs. 1 to 9 inclusive thirty-five times natural size).

Fig. 10.— Genitalia, dorsal aspect, of *S. agraria* (enlarged).

Fig. 11.— Group of setæ of *S. multiseta* (much enlarged).

Fig. 12.— Group of setæ of *S. pauciseta* (much enlarged).

Fig. 13.— Genitalia, dorsal aspect, of *S. fulvicauda* (enlarged).

PLATE VII.

Fig. 1.— *Plagionotus speciosus*; the upper two females, natural size.

Fig. 2.— *Saperda tridentata*, male and female, twice natural size.

Fig. 3.—*Neoclytus erythrocephalus*, male and female, twice natural size.

Fig. 4.— Work of *Saperda* and *Neoclytus* under the bark in elm, one-half natural size.

Fig. 5.— Cross-section of limb showing work of *Saperda* and *Neoclytus*, one-half natural size.

Plate VIII.

Fig. 1.— Under surface of elm-leaf showing eggs, the larvæ and their work, of the elm-leaf beetle (nearly natural size); in the lower left-hand corner a group of eggs is represented three times natural size.

Fig. 2.— Locust leaves skeletonized by *Odontota dorsalis*, nearly natural size.

Fig. 3.— *Odontota dorsalis*, three times natural size.

Fig. 4.— Lateral view of male and female chestnut weevil, *Balaninus rectus*, twice natural size.

Fig. 5.— Chestnuts injured by weevil, one opened to show work inside, nearly natural size.

Fig. 6.— Dorsal view of female chestnut weevil, *Balaninus rectus*, twice natural size.

Plate IX.

Cicada septendecim.

The Seventeen-Year Cicada.

Fig. 1.— Male and female with wings spread (the left fore-shortened in photographing); one with wings closed, nearly natural size.

Fig. 2.— Dorsal, lateral and ventral aspects of pupal shells, nearly natural size.

Plate X.

Vertical views of Cicada chambers taken at New Baltimore, N. Y.; the lower one nearly one-half natural size, the upper one much reduced.

Plate XI.

Cicada chambers collected at New Baltimore, nearly one-half natural size.

Plate XII.

Cicada chambers at New Baltimore.

Plate XIII.

Cicada chambers at New Baltimore, another view.

Plate XIV.

Fig. 1.— Galls of *Pemphigus rhois*, natural size.

Fig. 2.— *Gossyparia ulmi*, full-grown females, taken June 7, slightly enlarged.

Fig. 3.— Male cocoons of *Gossyparia*, three times natural size.

Fig. 4.— Half-grown females of *Gossyparia*, taken Sept. 7, four times natural size.

Fig. 5.—Full-grown females of *Gossyparia*, about three times natural size.

Plate XV.

Leptodesmus falcatus.

Fig. 1.— Male, three times natural size.

Fig. 2.— Leg (x 24).

Fig. 3.— Palpus (x 17).

Fig. 4.— Dorsum of segment (x 7).

Fig. 5.— Dorsum of terminal segment (x 7).

Fig. 6.— Lateral view of copulatory leg of male (x 65).

Fig. 7.— Gnathochilarium (x 35).

INDEX.

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ERRATA.

Page 197, line 3 from bottom, at end of line read: lying in.
Page 197, line 2 from bottom, for reportedon, read reported on.
Page 291, line 15, for Missouri read Illinois.
Page 308, line 10 from bottom, for current read currant.
Page 356, line 5 from bottom, for 238 read 243.
Page 357, line 9, for Birch-tree read Birch-seed.
Page 363, line 13, for beach read beech.
Page 363, line 15 from bottom, for FREEST read FREEST.

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Entomological Contributions — No. II. Albany: The Argus Company, Printers, 1872. Pages 76. Also in the Twenty-fourth Annual Report on the New York State Museum of Natural History [for the year 1870]. 1872. Pages 109–170.

Entomological Contributions — No. III. Albany: The Argus Company, Printers, May, 1874. Pages 80 (113–192), figures 17. Also in the Twenty-sixth Annual Report of the New York State Museum of Natural History [for the year 1872]. 1874. Pages 117–192.

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Lepidoptera of the Adirondack Region. Albany: 1880. Pages 28. Also in the Seventh Annual Report of the Topographical Survey of the Adirondack Regions of New York, by Verplanck Colvin. Albany: 1880. Pages 375–400. (See Sixth Report on the Insects of New York, 1890, page [82] 178).

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[**Reports of the State Entomologist to the Regents of the University of the State of New York, for the years 1884 and 1885,** are published (only) in the 38th and 39th Annual Reports of the New York State Museum of Natural History, for the above named years, pages 67–76, 77–125].

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University of the State of New York

BULLETIN

OF THE

New York State Museum

VOL. 4 No. 16

OCTOBER 1897

ABORIGINAL CHIPPED STONE IMPLEMENTS

OF

NEW YORK

PREPARED BY

WILLIAM M. BEAUCHAMP, S. T. D.

ALBANY

UNIVERSITY OF THE STATE OF NEW YORK

1897

CONTENTS

INTRODUCTION

In 1896, the legislature appropriated $5000 to be used by the regents of the University for increasing the state collection illustrating New York aboriginal life, and for preserving such facts as might seem to them of most value. Most of this appropriation has been judiciously used by A. G. Richmond, esq., honorary curator of this department of the state museum, in securing several collections of great value. It was also thought advisable to issue some bulletins of a popular nature, illustrating the antiquities of New York, especially the implements and ornaments of the aborigines. In furtherance of this plan the Rev. W: M. Beauchamp, S. T. D., of Baldwinsville, N. Y., was consulted and his aid secured. He had been engaged for a quarter of a century in this study, and had accumulated a vast amount of available material. His suggestion was that such work might be distributed under suitable heads, each subject complete in itself, but forming a series if desired. The first would be that of the chipped stone implements of New York, and a paper on this is subjoined. A second would be on those polished articles of stone, in which New York is so rich; the paper on this is nearly completed, and will be an important contribution to science. Others might treat on the articles of clay, bone, horn, shell and metal, so abundantly found in the state.

It was thought that, in this way, not only would clearer information be afforded, but that the state museum would be the gainer, by valuable contributions of many things altogether uncared for now. Such has been the result elsewhere, and the local pride of our citizens may confidently be relied upon to make the state collection one unsurpassed. The illustrations are selections from the thousands of drawings which Dr Beauchamp has made, and show both rare and common forms.

For this valuable bulletin the state is indebted solely to Dr Beauchamp to whom its publication has been wholly entrusted. For the admirable work done in increasing the archeological collection, the state is indebted to our honorary curator, A. G. Richmond, president of the Canajoharie national bank, who has for years given his active and extremely valuable expert service to the increasing of our collections without a dollar of compensation from the state. It is a pleasure to recognize in this public way a service so satisfactory in its result and so unusual in being rendered to the state without salary.

It is hoped that Dr Beauchamp may from the results of his work for the past 25 years give us a series of bulletins which will make his stores of special knowledge available to every student of the subject.

MELVIL DEWEY
Secretary of the University

ABORIGINAL CHIPPED STONE IMPLEMENTS OF NEW YORK

ARCHEOLOGICAL WORK IN NEW YORK

While much has been done by the state of New York in the preservation and dissemination of documents relating to early days, little until now has been accomplished in collecting and arranging those still earlier records, found so largely in stone, which reveal much unwritten history. All early writers describe a condition of things evidently not representative of periods which were then already days of old. Implements and ornaments had changed, arts and history had been forgotten, a new race had displaced the old, as we have taken its place in turn. We can only know what that history and those arts were, by seeking their surviving memorials in the soil.

The state, however, has done valuable service in embodying so much relating to what is called indian history, in many of its publications. Crude as was Mr Schoolcraft's *Report on the Iroquois,* made in 1845, it was a boon to the public, and preserved or suggested much valuable matter. This was notably the case with the several Iroquois dialects, afterwards much enlarged by him. The *Documentary history* and the *New York colonial documents* made other interesting matter accessible. The *Report on the indian problem,* in 1889, wisely placed the Iroquois treaties before the public, although it was great misfortune that the signatures to these were not submitted to an expert in indian names. It would have saved a host of needless errors.

The work of the regents in the same direction has been good as far as it has gone. The annual reports which contain the papers of L. H. Morgan on recent Iroquois implements and ornaments, are yet among the most popular and best preserved. Part of these were afterwards embodied in his valuable *League of the Iroquois,* and were first produced nearly half a century since. The publication of Father Bruyas' Mohawk lexicon, written two centuries ago, was one of the earliest attempts to bring a New York indian language before the public, when systematically arranged. It has since been fully translated. The publication of the explorations and plans of Messrs Hough and Cheney, in the northern and western parts of New York gave prominence to the interesting earthworks in both sections, with occasional notes from others.

In connection with Mr Morgan's literary work he made an interesting collection of modern Iroquois articles for the state museum, and this has been partially supplemented by that made for the World's fair at Chicago, by the Rev. J. A. Sanborn. These might be enlarged. Occasional stone and other relics have come into the state collection by donation, but no systematic or sustained work has been done until that now begun. Individuals have not been idle in making up their own cabinets, sometimes soon dispersed, sometimes remaining, but often far surpassing anything belonging to the state. Notable among these are the collections of O. M. Bigelow, in Baldwinsville, illustrating Onondaga and neighboring counties; that of J. S. Twining, Copenhagen, pertaining to Jefferson county, now in the possession of the state; and those of S. L. Frey, Palatine Bridge, and A. G. Richmond, Canajoharie, so rich in the relics of Montgomery county and vicinity. Many smaller collections of interest might be mentioned.

The early Dutch writers are now available in many ways, and the various historical societies have added much to our knowledge of the aborigines. The Pennsylvania archives and colonial records contain much relating to those of this state, and other valuable material will be found outside of our limits. The recently discovered journal of Arent Van Curler (Corlaer) is a treasure indeed. The *Jesuit relations* have been diligently culled and annotated, and large portions relating to New York are now within easy reach. Valuable notes on local antiquities may be found in such works as Bolton's *History of Westchester,* Hough's *Histories of Jefferson and St Lawrence counties,* Doty's *History of Livingston county,* Young's *History of Chautauqua,* the *Onondaga centennial,* Clark's *Onondaga,* and many other local histories. Some are carefully prepared, forming a good working foundation.

The work done by Mr Squier as yet stands alone as a general account of the antiquities of New York now accessible to the public. Dr Frederick Larkin published a little work in 1880, entitled *Ancient man in America,* which is a careful treatise on the antiquities of the western part of the state. The Rev. W. M. Beauchamp prepared a map for the U. S. Bureau of ethnology, some years since, with descriptive notes of the Iroquois portion of the state, much of it from personal field work. This has since been enriched, and now contains all the reported indian sites of New York, large and small. It is very suggestive in many ways. The Bureau of ethnology has done much here, although its larger fields in the west compel it to leave many things to local efforts.

Philology has had its students. The issuing of Father Bruyas' valuable Mohawk lexicon marked an era in this respect, and Mr J. G. Shea has made valuable contributions from early French publications since that time. Messrs L. H. Morgan and O. H. Marshall did excellent work on the indian names in the western and some other parts of the state. Mr W. W. Tooker in the eastern, and the Rev. Dr Beauchamp in the central part of New York have done much in the same line. Prof. Horsford published Zeisberger's *Onondaga and Delaware dictionary* in 1887, but his journal of his residence at Onondaga still sleeps in the old manuscript at Bethlehem. The late Horatio Hale's *Iroquois book of rites* is an invaluable contribution to our knowledge of Iroquois songs and ceremonies. Prof. Lyman, of Syracuse, has recently taken down a large collection of indian songs, with the accompanying music, and the Bureau of ethnology is steadily at work on the Iroquois dialects. Others might be mentioned.

Colden preserved much in his history of the Five Nations, and the quaint and marvelous history written by David Cusick, the Tuscarora, has passed through many editions. It has recently been republished, with ample notes. Morgan's *League of the Iroquois* is a standard work, but has little to do with prehistoric, or even early historic times.

ABORIGINAL OCCUPATION

The aboriginal occupation of New York was of a varied character and for a long time after it was first visited by man, almost its whole extent was but a temporary resort for hunters and fishermen. Rivers were the first places to attract men, and rifts on these were the favorite spots for camps. Good fishing and fording were important considerations and determined the routes of travelers and the location of many hamlets. The mere abundance of fish and game drew roving men to some places, and the small supply of the former was a sufficient reason why the Mohawk valley was so little visited until a recent day. For a similar reason deep lakes were little frequented here, unless at the shallow waters near their outlets. The aborigines of New York seldom used the hook and line until after European contact, and the harpoon, arrow, stone fish weir and net were useful only where the water was of no great depth. Large lakes, too, were often perilous places for canoes, while on most rivers they could be employed at any time. Accordingly early relics and camps are most frequent near large streams and small lakes. Where a river was as large as the Hudson in its lower course, camps would be expected only near the mouths of its tributaries, or in sheltered spots; near the sea they would also occur on shallow bays. In the one case the burnt earth and frequent relics, in the other the great shell heaps attest the presence of early man.

Many of the finest articles, however, have been discovered near the old trails, or in low grounds. If lost on a village site in peaceful times, they would have been sought and found with comparative ease. On the road, time could not always be allowed for this, and weeds, brambles and mire might have rendered all search useless.

These visitors came from many directions, and with differing habits, as relics plainly show; but having once been here, there were soon favorite places of resort. In process of time small hamlets were formed, often but the renewal of fishing camps from year to year. The old lodges would be repaired or rebuilt on the same spots, used in the summer and abandoned in the winter. This was the Iroquois practice in the seventeenth century, and in Canada the wandering tribes had a succession of camping places, to which they periodically resorted. Some northern tribes were thus winter visitors in New York. Nearer the sea, many indian tribes as steadily vibrated between the shore and the interior as some of our people do now. The new is ever the old.

When the Iroquois came into New York they brought a change. They hunted and fished, but they were also growers of corn, pumpkins and beans. Although they camped on the rivers, their towns and forts were almost always at some distance from them. It might be but a few rods, but often it was many miles. They wished not only strong positions, but situations where canoes could not reach them. This was always the case in warlike times, and the position of the town will often show confidence or fear. Their permanent homes also depended to some extent upon the soil, being a corn raising people; and in fact nearly all camps of others as well were placed on a light, and not a heavy soil. Very rarely indeed did other considerations outweigh this. Iroquois villages are thus not to be expected in regions characterized by primitive rocks; a glance at a map showing the indian sites of New York and Canada, will make apparent how much their location was affected by geological conditions.

The Algonquin tribes built palisaded forts in the eastern part of New York, somewhat like those of the Iroquois, and their long houses are reported to have been even longer than those of the latter. Earthworks here, however, were nearly all defenses of the Iroquoian family, and yield abundant earthenware. Some of these are quite recent, and in these are observed suggestions of a knowledge of European articles, soon followed by the articles themselves. These later sites, usually simple stockades, have often done a work similar to that of the Rosetta stone, but in another way. Knowing their age, and finding aboriginal relics on them of peculiar kinds, we are able to give the approximate age of similar articles elsewhere. In this will be found one great advantage of studying some New York sites, an advantage not confined in its results to our own borders.

One important question relates to the Eskimo. It will appear that some articles now used only by them are frequent in the northern part of New York, along with others which suggest their occasional presence. It is well known, also, that they once lived much farther south than now, and it may yet appear that they were sometimes visitors here. Rash conclusions are to be avoided, but so much is known as to call for further light.

It is to be deplored that such quantities of our finest relics are forever lost to the state, but this is a lament in which every part of our land shares. Enough remains to give us some idea of the arts — perhaps of the habits and history — of our predecessors. Although so many forts and sites have also been obliterated, quite a goodly number have been located and described, and with a moderate farther research it is possible to tell a great deal of the occupation of New York in historic and prehistoric times.

The articles left by the aborigines here have a wide range in nature and origin. In a broad way they may be classed as flaked or chipped forms of stone, those of clay, those of shell, horn or bone, those of metal, glass and wood; and most interesting of all, those of picked or polished stone. This is a simple matter of convenience, for many things in all these have other relations. Fine and beautifully wrought articles may precede those which are rude, or they may have coexisted in the same camp or town. Horn and bone were often used with stone. Metallic articles were of a remote date, as well as recent. Wood was used in every period.

While many rude implements closely resemble those called paleolithic, these are usually surface finds here, pointing to no remote antiquity. In fact quite deep burial often proves no test of age, owing to some well known customs as well as natural agencies. Some implements made of argillite, and much changed by weathering or contact with the soil, although surface finds, are precisely like those occurring in the higher deposits at Trenton, N. J. Thus far none of the ruder articles have been reported at any great depth here, though this is but negative testimony, which farther research may change. Up to the present time polished stone implements have been reported here deepest of all. How reliable the reports are it is difficult to say.

Caches of flint are frequent, commonly composed of broadly chipped stones, rather more triangular than leaf-shaped in form, and nearly alike in size, although this is not always the case. In general they are supposed to be those from which others were to be made, having been deposited either for security or to preserve the temper of the flint. Although not strictly correct, this word will be used for a common material. Many of these simple articles were not farther elaborated, but at once came into use. Others may have been changed into other forms, but this is little more than theory. Their uniformity in size, and their burial in quantities give plausibility to it, and it may well be allowed that they were brought from a distance for purposes of trade, or further development. Quantities of material came here in a still ruder form, which have not been found in caches, and among these were some of the choicer kinds. There are abundant flint flakes in places where they could only have come through the agency of man, and these indicate the arrow maker's temporary home.

The aborigines made but moderate use of the local hornstone, so plentiful in the corniferous limestone of New York, though it is often recognizable in the ruder articles to which it is adapted. At Black Rock in Buffalo, and across the river in Canada, one can easily see where blocks of hornstone were detached and used. Occasionally something of the kind will be seen elsewhere, but most of the material for the finer arrows, knives and spears came from without the state. Among these implements occur jaspers of every hue, white quartz, chalcedony, argillite, schist and sandstone, as well as the finer flints of bluish or brownish grey; yellow jasper was a favorite material, specially for large implements, and it is comparatively frequent in caches. It was probably derived from a neighboring state.

In a very broad way it is well known that the prevailing materials used in any region have a somewhat local character. Through Ohio and much of New York, the grey or drab cherts from the limestone are prevalent, with a projection of this material far southward. In the southern Atlantic states a brownish quartzite or coarse sandstone appears, with finer materials in the mountains. Along the Hudson and in New England white quartz was largely used; and in the northern states of the Mississippi valley an opaque white or pinkish flint was the rule. A characteristic dark hornstone also appears there in immense caches in some places. The beautiful arrows and other small implements of the Rocky mountains and the Pacific slope are also well known, and in other quarters yellow jasper is common. An experienced archeologist may thus often feel sure of the general origin of an article, without knowing precisely where it was found. That is a question of trade or migration.

Material is often a better guide in determining ultimate origin than form. The drills and scrapers of the east are often matched by those of the west. A few New York arrows rival those of Oregon in size, though not in delicacy. When the stone used is considered the difference is more obvious. Form and material may both aid in determining what people visited New York in early days. In a representative and ample collection from this state, where the locality of the specimen is clearly and correctly recorded, as it always should be, later critical study of this kind may establish facts now unknown, regarding early migration and trade.

Celts, gouges and pestles were often made of local pebbles, but those of basalt and striped slate may show a different origin. Gorgets, tubes, ceremonial stones and amulets often do the same. Native copper implements of course come from afar, and sheets of mica do not naturally occur here. Steatite, as fragments of vessels, is also found abundantly, hundreds of miles from any quarry, and other like things will appear in due time.

All flint implements are not arrows or spears, however much they may resemble them at first sight, and thus a lack of observation and distinction has led to errors. It is not long since Sir John Lubbock said that there were no scrapers here, whereas many forms are abundant in New York alone, some of them precisely like those used by the Eskimo now. They simply had not been observed or reported. A very large proportion of implements termed arrows or spears are really knives. They never could have been shot or thrown with precision, they are so bent or one-sided. Many drills have also been called arrows; and in fact articles often grade into each other, or unite characteristic features. Drill, knife and scraper may appear in one implement, and a writer in early days said of western arrow points, 'if no knife is at hand, they use them also to skin the animals they have killed.' They would answer well.

While there are many gradations, or variations of form, in the flint implements found in New York, few typical examples have been found or described which are without representatives here, unless it be in some massive forms. Farther observation may supply these, and perhaps even others. On the other hand, some notable types appear here as yet undescribed. These should have due prominence.

In chipped or flaked implements the simplest form was that of the knife, which might sometimes be used for a spear, but not often for an arrow-head, unless of unusual symmetry. Many simple flakes were employed for this, the edge being sharply and neatly chipped. Some of these inconspicuous flakes show better workmanship in these edges than large and symmetrical implements, but they seem to have served only a temporary purpose. A knife was wanted; a flake was picked up, to which in a few moments an edge was given; it was used and thrown away. So that it was sharp, little more was required for mere use, but in many cases knives were both large and beautiful. As has been said, in an emergency almost any article might serve as a knife, but there are many special forms. When the surface was bent, as was often the case, knives were probably used also as scrapers, without having the distinct scraper edge. Some agree with Loskiel's description, who says, 'their knives were made in a long triangular shape, the long sides being sharpened.'

ARROW MAKING

In an excellent article on the stone art of the Mississippi valley, (13th *Annual report of the bureau of ethnology*, p. 139-42) Mr Gerard Fowke gives an extended account of arrow making, as practised in different places. Without going into full detail, it may be well to say here that chipping was usually done by pressure or percussion. In almost all cases, a piece of horn or bone, slightly notched, was used as a flaker. The process has been observed by many, for it is not an extinct art, although steel is now often substituted for horn or bone, and glass for stone. Any stone which will admit of a conchoidal fracture, and some which will not, may be used; for large implements, and even for small, a siliceous limestone or even sandstone was often employed. Quartz was used, but some varieties were not adapted for delicate work, while for large implements it was a showy material.

Usually the stone is held in one hand, or placed on wood, buckskin, a blanket, or other yielding substance. More rarely it is held against a stone anvil, and chipped with a stone hammer. Simple pressure suffices in most cases, the bone flaker being set against the proper points, and small pieces being chipped off by pressing it in different directions. Some hold the stone in the hand, setting the tool at different points and angles, while an assistant gently strikes it. Pincers are sometimes used, and the Klamath indians hold the wooden handle of the flaker under the arm, pressing the stone against the point. A long flat tool, found in Great Britain, was thought a flaking implement by Mr Evans, but the same stone article is here either a scraper or knife.

The time required in arrow making differs according to the size or delicacy of the article to be made. In his account of the indians of Virginia, in 1607, Capt. John Smith said, 'His arrow-head he maketh quickly, with a little bone, of any splinter of stone or glass.' Evans said that the Mexicans could turn out a hundred obsidian knives in an hour, but these were probably only long and sharp flakes, often made at a single stroke. Crook, however, states that the indians of the plains will make from fifty to a hundred arrows in an hour, with a knife for a flaker. These must be rude, however serviceable. A Klamath indian made a complete arrow-head in five minutes, and a Shasta indian took an hour for this. On articles of extraordinary delicacy and size, many days might be employed.

Mr Frank H. Cushing, in his address upon the arrow, at the Springfield meeting of the American association for the advancement of science in 1895, gave an interesting account of his own experience in arrow making. In a boyish experiment he stumbled upon the use of the bone flaker, by which he at once chipped the flint 'in long, continuously narrow surface flakes wherever the edge was caught in the bone at a certain angle.' His experience proved to him 'that paleolithic man, of the French caves at least — that man who is said to have known no other art of working stone than by rudely breaking it into shape by blows of other stones — could not have existed in such primary status of art for more than a few seasons at most.' (See *Proc. A. A. A. S.* 1895. p. 205)

Before he went to the Smithsonian institution or to Zuni, he had elaborated 'some seven or eight totally distinct methods of working flint-like substances with stone age apparatus.' His whole account is worthy of careful study, and to him we are indebted for the knowledge of one purpose of caches. From one pebble he had made 'seven finished knife and arrow blades in exactly 38 minutes;' and, 'from obsidian or glass a very small and delicate arrow-point — the most easily made, by the way — in less than two minutes.'

ARROW-HEADS

There are local varieties in arrows, as in other implements, and on some sites one type may prevail to the exclusion of almost all others, but the distribution of all leading types is very general. There are few forms of the smaller chipped implements, from the Atlantic to the Rocky mountains, which may not be matched in form in New York, whether it be arrow, spear, drill, scraper, or knife, the early visitors bringing them from every part. In most cases the finer ones come from a distance, while for the smaller, more common and less valuable, the hornstone of the Helderberg group often sufficed.

Some small forms have been classed as boys' arrows, but there is little reason for this, for they are much too common, and were serviceable in hunting. Many are found in New York less than half an inch in length, and they occur in quantities not over an inch long. Primitive children's arrows were used with a blow-gun.

Arrow making was a necessity to every hunter, but all were not equally skilful, and some would acquire a high reputation, finding their work in demand. A division of labor was inevitable, even in savage life, and Roger Williams described this in 1643: 'They have some who follow onely making of bowes, some arrows, some dishes, (and the women make all the earthen vessels) some follow fishing, some hunting; most on the seaside make money, and store up shells in summer, whereof they make their money.' Some of the finest stone work here, also, was that of an early day, the Iroquois having no fondness for working in stone, and restricting themselves mostly to axes, small arrows and knives. The finest material, also, is not of recent date, but of that period when men were here as hunters and fishers, rather than as residents. This is true of ornamental stone work as well, except in the very recent introduction of red pipestone, and the fine stone pipes of the later Iroquois, made with metallic tools. The stone masks also belong to the historic period.

It is impossible to draw an exact line between arrows, spears and knives, although most of them may be easily distinguished; and it is almost as difficult to classify satisfactorily the varieties of either of these implements. Dr Rau arranged arrow-heads as leaf-shape; convex sided, with truncate base; triangular; triangular, but with indented base; notched at the sides, with convex, straight, or indented base; stemmed, but with various bases; barbed and stemmed. Others have suggested additional groups, but nothing exactly covering all has yet been proposed.

The common form of cached articles in New York is a straight base, straight or slightly concave edges gradually expanding to the full width of the stone, whence longer curved edges contract to the point. These coarsely flaked implements are commonly from four to five inches in length, and sometimes scores occur in one cache. Although usually of the drab, grey or dark hornstone, this is not invariable, nor is the size always the same. They may be found near streams navigable by canoes, but not always close to them. In some cases they are comparatively distant from prominent routes or resorts, but in places favorable for hunting or fishing. They are frequent in New York, and fig. 1 is typical of a large class often used without change. It is one out of a cache of 29 of the same form, and is four inches long, but among the rest were some larger.

Those which Dr Rau called leaf-shaped arrows, seem to be knives as a rule; at least they might have been used as such, and it may be best to refer them to that class. In most cases his convex sided arrows, with truncate bases, seem knives also. The triangular forms, with either the straight or indented base, are true arrow-heads, and these were favorites with the Iroquois, who seldom used others. Their use was not confined to them. Triangular arrows with straight bases are somewhat rare, but the other form is common, and sometimes very slender and beautiful; true arrow-heads, though suggestive of drills. They vary from one to two and one-half inches in length, and on some sites no others will be found. When the Iroquois had brass to use, they retained their favorite form, and the metallic point was simply sheet brass, cut in a long triangle, perforated or not.

To Dr Rau's classification may be added two kinds of bunts, which are divisions of the stemmed arrows, sometimes with expanded bases; pentagonal and straight sided, double notched, and what is locally known as the shark's tooth form. These might be placed in his classes, although he gives no examples of these forms. Some of them are somewhat local, and beveled arrows may prove to be scrapers.

The various forms of triangular arrows are often called war arrows, and Catlin makes a distinction between war and hunting arrows of a little different nature. (See *North American indians*, 33). He says that the quiver 'generally contains two varieties. The one to be drawn upon an enemy, generally poisoned, and with long flukes or barbs, which are designed to hang the blade in the wound after the shaft is withdrawn, in which they are but slightly glued; the other to be used for their game, with the blade firmly fastened to the shaft, the flukes inverted, that it may be easily drawn from the wound, and used on a future occasion.' If the barbs are the essential distinction, many other forms besides the triangular would be called war arrows.

The wonderful rapidity with which indians send their arrows has been remarked by both early and recent writers, and this argues a corresponding facility in making them. They were not confined to war and hunting, but were largely employed in shooting fish. Father Rasles mentioned this when he was among the Illinois in 1693. When they wanted fish, 'they embark in a canoe with their bows and arrows, standing upright, for the purpose of more easily seeing the fish; as soon as they perceive it they pierce it with an arrow.' This method was noticed farther east, and in Johnson's *History of New England*, 1654, it is said, 'Their Boyes will ordinarily shoot fish with their Arrowes as they swim in the shallow Rivers, they draw the Arrow halfe way, putting the point of it into the water, they let flye and strike the fish through.' Loskiel mentioned the same thing in Pennsylvania, in the last century, 'Little boys are even seen frequently wading in shallow brooks, shooting small fishes with bows and arrows.' Lawson (1714) observed the same thing in the Carolinas, and other early writers refer to it elsewhere. This is one reason for the abundance of arrows along rivers and streams, and this would allow of much larger heads than the usual 'regulation size.'

Triangular arrows with concave bases are widely distributed, and in New York their chief distinction is in material and breadth. In

Europe they seem rare. Sometimes they are almost equilateral; at others nearly as slender as many perforators. They are usually neatly chipped and thin. Fig. 2 is a small example, about as broad as long, being an inch in extent. It has a concave base, and is of common flint, slightly mottled. This comes from the Seneca river, where it is a frequent form. It is sometimes much smaller. Fig. 3 is of brown flint from the same stream. In this, however, while the base is more deeply concave, the lateral lines are slightly convex instead of straight, and the width exceeds the length, being one and three-eighths inches. Fig. 4*a*, a still broader form, seems a true arrow, and yet there are reasons for thinking it a knife. It is of common dark flint, and is one and one quarter inches wide. Fig. 4*b* is an extreme form of this, from Cross lake. It is of an obscurely banded drab flint, and the width is one and eleven sixteenths inches, more than double the length, if we call it an arrow, but its proper place seems with the knives. Fig. 4*c* shows the other extreme of this somewhat rare form. In this all the angles are a little rounded.

Three early forts, near Baldwinsville, have afforded some of the finest examples of the straight sided, slender triangular arrows, varying from one and one quarter to two and one half inches long. From one of these, a stockade on the north side of Seneca river, come both broad and extremely slender forms, with all intermediate grades. Fig. 5 is one of these, one and one quarter inches long, and of dark flint, proportionally quite as broad as those so frequent elsewhere. Fig. 6 is of light drab flint, and is two and one half inches long, the utmost limit technically allowed for arrow-heads. It will be seen that an inch more would add little to its weight, or resistance to the air. Fig. 7 is of the same material, and from the same place. It is two inches long, and another almost as long is very much narrower.

An Onondaga stockade, occupied about A. D. 1600, has this smaller and broader form, but with few examples. It occurs a little later in time, in common flint, in a stockade a mile south of Delphi, but is not as neatly chipped. An Onondaga stockade south of Pompey Center, apparently occupied about 1640, has the same form and material. Fig. 8 is an example, one and one eighth inches long. Some are smaller than this. Most of these later specimens are small, and have a deeply indented base. They occur on Indian hill in Pompey, the site of the Onondaga town which Father Le Moyne first visited in 1654. Fig. 9 is a beautifully mottled one from Watervale, in the same town. It is two inches long, and is exceptional in material, as most of these are of common flint.

In the early Mohawk towns the same favorite Iroquois arrow appears, but in a ruder form. Fig. 10 is a curious example from the earthwork in Minden, near Fort Plain. This work seems to have been one of the earliest triad of Mohawk forts, occupied respectively by the three clans of Turtle, Bear and Wolf, and having suggestions at least of European contact. Squier's statement that European articles have been found there, seems premature. This arrow point is of grey flint, one and one quarter inches long, and may be unfinished, as it is flat on one side, and much ridged on the other. Fig. 11 represents another of the same material, and much like the last, except in having a lower ridge and deeper base. This comes from a Mohawk town east of Wagner's Hollow, which has afforded some of the most remarkable relics of the early historic period. Although usually of common flint, fig. 12 shows a very pretty white one from Baldwinsville, which is not only a good example, but is very finely serrated.

There are distinct varieties of the triangular arrows, and fig. 13 represents one of the rarest of these from the double walled earthwork, three miles southeast of Baldwinsville. It is of a beautifully variegated and lustrous flint, with a distinct groove in the center of each surface, tapering from base to point. The base is much indented, though not as deeply as in some, and the length is two and one eighth inches, with convex edges. The locality is of importance, as showing this to be an Iroquoian form. Fig. 14 shows another of these from Cross lake, two and one half inches long, which is very fine, and of a light bluish grey flint. Other fine examples might be given, for though somewhat rare, it is widely distributed.

Another variety, in which the edge presents a double curve, is locally called the shark's tooth form. Jones, in his *Antiquities of Georgia*, calls most triangular arrows the shark's tooth form, but in New York it is restricted to a peculiarly curved outline. Fig. 15 is an extreme form of this, made of common flint, one and three quarters inches long. It is remarkable for its obtuse barbs. This was found on Onondaga lake. Fig. 16 represents the typical form, with gentler curves and sharper angles. It is a large specimen from Ithaca, of dark flint, and two and one quarter inches long. Many differ hardly at all from this except in size. Fig. 17 is a slender form from Brewerton, of common flint, two inches long. They are rarely as slender as this, but many intermediate varieties occur, none of which have slender barbs. Good examples seem almost peculiar to New York.

Notchless pentagonal arrows are moderately distributed, and occur in several materials. Fig. 18 is one of common flint, from the town of Van Buren, and has angles somewhat rounded. It is quite flat, and one and three quarters inches long. They are usually quite as broad as this, though slender forms occur. A ruder and more massive one, of the same size and outline, comes from Baldwinsville. It is made of a piece of common hornstone, which unites the light clay color and the dark drab tint. They may be either arrows or knives.

The name of bunt has been adopted for a class of stemmed stone arrow-heads, with broadly rounded or obtusely pointed ends. The term was first used in Missouri, and while Mr A. E. Douglass, of New York city, has 753 Missouri specimens in his collection, he reports none from this state. They are frequent farther south and southwest, and seem here most abundant on the Seneca river. In outline they often have the scraper forms, and are sometimes confounded with them, but the class will hold good. To this day the Onondagas use blunt headed arrows made entirely of wood, as they probably always did. Sometimes those of stone seem to have been merely broken arrows, long ago recut for use, as in fig. 19, from Seneca river. Of course this might have been used for digging purposes, like longer ones of this form, but it seems too short for this. In this specimen there is no perceptible difference in the flaking, as though it had a secondary use. It is one and one half inches long. Fig. 20 shows a longer and straighter form, made of light grey flint. This is quite thick, and about one and three quarters inches long. Fig. 21 is a typical form, of which there are many examples. It is of common flint, and is one and one half inches long. Most of these are from Onondaga county. The same form often appears in scrapers. Fig. 22 can hardly be assigned any other place, although too long and heavy to be strictly called an arrow, being two and three quarters inches long, and very coarsely chipped. It is of common flint, and occurs on the Seneca river in smaller sizes. As an arrow it might have been used to stun fish.

Fig. 23 is a fine arrow of the bunt form, quite flat, and with a finely rounded edge. It is one and three eighths inches long, and is made of a fine brown flinty sandstone. In this the stem expands at the base. Fig. 24 is even finer, and is of dark blue flint, about one and one quarter inches long. It differs from the last in having distinct barbs. Fig. 25 has a simple rounded stem, and is a beautiful specimen, made of light grey and lustrous jasper. It is from Cross lake, and is nearly one and seven eighths inches long. This is more properly a scraper, for though it is neatly chipped all over both sides, yet one side is much the flatter, and the edge is cut at the usual angle. It may be considered an intermediate form. A large proportion of the bunts on Seneca river have the rounded end, but some are angular. They are quite variable.

Among the stemmed but notchless forms are many having a suggestion of barbs, and of the kind which Catlin called hunting arrows. This projection, when not carried below a horizontal line, is now called a shoulder, and is a frequent feature. The edges may be straight or curved, and they are so common as scarcely to require illustration. Fig. 26 is a good typical specimen, made of light grey flint, and one and seven eighths inches long. This is from Cross lake. An infinite variety will be found in this simple form, produced by variations in length, breadth, and proportion of parts. Fig. 27 is a very odd example, of yellow jasper, suggesting both the pentagonal and bunt arrows, and having deep notches. A little central point also suggests the drill. It comes from Tonawanda and is but little over an inch long. Fig. 28 is still more curious here, being more like extreme western forms than those of New York. It is very small, too, though others here, of a different outline, are less than half the length of this. It might be described as a narrow and a broad triangle, united by their bases. It is of flint, one and one quarter inches long, and is said to have been found on Grand island, in the Niagara river. Fig. 30 is a very small and pretty arrow of yellow jasper, three quarters of an inch long, and comes from Amboy, west of Syracuse. Yellow jasper is a common material for small arrow heads.

Fig. 31 represents a very common form. This is of white flint, two and one eighth inches long, and comes from Brewerton. It is neatly chipped, and has a slightly expanding base. There are many small and often good specimens of this form, usually quite slender, and made of the nearest hornstone, but fine examples occur on most indian sites, except those of the Iroquois. Beveled arrows are commonly of this form.

Among the notched or shouldered arrows, of every variety, more or less occur which are of a spiral or twisted form, but whether this came from design may be a question. The indians were aware of the advantages of a rotary motion, and learned to rifle smooth bore guns very neatly for themselves. Loskiel said, 'Many of the Delawares and Iroquois have learned to make very good rifle barrels of common fowling pieces, and keep them likewise in good repair.' On the other hand, the triangular Iroquois arrow-heads, whether of metal or stone, were made as flat as possible. Obviously, a rotary motion was not always desirable in the woods, and to this day the Onondagas do not feather their own arrows, though they will do it for others. Accordingly, as the spiral twist is the exception rather than the rule with stone arrow-heads, and is quite as frequent in knives and spears, this feature is to be ascribed to the first flaking of the material, rather than to design. It may be observed that in the picture of the battle on Lake Champlain in 1609, the indians on both sides have feathered arrows, as is the case in the picture of a Susquehanna warrior made about the same time, and this might be thought the idea of the European artist, rather than the fact, were we not told elsewhere how the southern indians affixed the feather. When required, the Onondagas feather their shafts very simply and neatly. The shaft of the feather is split, one side only being used. The anterior part of this is stripped and bound on the arrow shaft, pointing toward the notch. Then the feathered part is reversed, given a slight twist, and bound firmly at the end. As this spiral twist is said to be purely American, some have claimed that thence came the idea of rifling gun barrels. This feature, however, appeared in Europe as early as 1520; even earlier as regards the mere groove.

Another arrow form is not distinctly notched in the usual way, but has an angular indentation on each side. Fig. 32 is a good illustration of this. It is of common flint, one and one half inches long, and was found on the Seneca river. Such arrows are quite flat, and might easily have served for knives. Fig. 33 is of the same form, but a little larger, being one and three quarters inches long. It is of brown flint, and was found on Oneida lake. These are typical of many others, but some are proportionally very long. Fig. 34 is an intermediate form, with curving instead of straight outlines, and this also is typical of a large class, many of which are not more than half this length. It was found on the Seneca river, and is one and five eighths inches long. The material is that whitish flint, so commonly used in some parts of Illinois, and which is frequently seen in arrow forms in New York.

Some parallel sided angular arrow-heads are both remarkable and rare. Two of the best specimens of these were found on the Seneca river, more than ten miles apart, and no one can doubt they were made by the same hand. Both were picked up by the writer, one being at first thought a broken arrow, as it lay on the ground. Fortunately something about it arrested attention, and a slight examination revealed its great value. For comparison, as well as on account of their unique character, both are represented in figs. 35 and 36. They are quite thin, one and one eighth inches long, angular and straight sided, and are of drab flint. The notch on each side distinguishes them from some other forms. One much like these was found at Newark Valley, of the same material, but slightly larger. It differed in having a distinctly concave base. Fig. 37 has a resemblance to these also, but is much larger and ruder, although thin. It is of a grey flinty limestone, and was found on the east side of Skaneateles lake. The length is two inches, and the width but very little less. Fig. 38 shows one from Herkimer county, of common flint, and one and one half inches long. It is not as symmetrical as the parallel sided ones mentioned, and it has a notch in the center of the base, besides those in the sides. There are other examples which are much less striking than these.

Fig. 39 is of yellow jasper, with curving edges, and somewhat thin. It is an inch long, and has long barbs, a feature not common here. It has the needle-like point, found in many arrow-heads, but usually more distinct than in this. This feature is shown in a broad way, though by no means typical, in fig. 40, which is of black flint, one and five eighths inches long, and from the Oswego river. This has long barbs, though shorter than in some imperfect specimens, such slender projections being peculiarly liable to fracture. Its general character is more like articles from Ohio than New York. Fig. 41 is the most remarkable for material, being a shark's tooth, perhaps a fossil, one and one half inches long. It has been deeply and narrowly notched, but is otherwise unchanged. It may be a memorial of the Iroquois wars with the Catawbas and other southern indians, or it may be of an older day, for, although found near an historic Cayuga site, its age is uncertain. It was found in a grave near Union Springs, on the east side of Cayuga lake, by Mr S. L. Frey of Palatine Bridge, whose account may be quoted. 'The burials at this place were very numerous, and judging from the state of the bones, older than the coming of the whites, unless a single glass bead which I found there, would seem to indicate white trade. At this place, associated with many small shell beads, or rather shells used for beads, was the arrow referred to. It is perfect, and just as it was in its original state, except the two slits which have been cut for fastening it to the shaft. The enamel is as hard, glassy and perfect as ever, and it is really a unique specimen, as far as my explorations go. I think similar ones were used by the southern indians.' The locality is one where there were early and recent cemeteries and villages, but on the whole the grave was probably comparatively recent. Perforated fossil shark's teeth were used as ornaments in Georgia.

A few double notched arrows appear, but this feature is more frequent in the spears, where the advantage would be greater. In fact these are so large that they might well be called a small form of spears. Fig. 42 is one of grey flint, and comes from Brewerton, where spears of the same kind are found, and it differs from them only in size. It is two and one half inches long, one corner of the base being broken off, so that but one notch remains on that side. The notches are neatly made. Fig. 43 is a curious one from Onondaga lake, of the same length, and of common flint. It is much thicker than the last, and has a narrower base and broader notches. A similar base appears in one from Seneca lake, though somewhat wider. The latter may have a more definite claim to the title of arrow, being one and seven eighths inches long. It has a rounded point, and the notches are neatly cut. This is the smallest of these thus far reported.

The ordinary notched or shouldered arrows, the most abundant of all, occur in several varieties. Those with widely expanded bases are frequent in central New York, and are usually quite thick, although not invariably. Fig. 44 shows one of blue flint, from Nine Mile creek, in Onondaga county. This has a base one and one half inches wide, making the three sides nearly equal. So broad is the point of the next that it might be classed as a bunt. This is shown in fig. 45, which is of common hornstone, one and one quarter inches wide, and with a concave base differing a little from the last. In both of these the broad wings of the base are notable features, well brought out by the deep notches of the lateral edges. Fig. 46 represents another frequent form, which may be thin or thick, long or short. This one is of a variegated drab flint, one and one half inches long, which is a very frequent size. It comes from the Seneca river, and differs from the last in being longer, having shallower notches, and a straight base. There are many beautiful examples of this form, and it was well adapted for preservation, specially when thick. It may be observed that many such arrows are thickest toward the point, thus allowing the thinner part to be inserted in the shaft.

Fig. 47 is a more slender form, also somewhat common, though not usually as fine as this. It will be seen that most of these are simply notched triangular arrows, many of them quite as thin as in that characteristic form. This specimen is of drab flint, one and three quarters inches long, and was found at Baldwinsville. One a little broader, but only one and three eighths inches long, was found at the same time and place. Some smaller and thicker forms are less deeply notched. They are among our most beautiful arrows.

It may be remarked that some eccentric forms were probably personal, or at least tribal, used to show ownership or nationality. It has been pointed out that two arrow points already figured, were made by the same man, so rare is the form, and so close the correspondence. If stolen or lost for a time he would have no difficulty in identifying his property. This extended into a national feeling. As we have seen, in recent times the Iroquois used the triangular arrow almost exclusively. If other forms were then as characteristic of other nations, the form of the arrow used would indicate the actors in any sudden raid, and these often had a pride in making themselves known. There are several instances in early history, where tomahawks or war clubs were used for this purpose. Thus, a Canadian indian, on a scout on Lake George in 1690, saw the English and Iroquois making canoes. Failing to make a prisoner he 'suspended three tomahawks within sight of their cabins, indicating to them that they were discovered, and that he defied them to come to Montreal. These tomahawks are a species of club on which they carve figures, and in that way manifest their wishes.' In speaking of some depredations committed in 1695, near Montreal, the French said, 'These blows were struck by some Mohawks and Oneidas, as we discovered by their tomahawks, which they left sticking in the ground, according to their custom.' It will be readily seen that a warrior who wished to be renowned might adopt a distinct form of arrow as his own, and be allowed a certain informal copyright. His arrow would prove his deed, whether in hunting or war. This, of course, could not be carried out to any great extent, and yet will account for some exceptional forms. Personal taste may well be allowed a place, but in a few instances a higher purpose may have been connected with it, and there is no doubt at all that little peculiarities clearly distinguished the implements and arms of various nations. Among the remaining Iroquois the snow snakes of the Onondagas and Senecas might seem precisely alike to the casual observer, and yet they have permanent distinctions. The same considerations have their application to very many other things. Closely related as they were, each Iroquois nation had its own fashions.

Fig. 48 is not common, and the work is somewhat coarse. The basal line is also convex, a rare feature in this form, unless there is a central notch or double curve, as in some of the following. The lateral notches are also deep, and the implement is beveled. It is of brown flint, one and three quarters inches long, and was found on the Seneca river. Fig. 49, from the same place, is by no means rare, though quite variable. This is of brown flint, one and one half inches long, and with a basal width of one and three sixteenths inches. The notches are quite deep, and the cutting edges convex. The base is hardly as concave as in most of this form, which is of wide distribution, extending far to the south and west. Fig. 50 is of the same general form, but has a hollower base and straighter edge. This is of brownish white flint, and comes from Brewerton, at the foot of Oneida lake, for ages a favorite resort of the aborigines. It is one and five eighths inches long. Fig. 51 is of dark brown flint, one and seven eighths inches long, the base being one and one quarter inches wide. This is also concave, and the implement is thick. It comes from Onondaga lake. Fig. 52 is another, made of common hornstone, with a fine concave base. The full length is two and one quarter inches, and the base is one and three eighths inches wide. It was found at Baldwinsville, and the form is rather frequent in that vicinity. A much smaller one, with some peculiarities, comes from the same place. It is but little over an inch long, and the base is much deeper and more indented. This form even occurs in quartz, but with less elaboration.

Some of the smaller arrow-heads have peculiar features, and slender ones, with one sided bases, occur occasionally. Fig. 53 is a good illustration of these. It is of drab flint, one and five sixteenths inches long, and quite inequilateral in every way, so much so as to make it a question whether it should not be called a very small knife. They are hardly common, and those figured here are from the Seneca river. Fig. 54 is another of these, of the same material, but proportionally much wider than the last. It is but little over an inch long, and browner than the one preceding it. Fig. 55 is of the same brownish hornstone, but perhaps more like limestone, and less neatly chipped than the others. It is also more symmetrical. It is one and five sixteenths inches long. The first may be considered extreme forms of these.

Fig. 56 has a double curved base, angular in the center, and is of an obscurely banded dark blue flint, rather thick, and two inches long. It comes from Seneca river, where there are many modifications of the form. Fig. 57 is from Wood creek, east of Oneida lake, an early thoroughfare in historic times, but less so at an earlier day. It is of common flint, two inches long, and has the double curved base more deeply notched than the last. It has also a much narrower and more rounded base, this being less wide than the main part of the arrow. They are sometimes distinctly barbed, rather than shouldered. A beautiful one of variegated brown flint, two inches long, comes from near the Seneca river.

Fig. 58 is from the same vicinity, and is of a light brown flint, with two black bands appearing on one surface. It is quite thin, and is one and one quarter inches long, the base being seven eighths of an inch wide, this being the broadest part. The form is quite odd in several respects, being somewhat angular, and with straight converging sides. Fig. 59 is another broad and peculiar form, less prominently notched than the last, but almost as nearly triangular. It is of drab flint, and quite thick. The length is two and one half inches, and the breadth one and five eighths inches. It comes from the Seneca river, and might be called either arrow or knife. It would be rather heavy for the former, unless used at close quarters or in shooting fish. It must be remembered that much of the primitive forest archery was at short range.

Fig. 60 is much like the last in outline, though with a deeper base, like some preceding forms. It is small for so neatly made an implement, being considerably less than an inch in length. This is of light colored flint, and is also from the Seneca river. The surface is even, and the outline very symmetrical. Fig. 61 resembles the last, but is a ruder specimen, being quite thick and ridged through the center. It is of dark flint, one inch long. This form is quite abundant along the Seneca river, and varying examples will be given later. Although small, they are quite large enough for effective use.

Fig. 62 is a very rare and beautiful arrow-head, made of light bluish flint. The point has been slightly broken, and was acute, making the original length one and one half inches. It is straight but not parallel sided, the base is deep, and the notches so much enlarged within as to give both base and sides the appearance of approaching barbs. Its most striking feature is that of expanding above the notches, until half way between these and the point. The surface is flattened. This unique specimen came from the Seneca river, which was a favorite early resort, both for its own advantages, and as being the outlet of so many lakes. At every rift are found camps and hamlets of varying age and character, and these rifts are quite frequent in its long course, which was easily navigable by the indian's light canoe, as it has since been traversed by the larger vessels of the white man.

Fig. 63 is a small, but prominently shouldered arrow-head of opaque white flint, found opposite Three River Point, where the Oneida and Seneca rivers unite to form the Oswego. The junction of two such important streams made this a natural stopping place, and many arrows and spear-heads of similar material have been found there. This is but one and one eighth inches long, and several have been collected of similar form, but usually smaller. In this all the outlines are concave, except the lowest of all. Fig. 64 is another of these, from the Oswego river, and but one inch long. It is of dark blue flint, and every way more slender than the last. The base is wider, and it was distinctly barbed, but one of the barbs has been broken. Fig. 65 is of drab flint, and was found at Baldwinsville. It is but seven eighths of an inch long, and has a deep and expanded base, but has a strong general resemblance to the preceding. On comparing these with articles from other places, this may be regarded as a rare form. Neither Rau, Abbott, nor Fowke give any figures closely resembling it.

Fig. 66 has been referred to before, among those arrow-heads which have concave bases. It is a fine example, with a deeper and more angular base than usual, while it is also quite small. It is of drab flint, one inch long, and quite thick. It was found on Seneca river.

Fig. 67 is a beveled arrow of drab flint, two inches long, and from the same locality. Besides the bevel on each lateral edge, the basal edge has also its bevel, which is not a common feature, and it is more slender than is usual with implements of this type and size. These are rarer here than farther west, and suggest scrapers. Those which are large enough to be classed as spears are sometimes quite slender. While the elaborate work distinguishes them from the broad flaking of the under side of the common scraper, it is difficult to assign any other use to the characteristic edge. At the same time, this edge is sharp enough for many cutting purposes, the bevel resembling that of a chisel.

Fig. 68 is a rare form from Wood creek, east of Oneida lake. It is of common flint, one and seven eighths inches long, indented but not notched, and presenting curved lines in every part. Except in the expanded base, it is much like one of the finest forms of knives, and might have been used either for knife or arrow.

Fig. 69 is a fair example of those arrows which end in a needle point, though this point is scarcely as slender as in some others. This is of drab flint, one and three quarters inches long, and was found at the mouth of Chittenango creek, where it enters Oneida lake. Such specimens are rarely perfect, but they often preserve the slender point, even when broken elsewhere. This curious feature suggests a union of the knife and drill. It has scarcely attracted attention elsewhere, nor are good examples frequent in New York. The points are too neatly worked to have been accidental, and they are too delicate for any rough usage, thus leaving their purpose to be conjectured.

Fig. 70 is quite another type, having convex edges and a slender base. It is of drab flint, two and one quarter inches long, and may have been either arrow or knife. It was found not far south of the Seneca river. The point is rounded, which is its main distinction from the next. Fig. 71 is not quite two inches long, and is of black flint, with sharp and thin edges all around. It is found in the same vicinity, and the same remarks apply to its use. This is straight and symmetrical, but in some examples the surface is so distinctly curved as to leave no doubt of their being knives. This is true of other forms.

Fig. 72 is an unusual form of the triangular arrow or knife, having a truncate base and convex sides. It is of common flint, one and one quarter inches long and very thin. This comes from Owego, on the Susquehanna, and is quite rare in this state, and probably elsewhere. Neither the truncate base, nor the convex edges are features of our triangular arrows. Usually the base is indented, and the sides straight, but in larger implements both features may appear, and often do, separately or together.

Fig. 73 is a broad, notched, and finely serrated arrow-head of dark flint, from Seneca river and one and seven eighths inches long. Distinctly serrated flints are quite rare in New York, but frequent farther west and south. Those most distinctly serrated, and preserving the knife or arrow form, have been considered saws, and might well have been used as such. This was Evans' view of those found in Great Britain, but it has met with but moderate endorsement here. This feature, however, is so conspicuous in some that they will hereafter be referred to as saws in this paper, simply as a possible use.

Fig. 74 is a thick stemmed arrow-head of dark flint, two and one half inches long, and found on Seneca river. It is distinctly shouldered, and has a convex base and edges. The form is quite common. Fig. 75 is of quite a different character, resembling some before figured, but with a narrower base, the lateral edges also presenting two nearly straight lines. This is two and one eighth inches long, rather thin and of dark common hornstone, from the same vicinity. Fig. 76 is quite curious in form, although one of the stemmed arrows with expanding bases. It is quite thick, while at the same time slender in outline, and is of dark flint, two inches long. The work is rather coarse.

Fig. 77 is almost unique, while having the leading features of some preceding forms. It is one and one half inches wide, and but one and one quarter long, broadly shouldered, and with a concave expanding base. The straight edges meet at an obtuse angle. It is of light colored flint, rather thick, and like the last, comes from the

Seneca river. The base has a double curve. It is a fine example of a rare form.

Fig. 78 shows a frequent form which is often rude. This, however, is neatly made, and is ridged on both sides. It is of brown flint, two and one quarter inches long, has a long stem, and is from the same place. Such forms are often flattened on one side, and ridged on the other. Fig. 79 is a small arrow of drab flint, rather flat and a little curved. It is but seven eighths of an inch long, stemmed and broad. This is also from the Seneca river. Triangular arrows are found there even shorter than this.

Fig. 80 represents one of the commonest forms, and one very variable in size, material and finish. They are usually coarsely made, and probably were rapidly finished and little valued. This one is of black flint, and is one and one half inches long. They are often much smaller, and on many sites scarcely any thing else occurs. In assigning these small points to boys, the fact has been overlooked that the efficiency of an arrow-head was not in proportion to its size. Its office was simply to open the way for the shaft which propelled it, and for this purpose it needed only to be sharp and slightly larger than the shaft itself. Thus Verrazano, in 1524, found the Long Island indians using arrows tipped with fish bones, while farther east many had them tipped with stones. In an account of New England indians, written in 1620, it is said, 'For their weapons they have bowes and arrowes, some of them headed with bone, and some with brasse.' Capt. John Smith said that the indians of Virginia had many arrows headed with bone. Others used sharp stones, turkey spurs, or birds' bills. The Sasquehanocks whom he met in 1608, had arrows a yard and a quarter long, 'headed with flints or splinters of stones, in forme like a heart, an inch broade, and an inch and a halfe or more long.'

It will be observed that the writer differs from some on the true distinctions of arrow-heads, while following the usual classification as a matter of convenience. The small points were not made merely for children, but were useful to men. Length is a less essential feature than breadth, and some long and slender forms may have been used as arrows, where shorter and broader forms were not.

Obviously, half an inch added to the width, or a doubling in thickness, would have produced more resistance in the air than a much greater increase in length. At the same time, for certain purposes and where the range was short, as in the shooting of bears or fish, neither an increase in weight or breadth would have been a disadvantage. In a general way, more than one form would be found in the quiver, even while a special object was kept in view. Sir John Franklin unexpectedly met a party of Eskimo in 1825. These at once changed their hunting arrows for those of war, showing that they were well supplied with both. This distinction of kinds probably went much farther. The hunting arrows themselves were adapted for different kinds of game.

Fig. 81 is another of these small arrow-heads, made of dark flint, and one and one quarter inches long. Fig. 82 is a little smaller, being one and one eighth inches in length. Fig. 83 is a fine arrow of white quartz, two inches long. All these are from the Seneca river, and others of these simple stemmed forms present many variations.

Fig. 84 is a large and broad arrow-head of drab flint, from Onondaga lake. It is quite thin, and is two and one quarter inches long. This would have served quite as well for a knife, and is notched and well worked. Fig. 85 is from the same vicinity, and is more distinctly notched, and also much narrower. It is of blue flint, and is two and one eighth inches long. The base is slightly wider than the blade. This form is quite frequent in larger sizes. Fig. 86 is a very neat notched arrow-head, from the same place. It is made of common hornstone, and is one and three quarters inches in length, being both thin and symmetrical. Fig. 87 is quite curious, and comes from Oak Orchard, on the Oneida river. It is made of olive slate, of uniform thickness, and the edges alone are worked, much like a scraper. Arrows made of stratified material are hardly rare, but slates like this are seldom seen adapted to such uses.

Fig. 88 is a large barbed arrow, nearly two and one quarter inches in length, and made of a bluish drab flint, variegated with white quartz. It was found, with others of similar material, near Three River Point. The barbs are well preserved, and the work is good. Fig. 89 is a small notched arrow of brown flint, one inch long, and comes from Seneca river, where many of this form have been collected. Fig. 90 is another neat little arrow-head from Onondaga lake. It is of light brownish drab flint, one and one eighth inches long. It has a wide base, and is almost barbed. Fig. 91 is a rare and beautiful form of the angular arrow-heads with parallel lateral edges. It is quite deeply notched, and differs from those already figured in the graceful concave sweep of the broad base. This unique article, of dark flint, and about one and one quarter inches long, was found at Newark Valley, Tioga county.

Fig. 92 is a small beveled arrow of dark flint, from the west shore of Cross lake, and is waterworn. Many articles are found in this condition in streams and on shores. This has a stem broadly indented on three sides, and is of unusual form for an article of this description. It is one and three eighths inches in length, and like all of its class, might easily be considered a form of scraper.

Fig. 93 has also a concave base, but much narrower. It is shouldered, and has a finely serrate edge, of irregular outline. The form is that of many Ohio specimens, and it is of a dark flint, one and one half inches long. It was found near Three River Point. Fig. 94 shows a very neat and unusual form of the notched base arrows, but it has the three conspicuous concavities which mark the last two examples. The point is broadly rounded, and while the length is but little over an inch, the width is seven eighths of an inch, from point to point. It is of common flint, and was found at Newark Valley. Fig. 95 is classed as an arrow-head, but is much like the flints so often found in caches, although smaller than most of these. It is of a light brownish grey flinty limestone, and is quite thin and sharp. The length is two and three eighths inches, and it was found on the Seneca river. Although this form, being symmetrical, is popularly classed with the arrows, its proper place seems to be among the knives.

Fig. 96 is a pretty stemmed and shouldered arrow-head of red jasper, from Baldwinsville, and is but little over one and one half inches in length. While articles of yellow jasper are quite frequent in New York, those of red jasper are rare, and sometimes, even then, the color may have been changed by heat. Fig. 97 has much the same outline, but is distinctly grooved at the base. It is a fine article, of blue flinty limestone, and is one and five eighths inches long. It comes from the same vicinity. From its general width Fig. 98 would be called an arrow-head by many, and yet its general character is that of a perforator. The worn appearance of the point tends to confirm this view, though this may have come in other ways, as in digging, for which it seems partially fitted. There are so many forms intermediate between the arrow and the drill, that it is now described with the former, in spite of a strong conviction that it belongs to the latter. It is coarsely flaked, and is two and one eighth inches long. This also is from the Seneca river.

Fig. 99 is of purplish flint, thick and smooth, and is two inches long. It is a form not so common in arrows as in spears, and this is round pointed. The rounded base is found almost everywhere, but perhaps is nowhere very common. This fine specimen is from the Seneca river, where the larger forms sometimes occur. Fig. 100 is a triangular arrow-head of common hornstone, from Onondaga lake. Its special feature is the straight and expanded base, which is also quite sharp. The length is one inch.

Fig. 101 is a broken article, but given to show a good example of what has been called here the needle point. It is very attenuated, and the section added will show how thin and delicate it is in every way. This fragment is of very thin, dark blue flint, now about two inches long, and nearly one and one quarter wide. It was found on the Seneca river, where similar specimens sometimes occur, though not very often. If found elsewhere they have not been reported, but they are so often broken that they may have escaped attention.

A large proportion of the arrow-heads figured are from Onondaga county and vicinity, partly because these were easily accessible, but partly, also, because there they are found in greater variety than in most other places, this arising from natural causes very important to primitive man. Notable forms from other parts have been figured when possible.

While it is of importance to know how widely some leading forms are distributed, and what is their comparative abundance, the study of man's early history here requires that some unusual forms should be recorded and illustrated. These are often the links which serve to connect widely separated sites. The knowledge already gained of the primitive articles used by the Iroquois, three centuries ago, has become of great and increasing value, and will hereafter aid in solving many problems. Different nations and ages had differing fashions, and the characteristic articles used and left behind, will throw much light on the early people of New York. To collect these articles for careful comparison, to illustrate them so faithfully that distant students may have the most significant facts before them, is something worthy of the attention of a state which has already done so much in the cause of science.

SPEARS

As with arrows, so is it difficult to place an exact line between knives and spears. Indeed the primitive spear may often have been but a knife fastened to the end of a long pole, as men in more recent times have armed themselves, when lacking suitable weapons. Even arrow-heads may have been put to the same use in time of need. Spears and knives may both have been leaf-shaped, stemmed or notched, and may not differ in the least in outline. Often the thickness and sharpness are the only distinctive features. As regards size, this does not affect knives, but usually small points are called arrows, and the large ones spears.

Dr C. C. Abbott made a division of spears and lances, while L. H. Morgan, in his *League of the Iroquois*, omits spears from his description of their weapons. In his subsequent account, in the *Regents report* for 1852, he says that they did not use them, and although he simply asserted this it was not without some reason. Spears do not generally appear in early pictures, nor are they usually mentioned in accounts of early indian armor. As far as the pictures go, this is of little importance. They were sometimes, perhaps usually, drawn by European artists from descriptions given them, and they availed themselves of the privileges of art. Champlain expressly said that the Mohawk chiefs, whom he killed in 1609, wore arrow-proof armor, but in the picture they are as naked as all their followers. Capt. John Smith said of the Virginia indians, ' They of Accawmack use staves like unto javelins, headed with bone. With these they dart fish swimming in the water.' This, however, may have been like the early Iroquois bone harpoon, barbed only on one side. The wooden sword, worn on the back, and sometimes with a deer's antler inserted, was mentioned by him, but no farther described. A strong point in regard to use is that on no Iroquois site in New York, has any early article been found which could be called a stone spear-head. At an early day they were abundant.

On the other hand, in his picture of Atotarho, David Cusick placed a spear in the hand of one of the messengers. Bruyas has allusions to spears in his early Mohawk lexicon, and their occasional use may be inferred from the *Jesuit relations*, but somewhat obscurely. The Iroquois sword, whatever that may have been, was often mentioned. Schoolcraft gives the word for spear in several Iroquois dialects, and Zeisberger uses for lance the name which appears in another lexicon, half a century earlier. One Virginia picture has indians with fishing spears, but these are described as having wooden points, not metal or stone. A weapon so useful was not likely to be abandoned until a substitute was found, but it seems certain that the large stone spear-head was not generally in use here three hundred years ago. History and archeology agree in this.

This is another of the curious proofs of a change in race and occupation. Iroquois and Algonquin alike seem to have known little of the higher stone art of their predecessors, and a weapon once everywhere abundant, had almost ceased to exist. A sweeping change had passed over the land, and the new comers did not inherit the arts of the old. If they did not, how could they have been their descendants? Allowing for every resemblance, there is still a wide gulf between the indian of our northern and eastern states, as first known to the whites, and those who preceded him. This difference can only be fully appreciated by those who have early sites of a known age, to examine.

Spear-heads vary greatly in character, and still more in size, if we make the minimum two and one half inches in length. In many places this would compel us to reckon more spears than arrows; and if we remember the vast numbers carried off — for these naturally first attracted attention by their size — the disproportion will appear still greater. At the time of colonization and earlier, the indian's bow and arrows almost alone attracted attention. If the larger points are all spear-heads, his predecessors must have been as conspicuous for these. The difficulty might be solved by supposing the bow to have been a very recent invention in America. It is rather probable, as said before, that we have placed too low a limit on arrows, while forgetting how much of forest and river archery was at very short range.

This significant disproportion will appear in almost any good collection. In the classified list prepared by Mr A. E. Douglass, he has 261 New York spears and 963 arrows; from the country at large 2172 spears and 8396 arrows, or less than one fourth, and this would be a fair proportion elsewhere. Now in New York no spear-heads appear on Iroquoian sites, which supply many small stone arrow-heads, so that the New York proportion of early spears and arrows will be yet more equal. Supposing the bow and spear were at first used together, we would conclude that the arrow-heads should vastly exceed the spears; but under the present classification they do not. It is evident that this subject needs reconsideration.

While speaking of this it may be well to say a few words farther upon indian arms, which here included both less and more than is popularly known.

As has been said, early accounts make no direct mention of the spear, although there seem allusions to it. That used in fishing was altogether of a different kind. The bow was not the short one, so efficient in the hands of horsemen, but rivaled the long bows of England, while the arrows often exceeded the cloth yard shaft. Capt. John Smith said of the Sasquehanocks, that such great and well proportioned men were seldom seen, and that they had bows, arrows and clubs in proportion. Their arrows were five quarters of a yard in length, and in the picture of one of their chiefs, his bow reaches above his head. These were of the Iroquoian family, and in Champlain's pictures of encounters with the Iroquois proper, the long bow is everywhere seen. We may, therefore, conclude that this bow, still made by their descendants, was that commonly used in our forests in early days.

Of the making of the bow and arrow something may be said later, in connection with some peculiar curved scrapers, admirably adapted for this work, but yet too rare to have been commonly used. Capt. Smith, again, says that the Virginia indians made their bows by scraping them with shells, and the Iroquois may often have done the same, as they used shells for knives. The arrow shaft was straightened in several ways, and the Onondagas have not lost the art yet. It was headed with almost any hard and sharp material, or might be made entirely of wood. The arrow point might be fastened merely with gum, in the cleft shaft, or be bound on with sinew or thread. An Onondaga recently had a triangular stone arrow given him to affix to a shaft. He at once cleft the shaft, inserted the stone, took a piece of thin sinew, dexterously and neatly wound it about the wood and stone, and the arrow was ready for deadly use. Different nations used different arrows. Thus the Sasquehanocks had stone points, shaped like a heart, an inch broad, and an inch and a half or more long. It is probable that in this way Capt. Smith described the indented triangular arrow-head, as the Sasquehanocks were of the same family as the Iroquois. The latter used triangular arrows almost exclusively. The force exerted by these simple weapons was a matter of surprise to the colonists.

Shields were everywhere in use among the Iroquois but soon disappeared before firearms. Smith speaks highly of those of the Massawomeks, who seem to have been either the Eries, or a nation allied to them, and not the historic Iroquois, as many have supposed, although of that great family. Their light targets were 'made of little small sticks, woven betwixt strings of their hempe and silke grasse, as is our cloth, but so firmly that no arrow can possibly pierce them.' There was evidently nothing like these in Virginia, and those he had and used were everywhere recognized at once, as were their other arms. Champlain describes the armor of the Mohawks in 1609, very briefly. 'They were provided with arrow-proof armor, woven of cotton thread and wood.' Corlaer saw a sham fight among the Mohawks in 1634. 'Some of them wore armor and helmet that they make themselves of thin reeds and strings, so well that no arrow nor axe can pass through to wound them.' Similar passages might be quoted from others.

The Algonquins used shields of a rectangular form, and a Dutch writer of 1671 says that these covered the body up to the shoulders. In fighting these could be set on the ground, leaving both arms free. A Jesuit father, writing of a Canadian chief in 1633, said that he 'bore with him a very large buckler, very long and very wide; it covered all my body easily, and went from my feet up to my chest. They raise it and cover themselves entirely with it. It was made of a single piece of very light cedar. I do not know how they can smooth so large and wide a board with their knives. It was a little bent or curved in order the better to cover the body; and in order that the strokes of arrows, or of blows coming to split it, should not carry away the piece, he had sewed it above and below with a cord of skin. They do not carry these shields on the arm; they pass the cord which sustains them over the right shoulder, protecting the left side; and when they have aimed their blow they have only to draw back the right side to cover themselves.'

The use of the war club is well known, and this implement, with or without a stone axe or antler inserted, was the original tomahawk. The French writers often speak of the swords of the Iroquois and others, but without any precise description. They were sometimes fastened to poles by the Algonquins and used as spears. Stones or shells were used as knives, but the white man's knife soon supplanted these; and this was the lot of the stone axe, which was not grooved among the Iroquois, nor was it usually in New York or Canada. First, the French trade axe, and then the smaller steel tomahawk, became favorites, while guns took the place of bows and arrows.

Although spear-heads present a few varieties in New York not common here in arrows, so many are essentially the same, except in size, that they will require fewer illustrations. They are quite often of fine or showy materials, and are as variable in coarseness or delicacy of work as in other ways.

Leaf shaped spear-heads are often quite large. One of common flint, from Baldwinsville, has lost half an inch from its tip, and is still nine inches long, with an extreme width of two and three quarters inches. The base is neatly rounded, and the outline that which botanists term lanceolate. This form is common and when thin may be termed a knife. Fig. 102 from Oswego county is a fine example of this type of spear. It is of pure white flint, and six and one half inches long. Articles of this showy material are frequent there, and are usually thin and finely worked. An early trail crossed that county from Oneida lake to Lake Ontario and the St Lawrence, and the many travelers lost some fine articles on the way. Between that trail and the Hudson river very few of the best early relics occur, as the Mohawk presented few temptations to those in search of game.

Fig. 103 has a straighter base than the last, and is not as neat in outline. It is quite thick, being eleven sixteenths of an inch in the short diameter, and five and one eighth inches long. The material is grey flint, and it comes from the east side of Skaneateles lake, in the town of Spofford. Another good example of this form is from the east end of Oneida lake, and is but three and seven eighths inches in length. A broad and fine one, with a slightly concave base, from St Lawrence county, is of white quartz, quite neatly chipped for this material. It is four inches long and one and seven eighths broad.

Fig. 104 is an example of a frequent and variable form, having a three-sided base. The edges may be straight or convex, and the thickness varies much. This comes from the north shore of Oneida lake, and is of black flint, five and five eighths inches long, and half an inch thick. These could only have been spears. A fine and larger one of common drab flint, from Baldwinsville, is six and one half inches long by two and three quarters wide. This has convex edges. Flinty limestone is a frequent material for these, and one from near Oneida lake, similar in form to the last, but little over four inches long, is made of birdseye limestone. Fig. 105 is one of the finest of these, made of common flint, and is seven inches long. It is very neat and symmetrical, and the form is the one so common in New York caches, though rarely as large as this. Large spears of this outline are not rare.

Those of a more triangular form are often knives, but spears will be found among them. It will not be necessary to figure many of these, or even to describe more than representative forms. A broad and massive one of common flint, from Onondaga lake, is five inches long, and has a width of nearly two and three quarters inches. The base is concave, with rounded angles, and the edges gracefully curve to the sharp point. One of similar length and general outline, from the same place, is little more than half this width. Fig. 106 shows a beautiful spear or knife of fine white and somewhat translucent quartz, from Oneida lake. It is so thin and even that it might well be called a knife, but it would have served for a spear quite as well. The length is four and seven eighths inches, and it is scarcely three eighths of an inch thick. The greatest breadth would have been full two inches, had not an angle of the base been broken. Another beautiful example of dark jasper, from the shores of the same lake, is nine and three eighths inches long, and two and seven eighths wide. The base is straight, and the convex sides slightly expand toward the center. A beautiful lance-head from the Oswego river, has lost half an inch from its point, but is still seven and three quarters inches long. It is one and seven eighths inches wide at the slightly curved base, whence it tapers to the point. A similar one of grey quartz, from the same place, is five inches long, and two inches wide. The straight edges taper almost to the point, which they form by quickly curved lines. Fig. 107 is a very handsome one of white mottled quartz, three and five eighths inches long, and is also from Oswego county. The base is slightly rounded, almost immediately reaching the extreme width of one and five sixteenths inches, and thence sloping in nearly straight lines to the point.

Fig. 108 is a very remarkable specimen in every way. It is a fragment of a very large spear apparently, and is very evenly chipped. The material is a dark green jasper, and the straight and sharp base is four inches wide. The thickness is but five eighths inches. Nine inches from the base, where it is broken, it is three inches wide, and if continued on the same straight lines to a sharp point, it would have been nearly or quite three feet long. It is hardly probable that this could have been. It is remarkably flat, and possibly may have been used as an axe, the base forming the cutting edge, in that case.

Stemmed forms occur, with and without notches. Fig. 109 is quite broad, and has parallel sides, slightly notched at the expanded base. The point is quite obtuse, and the full length three and three quarters inches, with an average breadth of one and five eighths inches. The material is a brownish drab flint, and it was found south of the Oneida river. It would have served quite as well as a knife. Fig. 110 is one of the simpler forms, with rounded stem, but ruder than in some examples, partly from its material. This is white translucent quartz, which allows little opportunity for delicate work. This form is frequent in many materials, and a beautiful one of chalcedony, with slightly rounded base, and four and one eighth inches long, comes from the town of Van Buren, south of the Seneca river. It is quite broad, with convex edges, and is slightly mottled. A much larger one, of reddish brown jasper, six and one quarter inches long, and three inches wide, has a point so broad and rounded as to suggest a spade. This is from Brewerton, and is coarsely chipped, though fine in outline.

Fig. 111 is a fine beveled spear-head of drab flint, found on the Seneca river southwest of Three River Point. It is three and seven sixteenths inches long, and about one and one eighth inches broad. This is narrow for a beveled spear-head, and of course there is a possibility of its being used as a scraper. In this example there is a notch in each lateral edge and the base is slightly wider than the blade. Simple notched forms like this are frequent in many sizes and materials, but beveled implements are much rarer. Many spear-heads occur with straight sides, but these are rarely parallel. The last four figures, all on one plate, are represented three fourths of the actual diameter.

Fig. 112 is a fine notched spear-head, with a small base. It is of common flint, six inches long, and the greatest width is nearly midway, where it reaches two inches. It comes from Baldwinsville, and, like most spears, is quite symmetrical. One much like it, but of light blue flint, was found at Cross lake. This approaches the double notched form. Fig. 113 has also a small base, and one perfectly simple. It is of a grey flinty limestone, and comes from the town of Elbridge. It is a trifle over six inches long, with an extreme width of one and three quarters inches, and is very symmetrical and neatly worked.

Fig. 114 is a beautiful notched spear or knife, made of a material much resembling moss agate, and often used in these larger implements. In flaking, this does not produce as sharp lines, nor always as symmetrical forms, but the effect is often fine. This is broader than usual with this material, and is almost three and one half inches long. It comes from the Seneca river, where articles of similar material often occur.

Fig. 115 is a very slender flint spear-head from the town of Wilna, Jefferson county. It is broadly notched near the base, and is four and one quarter inches long, with a width of much less than an inch. The base is about as broad as any part, and the slender form is not rare.

Fig. 116 is much like one already described, but has double notches on each side, although of a different character from those usually found. The base contracts to a point, and the notches are widely apart. It is a fine article of light grey flint, four and one quarter inches long, and was found in Oswego county, north of Brewerton, and half a mile from Oneida lake. The double notched spears seem more common in that vicinity than elsewhere, but this specimen is not of the usual type.

Quite massive and coarse spear-heads occur in several places, usually made of a grey quartzite, unsuitable for fine work. One of these, from Baldwinsville, is quite thick, and six inches long by two and one eighth inches broad. Fig. 117 is a good example from the same place, which is five and one half inches in length. Another from Owego, in Tioga county, is five and three quarters inches long, with an extreme width of two and three eighths inches. In this, however, the blade quickly contracts above the notch, giving the implement a much more slender appearance. Articles of this kind seem quite uniform in size. Fig. 118 much resembles these in form, especially the last described, but is much smaller, and of a variegated hornstone, a little over two and one eighth inches long, but the point is slightly broken. It comes from the Oswego river.

A broad form of the material resembling moss agate has been already given. They are usually longer and more slender. One of this description is from Baldwinsville, and is five inches long. It is a very fine example, a little unsymmetrical, rather broadly notched, and might be called a knife if it were sharper. Fig. 119 is one of the finest of these, but has lost the extreme point, having been originally a little over five inches long. It has two notches on each side, and the surface is flatter and straighter than in others of this material, while it is also more slender. It was recently plowed up near Three River Point.

These spears and arrows with more than one notch on each side are but moderately rare, and are of wide distribution in New York, as compared with other parts of the country. Dr Rau figured a broken one from Maine, made of brown jasper, whose full length would have been six and one quarter inches. He marked this as 'quite exceptional,' and it had three notches on each side. It is of the usual New York form. Dr Abbott did not place this among his New Jersey forms, nor does it appear in Mr Fowke's chipped implements of the Mississippi basin and the southern states. The writer does not find it in his collection of outlines of rare articles in Ohio. One occurs in the collection of the Canadian institute, in Toronto, which is three and one half inches long, and has double notches, but there it is also called rare, and more have come under the writer's eye in central New York, within a radius of a dozen miles, than have been reported in all the country elsewhere. It might be considered a New York form.

A broken one of white flint comes from the Seneca river, and has two distinct broad notches on each side, with others which are obscure. This fragment is now two and three quarters inches long, with straight edges, tapering from a base one and one half inches wide. The original length would have been four and one half inches, unless it had a rounded obtuse point, as in the next. Fig. 120 is a fine article from Oswego Falls, and is of greenish white flint, four and three eighths inches long. The double notches are much more distinct than in the fragment just described. One of white flint comes from the Mohawk valley, and is five inches long, with three notches on each side. Another, made of red jasper, is from Brewerton, and is three inches long, with double notches. Similar ones occur there. A well wrought one of drab flint, from the same place, is three and one half inches long, and has double notches. A smaller and broadly triangular specimen, of common flint, comes from Skaneateles lake.

It has double notches, and is two and seven eighths inches long. Fig. 134 was inadvertently placed out of its proper order, but is in every way the finest of these yet found. The material is clouded quartz, and thus the flaking produced no conspicuous lines on the surface, but the outline is very neatly wrought. It is six and one half inches long, and was found in removing a stump three quarters of a mile north of Brewerton, in 1896. It is flat and thin, and nearly two inches wide, but its prominent feature is the number of notches, five on one edge and six on the other. The base is truncate, and the edges slightly curving to the sharp point.

Fig. 121 is a good example of a thin and narrowly notched spear-head of common hornstone, quite sharp, and attenuated at the point. It is about two and five eighths inches long, and is a very frequent form. This specimen is from the Seneca river, as is the next. Fig. 122 is also of hornstone, but quite thick, and slightly shouldered. The base is long, and does not expand, but is rounded at the end. It is three and one eighth inches from extreme base to the point, and is typical of a large class, very widely distributed.

Fig. 123 is a notable spear-head from Owego, near the Susquehanna river. It is of a blue grey flint, seven and one quarter inches long, and is a very rare if not unique form. Either end might have been used for a spear, had occasion required, but apparently this was the office of the longer and slender part. This had mostly concave edges, rounding to the point. The shorter and broader portion has convex edges throughout. The whole implement is neatly wrought throughout.

Some stemmed spear-heads have concave bases; perhaps no great distinction, and yet one which has attracted attention. Many others, slender, but of the notched arrow form, are made of white flint, a favorite material for spears, but obviously brought a long distance. While fine examples they present few peculiar features. Stemmed spear-heads with a convex expanding base are also frequent, and are usually notched. Fig. 125 shows a parallel sided form from Skaneateles. It is of drab flint, two and seven eighths inches long, and one and one eighth inches wide. While it is notched, the general outline is a long pentagon. Much like this, but larger, is one from Queensbury. Judging from collectors' reports, fine spears may not be frequent in that part of New York. In the former Wagman collection, made at Saratoga and near Lake George, but 36 spear-heads were catalogued. The largest was six and one half by two inches, and another, six by one and one half inches, had serrate edges. This collection was sold and dispersed in 1886. In Holden's *History of the town of Queensbury,* however, we are told that arrows, spears, and other indian relics are found at every carrying place between Albany and Montreal, and this we might have expected. Mr Holden adds that while gun flints, bullets, stone arrows and spears were spread broadcast in Queensbury, there were particular places where they were found abundantly.

Out of the many examples of spear-heads but one more will be noted now. Fig. 124 is a broad and thin chalcedony implement from Baldwinsville. It is triangular, with an indented base and convex edges. The length is four and one eighth inches, and it is a little over two inches wide. One peculiarity of this fine article is the neat and small notches, which are almost circular.

KNIVES

The ruder forms of knives require but slight attention, as almost any flake or piece of hornstone might serve a temporary purpose, whether large or small. Early accounts show us an extensive use of bivalve shells, with or without alteration. Few of these can be found now, but the rude stone knives are abundant in many places, and are interesting as showing, not so much progress in economic arts, as the frequent utilizing of otherwise waste material. A flint chip was neatly edged on one side, or more, and did all that was required without farther elaboration. Fig. 126 is the type of many rather large and straight pieces, triangular in section, which were often used as knives, and might have served for scrapers. One angle or edge is left without farther work, but one or both of the other two may be delicately chipped for more effective use. Of course these could have been employed only in very simple ways. This one is of grey flint, and comes from Seneca river, where the form is frequent on many camp sites. The length of this specimen is three and one quarter inches, and one angle is quite obtuse.

Many rude knives, large and small, were nearly circular, and these also will require but slight notice. They are chipped to a sharp edge all around, and may sometimes have served as scrapers, although they do not have their peculiar features. The leaf shape is also very common and of wide distribution, varying from very small to very large. A very long one of brown flinty limestone, seven inches in length, has a surface greatly curved, being convex on one side, and concave on the other. The concave surface is a large single flake, except for the chipping along the edge. This special form is not rare, and is almost as much scraper as knife. The one described is two and one half inches wide. Another of dark hornstone, from Oswego Falls, is a typical leaf-shaped knife, five and one half inches long by two inches broad.

Fig. 127 is interesting, as being one of 23 found in the mound at Greene, Chenango county. It is of yellow jasper, three and three quarters inches long and two inches wide, and may have been buried there long after the mound was made. In the *Annals of Binghamton,* it is stated that 'At one point in the mound a large number, perhaps two hundred arrow-heads, were discovered, collected in a heap. They were of the usual form, and of yellow or black flint. Another pile of 60 or more, was found in another place in the same mound. A smaller leaf-shaped knife of yellow jasper, two and three quarters inches long, also came from a grave in Greene, as reported, but may also have been from this mound, so many articles of yellow jasper having been taken from it.

A very large and rude knife, seven and one quarter inches long, also came from a cache of 19 pieces at Baldwinsville. It was an unusually rough and mixed lot, nearly all of yellowish jasper, tinged with brown. Most of the pieces had the form usual in caches, but some were of ruder outlines, and a few could only have been utilized as scrapers.

Knives which are elliptical, or of a long diamond form, pointed at both ends, are often very fine, and are by no means rare. Fig. 128 is of drab flint, four inches long, and more slender and pointed than many of this form, besides being more angular in the center. It is quite neatly worked. A fine one of yellow jasper, from the Oneida river, is almost a true ellipse, five inches long by two and three eighths inches broad. It is scarcely pointed, and many have this feature in other forms. A small one of common flint, which is but two inches long, differs little from fig. 128 except in size. Fig. 129 is a beautiful knife of light blue flint, five inches long. It is not a rare form, but with this outline is quite as often a scraper as a knife. Nothing can be prettier than fig. 130 which is of a beautiful banded white flint, three inches long. It comes from the town of Van Buren, some miles south of the Seneca river. Among the finest of this form is a very long and slender one from Chautauqua county. It is 11½ inches long, two and three quarters inches wide, and about a quarter of an inch thick near the two sharp points. The edges present so symmetrical a curve that the outline may be reproduced from these measurements. It was a surface find.

Three small elliptical flint knives are represented by the following numbers, all from Seneca river. These are commonly less than two inches long, but may reach seven inches. Fig. 131 is one of the small specimens, made of common flint. It is one and five eighths inches long. Fig. 132 is of similar outline, but made of dark blue flint, and of the same length. It is a neater article. Fig. 133, of grey limestone, is more slender, and is pointed. The point and part of the edges are slightly ground. It is two inches long. Specimens like these were once quite frequent.

Many stone knives approach what we call a knife form, and vary much in size. One of brown flint, four and three eighths inches long, is but moderately curved in its outline, while others are conspicuously so. A black flint knife, three and one half inches long, found on the Oswego river, is very distinctly curved in this way. Fig. 135 is of this curved form, and is quite thin and sharp. It seems to have had a straighter part of some length, for insertion in a handle. This has been partly broken off, but the remainder of the implement is still three and one quarter inches long. It is of brown flint, and comes from the Seneca river. Evans described some curved knives in Great Britain, much like these, and thought them peculiar to that land, but could assign no use for them. They seem well adapted for several purposes, but their very form suggests the knife, alike available in war or hunting.

Fig. 136 is somewhat like the last, and from the same river. It is much thicker, and not unlike some of the curious scrapers yet to be described. It is of brown flint, three and one quarter inches long, and somewhat twisted. Several have this feature. Fig. 137 is curiously curved, but is typical of quite a group. It is of brownish flint, three and five eighths inches long, and comes from the east side of Skaneateles lake. The general thickness is considerable, but the back of what might be called the handle is not sharpened, as is the rest of the implement. Another curved and twisted knife of common flint is six and one quarter inches long. All of this type vary much in thickness and neatness of work. Fig. 138 may be classed with these, though with quite a different outline. One edge is nearly straight, and the other much curved, the surface is also much curved, being concave on one side, and rounded on the other. It is of brownish flint, two and one half inches long, and comes from the Oswego river.

Some of the most delicate knives have straight bases and curving sides, the blade being broadest toward the point. Fig. 139 is one of these, of brown flint, delicately worked, and three inches long. This is from the Oswego river, and is typical of many others, always neatly finished, but often broken. Another from Three River Point is of yellow jasper, four and one eighth inches long. This is also a fine example. A longer and neatly worked specimen, made of brown flint, and five inches long, is from the east end of Oneida lake. Evans called a similar form in Great Britain a dagger, and it readily suggests that weapon, though usually rather frail for any rough usage.

Another frequent form of knife in some places is thin, parallel sided, and broken squarely off at each end, as though by design. They are somewhat local, and on many sites are never found. Fig. 141 represents one of these, of common flint, thin and bent, and two and three quarters inches long. This is from the Seneca river, where almost all have been found on two or three sites. One from Queensbury, three and one quarter inches long, seems much like these.

Triangular forms, with straight or convex sides, are common, and hardly require illustration. They vary much in width and thickness, and reach five inches in length, but are usually less. They are often curved on the surface, and are sometimes quite broad. Fig. 142 is one out of a number of narrow knives of this form, all found on one small site on the Seneca river. They varied from three to four and one half inches in length, and were very thin and sharp. From their numbers and uniform character, it is probable they were scattered from a cache. The one figured is four and one half inches long, and one and one eighth inches broad. One of the finest of this form is of striped jasper, five inches long, and comes from Oneida lake. This, however, has curving edges, and is broadest near the center. A broader form than that last figured, appeared in a lot of 125 like specimens in a grave in Bellona, near Seneca lake. A few are nearly long, straight sided triangles. Some knives have the simple pentagonal form, so common in caches, and these are sometimes bent. This peculiarity is frequent in notched forms, usually classed as knives because of this. Fig. 146 shows an arrow form thus bent. In one instance a broad notched form from Oswego Falls, three inches long, has a distinct double curve of the surface. Other notched forms, and some of the simpler, may not have an equilateral blade.

Fig. 143 is a fine knife of grey limestone from Cross lake, much like the Queensbury knife just mentioned. It is truncate at each end, three and five eighths inches long, one and one quarter inches broad in the middle, where it is widest, and is somewhat thick. Fig. 140 is a small, slender knife, approaching the drill form, if not an implement of that kind. It is of variegated flint, two inches long, and comes from Seneca river. Fig. 144 is a coarse and heavy curved knife of hornstone, from Onondaga lake. It is five inches long and two and one quarter broad, with nearly parallel edges. This is quite a frequent form. Fig. 145 is the ordinary leaf-shaped knife found almost everywhere. This is of common flint, three and one half inches long. In other examples it would vary in size, length or breadth, ranging from broad to narrow, and similar differences will be observed in every form here represented.

SPADES OR HOES

Spades are of very uncertain character, and some articles possibly used as such might be considered spears, knives, or even rude celts. Few are found that we can call spades and nothing more. The early visitors had little use for those of stone here, as they came for hunting and fishing, and not to till the soil. The Iroquois, who were an agricultural people, used stone as little as possible, and made their hoes and digging tools of wood or bone; mostly the former. In Bruyas' *Mohawk lexicon,* about two centuries old, onarate is the wooden hoe, but there is no word for spade, which they would only use in digging post-holes, or pits for caches, where the hoe would be quite as serviceable. In the early book called *New England prospect,* it is said that part of the women's work was 'their planting of corne, wherein they exceede our English husband-men, keeping it so clear with their clamme shell-hooes, as if it were a garden rather than a corne-field.' Loskiel said of the cultivation of corn 'They used formerly the shoulder blade of a deer, or a tortoise-shell, sharpened upon a stone, and fastened to a thick stick, instead of a hoe.' In Van der Donck's *New Netherlands* are interesting notes on points connected with indian agriculture, although their implements are not described. 'They say that their corn and beans were received from the southern indians, who received their seed from a people who resided still further south, which may well be true. . . The maize may have been among the indians in the warm climate long ago; however, our indians say that they did eat roots and the bark of trees instead of bread, before the introduction of indian corn, or maize.' They had beans before the whites came, and 'have a peculiar way of planting them, which our people have learned to practise: when the Turkish wheat, or as it is called, maize, is half a foot above the ground, they plant the beans around it, and let them grow together. The coarse stalk serves as a bean prop, and the beans run upon it.' The Onondagas have a pretty story about this.

In the fall they burned over the places which they wished to plant the next spring. There are many accounts of the large caches in which they kept their corn, and these are yet found in many places, while the corn itself is often plowed up. One piece of woodland in Montgomery county is full of the open pits, but the Iroquois also stored corn in boxes made of bark, and sometimes had vast amounts of this. The cache method, however, was very common, and in the pits both corn and beans were stored. In his early account of the

Mohawks, the Rev. Johannes Megapolensis says, 'When their corn is ripe, they take off the ears and put them in deep pits, and preserve them therein the whole winter.' A fuller account will be found in the *New England prospect*. 'Their corn being ripe, they gather it, and drying it hard in the sunne, conveigh it to their barnes, which be great holes digged in the ground in forme of a brasse pot, seeled with rinds of trees, wherein they put their corne.'

The origin of indian corn is a question of much interest, and a great deal has been written upon it. Besides what has been said above, Roger Williams gave the New England tradition: 'The crow brought them at first an indian grain of corne in one eare, and an indian or French beane in another, from the great god Kautántouwit's field in the southwest, from whence they hold came all their corne and beanes.' Corn hills were large, and stood well apart. They are still to be seen in some New York woods, and the cultivation was very simple. Roger Williams has a note on what he thought a curious preference in tools: 'The indian women, to this day, (notwithstanding our hōwes,) doe use their naturall howes of shells and wood.' Spades are not mentioned, and, bearing this fact in mind, it is quite likely that those stone implements of New York which resemble what are called spades elsewhere, are to be considered hoes, if they were really digging tools. The question admits of reasonable doubt, but the classification may be allowed for present convenience. It may be added that less was needful for digging than is often supposed. In an emergency the writer has been surprised to see how much excavating he could do on an indian site with a sharp stick, or a broad and pointed stone. With improvised tools and plenty of muscle a great deal could be easily accomplished, but the necessity for this was so rare in indian life that little faith need be placed in the New York stone spade.

Fig. 147 represents the finest of these articles known to the writer. It is a leaf-shaped implement of a bluish grey stone, and came from Oneida lake, where it was plowed up in 1877. The average thickness is three eighths of an inch, and the length is $11\frac{1}{4}$ inches, with a breadth of five and one quarter inches. This and the two following figures are reduced to about two thirds of the actual size. It is sharpest at the broad end. This article seems much too large for either spear or knife, though both these have been found quite as long, and it may be best to consider it a digging implement for the present. Smaller specimens are common, with a similar outline. An elliptical one of drab flint, five and three quarters inches long, also came from Oneida lake. Another, with straighter sides, is from Brewerton, at the foot of the same sheet of water. This is of grey flint, and is seven and three eighths inches long, and three and one half inches wide. This would be called a knife but for its size. It is not equilateral, but while one of the lateral edges is straight, the other is longer, and curves gradually to meet it at the point. Quite a number are between five and six inches long, coming from several places.

Two fine leaf-shaped implements from the Susquehanna river should be mentioned. One is from Nichols, and measures 10½ by six inches. It was found 25 years ago. The other is from Owego, and is a little smaller, being 10 inches long by four and three eighths wide. It is of a light translucent flint, and was found 50 years ago, just below the Susquehanna river bridge.

A different form of flint implement was certainly used for digging, although in a very moderate way. The form was often that of a shouldered spear, but with the point rounded and polished by contact with the earth. Fig. 149 is a good example from the Seneca river, made of grey flint, and four inches long. Fig. 148 is another of common flint, found near Rome, N. Y. This has no shoulder, and may also have been used as a knife, but the narrow point is highly polished by use. It is three and one quarter inches long. It is quite probable that this was a secondary use; a broken point being re-chipped, and then used in this way. It is even more likely that spears and knives were sometimes used in digging.

Fig. 150 is a pointed leaf-shaped implement, which one hesitates to call either spade or hoe, so handsome is the material and so fine the work. It is a fine orange jasper, five inches long and nearly three and one half inches wide. It was found on Onondaga lake, where others of less beauty occur. This figure and the following two are reduced to three fourths of the actual size. Others, of the same general shape as the last, are less pointed.

Some broad, thin, and celt-like chipped sandstones are often now classed as spades, and occur on some village sites. They would do moderately well in digging, though a sensible savage might have much preferred a sharp stick, horn, or bone. As hoes they would have been more useful, and this may have been their office. They range from four to seven inches in length, with a proportionate width of more than half, and have a wide distribution. Fig. 151 will suffice as an example of these. It is of red sandstone, having parallel edges and rounded angles. It is chipped much like the flat net sinkers, but has no notches. The length is five and seven eighths inches, width three and three eighths, and thickness five eighths of an inch. This is from a village site on the Seneca river, where many were found. On some smaller sites they also occur, while on others they are altogether lacking. It may be added that the nature of these sites does not favor the theory that they were used in agriculture.

CHIPPED STONE AXES

Grooved axes are rare in New York and Canada, and probably were never used by the Huron-Iroquois family. Chipped implements of an axe-like form are no more plentiful in New York, while the common celt, or polished stone axe, without grooves, is both abundant and variable. These were used by the Iroquois, even after white contact. Although iron axes quickly came into use, yet Champlain said that the Mohawks were not well supplied with these in 1609, and some still employed the primitive axe of stone. Fig. 152 shows a rudely notched implement of brown sandstone, from Oswego Falls, much like a modern hatchet in outline. It is five and five eighths inches long, and is quite flat. This is an unusual form, although other rude implements have some resemblance to it. A much neater and more regularly chipped axe of the same material, is from Brewerton. It is five inches long, with a width of two and seven eighths inches towards the cutting edge, and one and one half inches at the top. The lateral edges are straight. Fig. 153 represents a fine article of ferruginous flint, somewhat square, and five and one eighth inches long by about three and three quarters wide. It comes from the Oneida river, and is of moderate thickness. There can be no doubt that it was used as an axe.

Chipped celts were quite abundant almost everywhere, and were sometimes a final, sometimes a transitional form. The usual course was to chip the stone into the shape of the celt, when this could be done. This might go no farther, for as a weapon of war it was already serviceable, and perhaps in some of the arts of peace. If the material was fine, it might afterwards be picked and polished. Often the edge was ground before these things were done. The finish has nothing to do with the age, for the rudest and most finished forms may be found, side by side, on the same village site. Many show all three processes in the unfinished implement. The work might go on for years, at intervals, the weapon being used nearly all the time. As the difference is thus only one of finish, except in flint celts, no illustrations need be given of those of common stone.

A micaceous stone is frequent on a few sites, showing no signs of work, but presenting such resemblances to finished celts that one can hardly doubt its use. It would soon lose all marks of human skill.

In the examination of Iroquois sites, one can hardly fail to observe how the stone age was on the wane, in this family at least. With rare exceptions stone implements were rude, and there was neither the variety nor beauty in articles of stone everywhere seen among their New York predecessors. Bird amulets, gorgets, stone tubes, scrapers, drills, and banner-stones were already things of the past. Arrows were small, comparatively few, and mostly of one form. Stones were still used in grinding corn and cracking nuts, but the wooden pestle and mortar had their established place among prosperous people. Stone vessels were forgotten, and bone and horn took the place of flint. Still, stone was necessary, and the ungrooved axe was often finely finished.

There are a few chipped celts of flint, often ground at the edge, but ground flint is rare in this country. Fig. 154 is a good example, coming from Onondaga lake. It is of common hornstone, two and three quarters inches long, seven eighths wide, and five eighths of an inch thick. It is ground to a moderately sharp edge at both ends. A broad edged one of chalcedony, three and five eighths inches long, comes from Oswego Falls. Fig. 155 is of grey flint, two inches long, one inch wide, and nine sixteenths thick. The cutting edge is neatly chipped, and one surface is much flatter than the other. This is from Onondaga lake. A much larger one of grey flint, comes from the town of Marcy. This is eight and three eighths inches long. Fig. 156 is a well marked form. In this most of the surface is flat, the cutting edge being sharply beveled on each side. It is of drab flint, two and one quarter inches long, and five eighths of an inch thick. It comes from Seneca river. Another finely chipped celt is from near Skaneateles lake, and is represented by fig. 159. It is of brown flint, over an inch thick, and sharpened at both ends. The length is nearly four inches, and it is symmetrical throughout. Fig. 160 is of common hornstone, with parallel sides and rounded edge. It is from Cross lake, and is two and one half inches long, one and one eighth wide, and three quarters of an inch thick. It is very neatly chipped. Fig. 161 is of unusual material, being of clouded quartz, well worked. It is two inches wide, and two and seven eighths long. This is from Onondaga lake. Others might be described, but there is no great variation in form. Only a few are elliptic, but several have the wide and ground edge. Although rare, they are widely distributed, and are sometimes of choice material.

An earthwork in the town of Granby has no relics beyond small fragments of earthenware, a few flint flakes, a flat sinker, and one or two skeletons, but a rude celt of greenstone, seven and one quarter inches long, was found quite near. The indications are that its occupation was very brief. An earthwork, three miles southeast of Baldwinsville, has fine celts, but many more which are very rude, varying from three and one half to nine inches in length. One of the latter length is massive, prominently ridged on one side, and but little worked. Another of talc, four inches long, and laterally curved, is rudely chipped, but is remarkable for form and material. Some of these rough celts are a broad ellipse. The only earthwork in Wayne county furnished a rude one of dark crystalline stone, nine and one eighth inches long. Numberless examples might be given.

PERFORATORS

Among the most remarkable and perplexing articles of flint are those known as perforators or drills. They are widely distributed, and are of a comparatively early date, in New York at least, not having been used by the Iroquois, who preferred awls of horn or bone. Some are found in Great Britain, but of simple forms and rude workmanship. Dr Abbott well said of these, and some other things, 'It is certain that the majority of our specimens, such as scrapers, drilling stones, etc., are manufactured with greater elegance, and evince a more thorough knowledge of the chipping art. The English specimens appear to be all flakes, which have had the edges chipped, that the required shape might be given to the specimen.' Ours are usually worked over the entire surface, but not invariably, for we have specimens as rude as any in England.

In some places perforators are rare, and but six were catalogued in the Wagman collection at Saratoga. Out of 327 in Mr Douglass' collection, but 29 are credited to New York, where they really are abundant.

So slight is the division between these and arrow-heads, in very many cases, that it has recently been suggested that they are but a slender form of these. Sometimes it is a question to which class to assign some forms. A series of triangular arrows from one site, commencing with a broad form, grades insensibly into those so slender that they would be called drills anywhere else. The main difficulty, however, is to assign them a distinct use. They fit well in the spiral perforations of gorgets, but no great length would have been required for these. Possibly they may have been used in perforating wood, but this is doubtful. For piercing leather a sharp bone or thorn would have been preferable. An early writer, in speaking of shell beads, said they were drilled with a nail or a sharp stone. We might suppose that their use was of this nature, were it not for their abundance in places where large shell beads were not likely to be made. Their fragile character and few signs of use, increase the difficulties of the problem. Some, therefore, have suggested that many were pins, more or less ornamental. Dr Rau thought some of the straight, double pointed forms might have been used in fishing, the line being attached in the center, according to a well known method. The question can not be satisfactorily discussed now.

Long straight perforators or drills, for the common name will be used here, are quite common, and are usually of grey, drab, or black flint, often expanding at the base. They suggest awls or bodkins, at once. Fig. 157 is such an article, of common flint, representing a frequent form on the Seneca river. It is three inches long, and the base is but slightly wider than the main part. One of the same form and material but four inches long, comes from Onondaga Valley. This also is straight, and has but a trifling expansion at the end. Another of similar form and material, from Brewerton, is a little thicker, and three and five eighths inches long; nor are these solitary examples, although they may represent the extreme length of this form here.

Some expanded forms do not exceed an inch in length. Fig. 158 shows one of these which is not an inch long, but which is neatly worked and symmetrical. It is of bluish flint, and was found at Baldwinsville in 1878. Fig. 162 has a thicker base than usual, and indeed is somewhate massive throughout. It is of brown flint, three and three quarters inches long, and comes from the Oswego river. Fig. 163 is a beautiful drill, yellow at the base and shading into red, which is the color most of the way towards the point. This may have been caused by heat. The base is moderately broad with concave sides, and is three and three quarters inches long. It comes from Onondaga lake. In many such forms there is little more than a quick expansion of the base, tapering, rounded, or angular, as the case may be. These vary little in length, but are often quite wide. Fig. 164 unites the scraper and drill, as in some other cases, having a scraper edge almost to the point. It is of mottled flint, two and one half inches long, and was found on the Seneca river.

Another form of the long drills was distinctly notched. Fig. 165 is a beautiful example of these. It is from the same river, and is of a mottled grey flint, three and seven eighths inches long. Both work and material are fine, and it is slightly barbed on one side. Very closely resembling this is another from the Mohawk, at Canajoharie flats. It is of drab flint, a little shorter and wider than the last, but equally fine. The length is three and three eighths inches. A broader form still, but of about half the length, comes from Brewerton, and there are many approaching these.

Excepting as they approach the triangular form, those with a very long and broad base rarely reach two inches in length. Fig. 166 is very odd, the broad and notched base having elevated points on either side. It is from the Seneca river, and is of light brown flint, one and three eighths inches long. Fig. 167 is a frequent form, with a broad and deep base, which in some may be widest above or below. Sometimes the contraction above the base is very moderate at first. This is of common flint, and is one and one quarter inches in length. It is one of the frequent forms. Fig. 168 is one of the largest and oddest of this variety, and comes from Brewerton. It is of brown flint, and the broad and curving base has obtuse raised points, strongly suggestive of those in a drill already figured. The length is two inches, and it is nearly as broad.

Some of these expanding bases suggest the gimlet and thumb-screw, and might have been used with or without an additional handle, but the straight and slender ones, if used for perforating, would have required a handle of some kind. Fig. 169 is a small example of the thumb-screw pattern, the three arms being much alike, though one is a little longer and narrower than the others. It is of drab flint, one and one eighth inches long, and could be easily turned by the fingers. This is from Seneca river, and another from Brewerton, two inches long, presents the same concave base. This is carried still farther in fig. 170, a specimen unfortunately broken, where the wide base is almost as slender as the shaft. One prong terminates in a notched and rounded point, as if for suspension, and it is a question whether the broken part had the same feature, as is probable, or whether it was a double pointed drill. It is of black flint, two and one half inches long, and comes from the Seneca river. A smaller one, somewhat like this but with a narrower base, was found on the Canajoharie flats. The one figured, however, is unique in some respects.

Fig. 171 is a good example of the gimlet form from Onondaga lake. It is of grey flint, two and one half inches long, and very symmetrical. One from Geneva is almost equally so, and is two inches in length. This form is rarely perfect, from its great liability to injury, but more might be described. Among those having deeper expanded bases is one of rosy quartz, one and three quarters inches long. This is also from Geneva, where many small forms have been found. There are one sided basal drills, and those oddly curved, but these seem mere freaks, and but one will now be mentioned, because some have thought it may have been used in forming a primitive fish-hook, by binding it to a perforated stick. Dr Rau (see *Prehistoric fishing*, fig. 180) shows one closely resembling this in a Greenland hook of wood and stone. Capt. John Smith speaks of a similar use of bone in Virginia. 'Their hookes are either a bone grated, as they noch their arrowes in the forme of a crooked pinne or fish-hooke, or of the splinter of a bone tyed to the clift of a little sticke, and with the end of the line they tie on the bait.' That this article is well adapted for such use will be readily seen, and Dr Rau's figure seems almost conclusive proof.

Occasionally a drill is widened in the middle, between the base and point. Very simple examples of these occur, but sometimes they are rather curious. Fig. 173 is a flat form of drab flint, one and one half inches long, and might be described as a double thumbscrew. While the center has been well preserved, both points have been broken off, but they were evidently quite short when perfect, so that the figure presents very nearly the original outline. Even now it is a most interesting article. Fig. 174 is another odd form, very wide, and deeply notched. Above the notches it might be described as broadly winged, but the barbs form its most distinctive feature. It is of drab flint, one and one quarter inches long, and was found not far from Rome, N. Y.

Many drills are nearly triangular, and occasionally one may have been formed from an arrow-head. Fig. 175 may have had such a primary use, followed by a moderate narrowing of the point. It is notched, of dark flint, one and seven eighths inches long, and was found near Three River Point. Fig. 176 is a straight perforator of common hornstone, two and five eighths inches length. The base is better finished than in most examples of this variety, which are often smaller, and of black flint. This comes from Onondaga lake, where many of this form have been found.

Sometimes one occurs, straight and uniform, which has a rounded point at each end. These grade into a broader form, which seems a small knife. A few have an erratic form, marked by a one sided base. Some convex sided arrow-heads, as has been said, are drawn out into a slender point, suggesting a perforator, and there are rude specimens, perhaps used for temporary purposes. One of these forms, not rare, is a slender splinter of hornstone, triangular in section, and chipped so as to present three faces on the shaft. In such cases the base is sometimes left unaltered.

While perforators are widely distributed, from the Atlantic to the Pacific, their most ornamental development seems to have been in Missouri, where they grade into animal forms. This gives countenance to the idea that some may have been used merely as ornaments, a remark which will not apply to all.

SCRAPERS

The typical scraper has one flattened side, usually formed by one or two broad flakings; and another, more or less elevated or ridged, which is beveled down to the other surface. It is often combined with the knife or drill, especially in implements approaching the leaf shape, or in distinctly curved knives. Scrapers are often very rude, some being made of flat pieces of hornstone, merely chipped down to a scraper edge. Sometimes other flat siliceous stones were utilized in the same way, resulting in rude and unusually large implements of this kind. Many were made of broken arrows, in which case the under surface may be quite delicately chipped. This secondary use may be the reason why they were so long overlooked here, as they were not attractive articles to collect until their true nature was known.

Many of them may have been used in handles, as in comparatively recent times elsewhere, but others were so large as not to require these. Carved handles of horn or bone have been occasionally found, but these may have belonged to other implements, as they came from Iroquoian sites, and that great family knew little of stone scrapers or perforators. Absence of such handles in other places, however, proves nothing, as horn or bone articles quickly decayed except in fireplaces and refuse heaps. It is still more likely, in a forest land, that handles would have been made of wood. Small scrapers would often require handles of some kind, but the larger ones might not.

They vary greatly in form and finish, and some very closely resemble those yet used by the Eskimo. They form a very widely spread class of implements, often adapted to local needs.

The ruder scrapers need not be illustrated now, as they took almost any form, like the ruder knives, presenting nothing characteristic except the beveled edge and flat under surface. A chance flake, or a flat pebble might be otherwise unaltered. Some are extremely small, being less than half an inch long, while others are quite massive. Fig. 178 is a fine example of a simple and large form from the Seneca river. The material is brown flint, two and five eighths inches long. This is boldly but neatly flaked, and is more massive and uniform in thickness than usual, as well as flatter on the under side. Another from Onondaga lake, of mottled flint and one and seven eighths inches long, is very much like this, but the under surface is somewhat curved and twisted, and the implement is proportionally broader. One of yellow jasper, from Oswego Falls, closely resembles this in size and character. A fragment of a large one from the Seneca river, is still two and three quarters by three and one quarter inches, but is of a ruder type. A very neat and depressed scraper, almost of a horse-shoe form, was found in the town of Marcy, north of the Mohawk river. It is of drab flint, and is three and one quarter inches in length.

Fig. 183 is given on account of its small size, although typical of quite a class. There is a small site on the bank of the inlet of Onondaga lake, which was a frequent camping place in early days, sometimes apparently occupied for months at a time. Bone harpoons, pottery, flint and bone articles, the so-called spades, and other things occur there. In excavating an ash-bed there this little scraper was found. It is of common flint, ridged in the center, and but seven sixteenths of an inch long. Another, but five eighths of an inch in length, comes from Seneca county.

Fig. 177 is a very curious article, not a typical scraper, and yet probably used for one of its purposes, that of fashioning the shafts of arrows. It seems to have been made from a broken arrow-head, and was found in 1889 in a cache in Cayuga county. The cache contained also twenty arrows and the same number of flint knives, a quantity of mica, some antler prongs, paint, and other things. Also a turtle totem of grey stone. One of the arrows was translucent, and another was of white quartz. The remainder of the arrows and all the knives were of native hornstone. The writer has seen a similar article from Missouri, and supposes it to have been used in scraping the shafts of arrows in the speediest way.

Fig. 179 has one end rounded, and the other straight. The edges are somewhat parallel, but the surface is widest along the center. These opposite edges are beveled from opposite surfaces, so that there are one or two scraping edges, whichever way it may be turned. It is probable that some of the beveled arrows, so called, were scrapers of this kind. Part of the length has been lost, so that no scraper now appears at that end, if indeed there was ever any there, for in that part the edges become sharp, and probably the knife and scraper were combined. It comes from the Seneca river, and is made of brown flint, still two and seven eighths inches long. A smaller one of these has much the same character; the base and edge being beveled on one side, with the other edge beveled from the other surface. It is of light drab flint, one and three quarters inches long, and does not have the knife edge of the last mentioned. This was from Three River Point. Another similar scraper, of light grey flint, has four beveled edges on one side, nearly parallel, and is one and three quarters inches long.

Some which have been called gambling flints, are small and nearly square. They are not all distinctly scrapers, and seem to have been Iroquois gun flints, made by themselves for an emergency. The beveling is from both sides, as in a knife. As some of these were certainly made at a time when the Iroquois used deer buttons and peach stones for gambling, and as most of them were associated with European articles, they may well be classed as indian gun flints. Fig. 180 is one of these from the Seneca river. It is of dark flint, nearly an inch square. The square center is flat, and the stone is beveled to the edge on each side. Fig. 181 shows a Cayuga specimen, to which the name of gambling flint has been distinctly given. It is of hornstone, and was found, with 20 others, in a grave well supplied with European articles. This is an inch across, but others were smaller. A gun, bullets, and two gun flints, were among the articles accompanying these. Fig. 182 is a smaller one from the same grave.

It will be remembered that the proper name of the Mohawks was Kaniengas, People of the flint, and that their proper symbol was a steel and flint; often only the former. Their associations were not so much with the flint as material for arrows. From almost the first they connected with it its fire producing powers. As soon as they had guns — and they were the earliest New York indians to possess them — they saw occasional economy in the use of their favorite stone. On this point there is a curious passage in the *Jesuit relations* of 1668, of an incident which happened when the French missionaries were about two miles north of Ticonderoga. 'We all stopped in this place, without knowing the cause of it, until we saw our savages gathering upon the edge of the water, gun flints, all nearly shaped. We gave this not much thought at the time, but afterwards learned the mystery, for our Iroquois told us that they never fail to stop in this place, to render homage to a nation of invisible men, who dwell there in the depth of the water, and are occupied in preparing gun flints, nearly all ready for the passers by, provided they do their devoirs in presenting them tobacco; if they give much of it they make them a large largess of these stones.' These men were farther described, but the French concluded that, in storms, 'when the wind comes across the lake, it casts upon this shore a quantity of stones, hard and fit to strike fire.' This sufficiently shows that the Iroquois often provided their own gun flints, instead of using those imported by traders.

Many scrapers are almost or quite elliptical, and some circular forms may be gun flints. Fig. 184 is a fine example of the former class from Brewerton. It is of drab flint, thin and flat, and the edges are beveled all around from one surface. It is one and three eighths inches in length. One much like this is from Auburn, and is one and five eighths inches long. It is by no means a rare form, but grades into knives.

A heavy, rounded, triangular scraper from Oswego Falls, has a double curve in the long section, and is one and one half inches long. Another of similar outline is from Cross lake. It is, however, uniform in thickness, with edges abruptly beveled in opposite directions, forming a double scraper, which is not a rare feature. The length is but one inch. A handsome one of brownish, banded flint, one and one eighth inches long, comes from Baldwinsville. Fig. 185 represents this. It is of uniform thickness, a quarter of an inch, but is peculiar in having a concave and convex surface, with the scraper edge beveled from the former to the latter.

Fig. 186 is a long, leaf-shaped scraper or knife of brown flint, found near the rifts south of Three River Point. It is five and one half inches long, and suggests a long knife, but has but one or two long flakings on the under surface, to meet which there is the usual bevel nearly all around. It is moderately thin, and very much twisted. Several of this form and size occur, with many variations, and nearly all would serve for knives almost as well as scrapers, although having the characteristics of the latter.

Fig. 187 shows one of the finest scrapers, in material and form almost identical with some knives, except in the edge. It is of lustrous brownish grey flint, four and one eighth inches long, and widest in the middle, whence it tapers almost to a point at either end. This was found at Onondaga lake. The greatest width is one inch, and it is less than half that in thickness.

Quartz scrapers are rare in New York. One from Brewerton, one and three eighths inches in length, is triangular, and like others with that outline, is much the thickest at the broad scraper end. Fine leaf or rather often triangular forms, however, occur in common or light grey flints. Fig. 188 is one of these from the Seneca river, which is of dark blue flint, two inches long, and very evenly beveled around and near the end. The lateral edges are sharp, as though intended for cutting, and as it might have been used without a handle, if desired, it probably combined two implements, as was so frequently the case. Scrapers of this form are usually thin and flat, but are a little thicker at the broad end, and are also neatly chipped on the lower surface. Many are much smaller than this specimen, and some have the point turned to one side.

Among other remarkable scrapers are some from Canajoharie, found along the river bank. Fig. 189 represents a long form of these. They are not many in number, and have been reported nowhere else. They vary from almost triangular to nearly circular. This one is of common flint, with conspicuous but obtuse serrations at the broad end, and is one and one half inches long. Some others there are much more finely and sharply serrate, but this serration is along one of the longer sides. They probably had some local use.

A very remarkable class of scrapers, combining the knife with these, occurs in but very moderate numbers, and somewhat local at that. They may be nearly straight, or very much curved, and there is usually a tang at the base, resembling a handle, drawn out into a shoulder on each side. They are quite likely to have been used in fashioning bows and arrows, for which the combination of a convex knife with a concave scraper admirably fitted them. Perhaps less than a dozen have been found in New York. Fig. 190 is a perfect example from the Seneca river, made of brown and drab flint, and three inches long. This is the typical form, much like that of a curved sword with its cross hilt. One much more curved, but unfortunately a little broken, is from Brewerton. It is of common hornstone, two and one half inches long, and has the deepest curve of any yet reported. Out of several which do not essentially differ from these, may be mentioned one of a gritty brown flint, which is one and one eighth inches long. Fig. 191 represents this, which came from the Oswego river. At the point there is a knob-like expansion. A very odd one comes from Cross lake, and is made of a light grey flint, one and seven eighths inches long. It is more angular than others, but the blade does not present so decided a curve. In others the scraper edge is quite as decidedly developed, and they grade into nearly straight forms with the same features. In all the concave edge of the blade is quite thick, while the convex edge is comparatively thin and sharp. In the supplement to his illustrations of the Smithsonian collections, Dr Rau figured a fine example from Ohio, about two inches long, but they are not described by Abbott among New Jersey articles, or by Fowke among those farther west and south. None have been reported in Canada, and they seem practically a New York implement, local even there. The advantage of the combination and the peculiar form will be readily seen.

A still rarer form, in fact quite unique, is one which did not return from a scientific mission, greatly to the owner's sorrow. Fig. 192 is of dark green jasper, and was found on a small camp site on the Seneca river. It is broadly flaked, and the upper end is notched as if for suspension. The remarkable features, however, are the angular central projection of the broad scraper end, and its continuance on either side beyond the lateral lines. The length is one and seven eighths inches. It is greatly to be desired that this unique article should be recovered, from its local and general value. For the present the finder can only depend on his record and figure. Notches, apparently for suspension, are sometimes found in these and other articles.

Stemmed scrapers often have the outlines of arrows, and are distinguished only by the edge. Some were made from broken arrowheads, and these are readily identified by the under surface. Fig. 193 is like the long-stemmed bunts, but is a true scraper, somewhat coarsely chipped. This variety has been described in New Jersey and elsewhere. The material is a grey flinty limestone, two inches long, which is larger than the ordinary size. A long and ruder one, however, also from the Seneca river, is three and one quarter inches in length. It is quite thick, and has an unusually long stem.

Others of this general form have a slightly expanded base, as in the bunts. Fig. 194 is a good example of these, of brown flint, one and one eighth inches long, which comes from the Seneca river. A frequent short and very wide form has some general resemblance to these, but is in many ways quite distinct. They suggest what is sometimes called the sheaf of wheat pattern, and are often made of the bases of broken arrows, but the form was often the original design. Fig. 195 is a good example, and quite thick. It is of common hornstone, seven eighths of an inch long, and one and one quarter inches wide, but the base does not expand below the broad shoulders, and presents a rounding outline. Fig. 196 is broader, being one and one half inches wide, with the same length. It is of drab flint, more angular than the last, and has distinct barbs and an expanding base. It was always a scraper. This is true of another, even more angular, made of dark flint, three quarters of an inch long, and one and one quarter inches wide. Fig. 197 is another fine scraper of this type. It is of brown flint, one and one eighth inches long, and one and three quarters wide, with a longer base than in the last. All these, as well as the following two, are from the Seneca river.

Fig. 198 is much like these, but is simply and angularly notched, and has a broad scraper edge. The material is black flint, and it is an inch long, with a little greater width. It is a rare form. Fig. 199 is another small and peculiar form, made of dark flint, and seven eighths of an inch long. It has a scraper edge nearly all around, and the notched stem seems to have been intended for insertion in a handle. The form is unique. Fig. 200 is another odd form from the same river, having rounded projections on the sides, and it is much the thickest at the scraper end, though having a somewhat massive character throughout. It is of quite dark flint, one and one quarter inches long by an inch broad.

Some others combine a short drill with a broad scraper base, but these are usually rather small. The combinations with knives are many. Few implements vary more, and their forms had probably much to do with special uses, as in dressing hides, cleaning fish, or smoothing wooden implements. Their complete disappearance in recent prehistoric times in New York, along with that of other implements quite as remarkable, argues a great and sudden change in the dwellers or visitors here. The Iroquois seem not to have used them, nor do we find any suggestion of a similar implement, as in the substitution of bone or horn perforators for those of stone. The makers of the stone scrapers disappeared from New York long ago, and yet it is clear that they were once very widely used, reaching the Pacific coast and even Mexico. Plainly the modern indian did not inherit some of the most remarkable arts of his predecessors. This is one of the significant revelations of archeology. A new race came in and early arts perished. Beyond the making of arrows and axes scarcely anything survived in New York.

This, however, must be understood of peculiar implements. The dressing of hides still went on, and some of the results have hardly been surpassed. If the Iroquois did not use the stone scraper, or any thing closely resembling it, they employed something quite as effective, and perhaps in a similar way. Corlaer, in 1635, gave *canagoerat* as the Mohawk word for scraper, which may or may not have some reference to flint, or *kahnhia*. A little later Father Bruyas defined the Mohawk *gannohouagethon,* to scrape a hide, and another word expressed the stretching process. In a rude way they are still, or were recently, in use among some of our western indians, but not in forms like those of old. The Eskimo still use them, inserted in handles, and one specimen here figured is almost exactly like those which they make.

Dr Abbott says of New Jersey scrapers, 'One feature of the European scrapers is having one side flat or uniform, the result of the breaking away of a large flake, thus giving on one side the smooth surface of a single plane of cleavage. We have all our specimens chipped upon both sides, unless it be those of about the minimum size, which appear absolutely identical with the European specimens.' In New York, however, a large proportion of the larger examples have this single cleavage, while full chipping on both sides is confined to a few. From Sir John Lubbock's illustrations, Dr Abbott also thought European specimens rudely chipped in comparison with American, and a similar comparison would show the high character of those of New York.

As regards their distribution no exact statement can be made. In some form they seem distributed throughout the world, but the proportion in any collection will vary according to the field in which it has been principally made. Mr Douglass has 220 New York scrapers, out of a total of 1061. Of these 636 came from Missouri, and 71 from Arkansas. From the New England states he has none at all. Dr Rau figured them only from Ohio and Texas. In the Wagman Saratoga collection none are mentioned, but such omissions may be due to their frequent lack of beauty. In a show collection they might make a poor figure.

SERRATE ARROWS

The serrate arrow forms, which Evans called saws in Great Britain, are quite rare in New York, but are common farther west and south. The materials of which the few found here are made, point to a distant origin. Fig. 201 is of translucent horn colored flint, one and three quarters inches long, and it comes from Nine Mile creek, some miles west of Onondaga lake. The base is gone, but this example is given because of its distinctly serrate character. Another broken specimen, of bluish flint, now one and one half inches long, is as serrate, and comes from the same vicinity. Good examples should occur in the southwestern part of New York, but none have yet been reported.

FLINT HAMMERS

Flint hammers have thus far been more frequently observed in the lower Mohawk valley than elsewhere. They are rude nodules of flint, showing traces of hammering, and sometimes of chipping, but were naturally used but little in a land where field stones are abundant. They differ much from the so-called hammer-stones. Fig. 202 shows one from Spraker's basin, which is two and one quarter inches across, and just a third as thick, one broad surface being quite flat. Fig. 203 is more characteristic, and is from the Seneca river. This is one and seven eighths inches long, and an inch thick. Fig. 204 is a smaller one, not far from one and one half inches each way. Smaller ones yet appear. A more remarkable one comes from Onondaga lake, which is two and one eighth inches long. Its peculiar feature is the rough grinding in two contiguous planes at one end. Flint is rarely ground here, but when this has been done the result is commonly a polish. A few chipped hammers of greenstone present nothing worthy of remark, except a slight expansion at one end. They are from three to four inches long. The ordinary hammer-stones, and the common field stones perhaps restricted the use of these ruder implements. The faceted and picked balls of stone, possibly used in war clubs, properly belong in another class.

MISCELLANEOUS

There are many odd flint forms of uncertain character. Fig. 205 represents one of these, being a fragment of some article unknown. It may be the base of a knife, but is strongly suggestive of the fine stone sceptres found of late in Illinois and Tennessee. In that case this would have been the upper end instead of the base. It is of thin, light drab flint, neatly worked, and is yet over three inches long. It is broken where a line of fossils crossed the stone.

Unfinished articles often awaken curiosity, and sometimes reveal the processes by which they were made, and the several stages of the work. This is notably the case with some celts, and unfinished drilling has even yet greater importance. With articles of flint it is more a question of ultimate intention. Fig. 206 is an odd article, which may have been a completed and broken implement, or an unfinished one, just as well. What we call the lower part has been broken, giving an element of uncertainty to the actual or intended form. As it now is, it is two and three eighths inches in length, and is made of common hornstone. One side is flat, and the other neatly chipped over most of the surface, the concave edge being thickest. This might be classed among implements combining the knife and scraper, for the convex edge is sharp. There are hints, also, of a future modification of the form. The striking peculiarity, however, is the rounded point, deeply indented below, as if for suspension. Fragments like this and the last, are often valuable for their peculiar features.

Fig. 207 is a small curved scraper of common flint, about one and one half inches long, which is from Cayuga county. It differs from those already described in having simply an expanded base, without a tang. The curve is greater than usual, and it has been accepted by some as the flint point of an early fish-hook, for which it might have answered, though it seems too short and thick for such a use. On the whole it seems more reasonable to place it among the curved scrapers, for grave objections might be made to the other use, and it certainly closely resembles these.

Fig. 208 is simply a flint pebble of an oval form, split in two and chipped on the flat surface. These pebbles are water-worn, and not very large, although this is one of the smaller sizes. They seem unfinished, although neatly chipped; and in their present condition would serve only for scrapers. This one is from Seneca county, and they are found there and elsewhere, although nowhere frequent.

Fig. 209 is one of the smallest forms of New York arrows, of the class called bird points. It is less than half an inch long, and comes from Tioga county, where they are frequent, but with various outlines. Many think these were made for children, on account of their small size, but they are quite as likely to have had other uses.

FISHING AND STONE NET SINKERS

One very important article in the food of the American aborigines was fish. The accounts which early travelers and colonists give of the abundance of all descriptions of fishes in lakes and rivers, seem wonderful now, when we are trying to restore them to some degree of their early condition, and yet they are harmonious and well supported. The only difficulty the indian had was to preserve and store up this abundant supply for hours of need. In Canada and New York, eels were taken in vast numbers, and were easily preserved by smoking. It does not appear that this was usual with fish of other kinds. Salt they did not use, and it was distasteful to them. The Iroquois now ascribe their degeneracy and lack of manly vigor, to using salt meat, instead of obtaining all its fresh juices, as their ancestors did.

It becomes a matter of interest to know how they took the fish which swarmed in every stream, for certain relics have direct reference to this. In doing so, however, bare allusion will be made to harpooning, for the harpoon of colonial times was made of bone or horn, and sometimes of wood and iron, thus lying outside of those chipped stone implements to which this paper relates. Only incidentally will angling be touched upon, for the same reason.

In the account of Champlain's voyages, that great discoverer told of Huron customs. 'The men make the nets to capture fish in summer as well as in winter, when they generally fish, reaching their prey even below the ice, either with the line or the seine.' This winter fishing was described by others as well as Champlain, but he mentions the fact which is of importance here, that the net 'sinks to the bottom of the water by means of certain small stones attached to the end.' While Sagard describes the making of Huron nets and their use, he says nothing of these weights, for the one was a necessity of the other. He does, however, allude to one fact in angling, which is important if we substitute the curved and slender stone drill for the piece of bone. He said, 'We found in the bellies of several large fishes, hooks made of a piece of wood and a bone, so placed as to form a hook, and very neatly bound together with hemp.' A figure has been given of a New York stone perforator, suitable for this use. The

Canadian institute has several well adapted for this also, varying from two and one quarter to four inches in length. The early Huron practice of marrying the nets to two young girls, is well known, and seemed long established when the French first met them. The Algonquins had an old story that Michabou taught their ancestors how to make nets, having taken the hint from watching a spider catch a fly. Nets were therefore plainly an aboriginal invention, and their use is directly connected with the large numbers of flat net stones found by all considerable streams. These nets were made of native hemp, out of which some of the New York Iroquois still make thread in their primitive way.

Mr William L. Stone gave Dr Rau an 'account of a stone structure, evidently a fish-pen, in the state of New York.' It was on the right or south bank of Fish creek, the outlet of Saratoga lake, and the plan and description will be found on page 201, of *Prehistoric fishing*. It is a matter of considerable interest, and Mr Stone readily disposes of a seeming difficulty, the fact that the opening to the pound was down stream, by supposing that it was employed mainly when the fish were ascending the creek to spawn. Such pounds were frequent among the indians elsewhere within historic times, made of stones or wood, and there is no great difficulty in assigning such a use to this. In Sullivan's campaign, in 1779, a town was destroyed on the present site of Waterloo, where were 'several fish ponds abounding opposite the town.' This was the statement of Sergeant Major George Grant. Gen. John S. Clark, a well known antiquarian made a note on this: 'These were circular enclosures of stone from 30 to 40 feet in diameter, built upon the rocky bed of the stream, where the water was neither very deep or rapid, so constructed as to permit the water to pass through, but to retain the fish.' These, of course, were simply places for keeping surplus stock.

These were modern structures. When the famous 'Lessee company' made its agreement with the Six Nations in 1787-88, the indians reserved 'one half of the falls and convenient places for weirs, for the purpose of catching fish and eels, from Cross lake to the Three Rivers.' Without questioning whether eels are fish, it is clear that the Iroquois attached importance to the use of weirs, and that some might be even now looked for in the waters mentioned. When Francis A. Vanderkemp descended the Oneida river, in 1792, at one rift he remarked, 'It was said here was an ancient indian eel-weir — by which this natural obstruction in the bed of the river had been increased.'

Several such stone weirs still remain in the Seneca river, in a more or less fragmentary condition. One which is several hundred feet in extent, runs in a zigzag way across the river, and two deep bays are in excellent order. The third was removed to permit the passage of large boats. The French missionaries mentioned such structures here in 1656, in these terms: 'The fish which are most common here are the eel and salmon, which are fished for from the spring until the end of autumn, our savages managing so well their dykes and weirs, that they take at the same time the eel which is going down, and the salmon which is going up.' They also speared fish by torchlight, but often used a peculiar wooden spear for this. Fifty years earlier they had bone harpoons.

There are several early accounts of the use of these fish-weirs, in various parts of the country, and Loskiel gives that which was common in Pennsylvania, when the shad ascended the rivers. 'The indians run a dam of stones across the stream, where its depth will admit of it, not in a straight line, but in two parts, verging towards each other in an angle. An opening is left in the middle for the water to run off. At this opening they place a large box, the bottom of which is full of holes. They then make a rope of the twigs of the wild vine, reaching across the stream, upon which boughs of about six feet in length are fastened at the distance of about two fathoms from each other. A party is detached about a mile above the dam with this rope and its appendages, who begin to move gently down the current, some guiding one, some the opposite end, whilst others keep the branches from sinking by supporting the rope in the middle with wooden forks. Thus they proceed, frightening the fishes into the opening left in the middle of the dam.'

Though their use may be inferred in this, nothing is said of stone sinkers. In another account, published by Adair in 1775, there are mentioned on the vine, 'stones attached at proper distances, to rake the bottom.' This was another use of the flat stone sinker, differing slightly from its use in nets. The polished and grooved plummets, so distinct from these, had other uses, though notably most abundant at two early fishing resorts. The grooved pebbles were many of them sinkers.

It may be remarked that the Hurons and others placed hurdles in streams, with nets across the openings, and that the Oneidas in New York made fish pounds with two rows of stakes across streams, driving the fish into them and killing them there.

The flat stone sinker was easily made by the aborigines, and in fact is still made and used by their white successors. A small flat stone was found and neatly chipped around the edge, or sometimes left almost unchanged. As a sinker it might have two to four opposite notches by which it could be attached more securely. If used as a quoit, the notches might be omitted, and the whole surface neatly chipped. This was the sole difference between these two forms, which might be large or small in either case. Occasionally a small and thin smooth pebble is found on a village site, not over an inch across and with two opposite notches cut in the edge. These have no relation to either of the preceding forms. There are also grooved and chipped stones of considerable size, which were used for anchors, but these are somewhat rare. A series of grooved elliptical pebbles may be classed with those of picked stone, although probably net sinkers. They occur most frequently on Cayuga and Seneca lakes.

Some of the flat sinkers are quite large. Dr Rau figured one which was eight inches across, and one and three eighths inches thick, the weight being two pounds and fourteen ounces. Dr Abbott found one on the Delaware river, which was eight inches square, and had four notches. The weight was nearly five pounds. Here they are rarely much over six inches across, when of the typical form. One fine one, however, unwrought except by the slight notches, is nearly seven inches across, and two and three quarters thick. It may have been used for an anchor, for which it is well fitted in every way.

While abundant near many fishing places on the land, heaps of them have been found in Onondaga lake below the present low water mark, itself the result of drainage. The unnotched forms are found on village sites, more or less remote from water, and undoubtedly were some form of quoit, or they might also have been used somewhat like the southern chungke stone. They occur in many places where they have attracted little or no attention. Fig. 211 represents an example, made from red sandstone. This has no notches, and was found on a village site in Cayuga county, four miles from any water where nets could have been used. Notched forms, however, occur in earthworks from one and a half to three miles from water. Fig. 212 is a good example of the notched form, three and seven eighths by four and one quarter inches. This is a grey sandstone sinker of medium size, from Cross lake, and is rather thin. The larger sinkers usually have four notches. Grooved sinkers or anchors of the larger and ruder forms scarcely require illustration. One of coarse sandstone comes from Brewerton, and is six inches long by four and one quarter wide, the thickness being three inches. On the flattened surface, lengthwise, a broad and deep groove goes all the way around. Few worked anchors are found.

This is a summary of the leading forms of chipped stone implements found in New York. They preceded and survived the finer articles of polished stone, which is naturally the next subject to be treated, and of which New York furnishes so many good examples. That every important locality will yield striking varieties of chipped implements not here illustrated, is to be expected. The purpose of such a paper is to furnish information, but yet more to be a basis for comparison, so that collectors may judge of the real value of the articles they find, and thus be induced to contribute rare specimens to this department of the state museum.

In conclusion it may be said that the value of many articles depends greatly upon the places where they were found, and that a good record of localities is essential to scientific progress. A good local map, on which sites may be placed; a book of outlines, however rude, with descriptive notes, will aid greatly in doing a noble work for the people of New York. These every collector should have.

EXPLANATION OF PLATES

Fuller descriptions are given in bulletin. For exact page reference see index under *Plates*.

Arrow-heads

FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES
1	Drab hornstone	4	----------
2	Mottled flint	1	1
3	Brown "	------	1⅜
4a	Dark "	------	1¼
4b	Drab "	------	1 11/16
4c	*a*..........	------	----------
5	Dark flint	1¼	----------
6	Drab "	2½	----------
7	Drab "	2	----------
8	Common "	1⅛	----------
9	Mottled "	2	----------
10	Grey "	1¼	----------
11	Grey "	------	----------
12	White "	------	----------
13	Lustrous "	2⅛	----------
14	Bluish-grey "	2½	----------
15	Common "	1¾	----------
16	Dark "	2¼	----------
17	Common "	2	----------
18	Common "	1¾	----------
19	Stone	1½	----------
20	Grey flint	1¾	----------
21	Common "	1½	----------
22	Common "	2¾	----------
23	Brown flinty sandstone...	1⅜	----------
24	Dark blue flint	1¼	----------
25	Lustrous jasper	1⅞	----------
26	Grey flint.....	1⅞	----------
27	Yellow jasper..	1	----------
28	Flint..........	1¼	----------
29	*a*..........	------	----------
30	Yellow jasper..	¾	----------
31	White flint	2⅛	----------
32	Common "	1½	----------
33	Brown "	1¾	----------
34	White "	1⅝	----------
35	Drab "	1⅛	----------
36	Drab "	1⅛	----------
37	Grey limestone	2	2—
38	Common flint..	1½	----------
39	Yellow jasper..	1	----------
40	Black flint....	1⅝	----------
41	Shark's tooth..	1½	----------
42	Grey flint	2½	----------
43	Common "	2½	----------
44	Blue "	------	1½ at base
45	Common hornstone.......	------	1¼ at base
46	Drab flint	1½	----------
47	Drab "	1¾	----------
48	Brown "	1¾	----------
49	Brown "	1½	1 3/16
50	Brownish-white flint	1⅝	----------
51	Brown flint...	1⅞	----------

FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES
52	Common hornstone.......	2¼	1⅜ at base
53	Drab flint	1 5/16	----------
54	Brown "	1+	----------
55	Brown hornstone.......	1 5/16	----------
56	Dark-blue flint	2	----------
57	Common "	2	----------
58	Light brown "	1¼	⅞ at base
59	Drab "	2½	1⅝
60	Light color'd "	1—	----------
61	Dark "	1	----------
62	Light bluish "	1½	----------
63	White "	1⅛	----------
64	Dark blue "	1	----------
65	Drab "	⅞	----------
66	Drab "	1	----------
67	Drab "	2	----------
68	Common "	1⅞	----------
69	Drab "	1¾	----------
70	Drab "	2¼	----------
71	Black "	2	----------
72	Common "	1¼	----------
73	Dark "	1⅞	----------
74	Dark "	2½	----------
75	Dark hornstone	2⅛	----------
76	Dark flint	2	----------
77	Light "	1¼	1½
78	Brown "	2¼	----------
79	Drab "	⅞	----------
80	Black "	1½	----------
81	Dark "	1¼	----------
82	*a*..........	1⅛	----------
83	White quartz..	2	----------
84	Drab flint	2¼	----------
85	Blue "	2⅛	----------
86	Common hornstone	1¾	----------
87	Olive slate....	------	----------
88	Drab flint	2¼	----------
89	Brown "	1	----------
90	Drab "	1⅛	----------
91	Dark "	1¼	----------
92	Dark "	1⅜	----------
93	Dark "	1½	----------
94	Common "	1+	⅞
95	Grey flinty limestone ...	2⅜	----------
96	Red jasper....	1½+	----------
97	Blue flinty limestone....	1⅝	----------
98	*a*..........	2⅛	----------
99	Purplish flint..	2	----------
100	Common hornstone.......	1	----------
101	Dark blue flint	2	1¼

a Not given

EXPLANATION OF PLATES, *continued*

Spear-heads

FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES	FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES
102	White flint	6½	....	114	Resembles		
103	Grey "	5⅛	....		moss agate..	3½	....
104	Black "	5⅝	....	115	Flint..........	4¼	1—
105	Common "	7	....	116	Grey flint.....	4¼	....
106	Translucent			117	" quartzite (?)	5½	....
	quartz......	4⅞	2	118	Variegated		
107	White mottled				hornstone...	2⅛	....
	quartz......	3⅝	1 5/16	119	Resembles		
108	Green jasper..	9 from			moss agate..	5+	....
		base	4 at base	120	Greenish white		
109	Drab flint	3¾	1⅝		flint........	4⅜	....
110	White translu-			121	Common horn-		
	cent quartz..	......	....		stone.......	2⅝	....
111	Drab flint	3 7/16	1⅛	122	Hornstone....	3⅛	....
112	Common "	6	2	123	Blue grey flint	7¼	....
113	Grey flinty			124	Chalcedony...	4⅛	2
	limestone...	6+	1¾	125	Drab flint....	2⅞	1⅛

Knives

FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES	FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES
126	Grey flint.....	3¼	....	137	Brown flint	3⅝	....
127	Yellow jasper	3¾	2	138	Brown "	2½	....
128	Drab flint	4	....	139	Brown "	3	....
129	Light blue "	5	....	140	Variegated "	2	....
130	White "	3	....	141	Common "	2¾	....
131	Common "	1⅝	....	142	*a*	4½	1⅛
132	Dark blue "	1⅝	....	143	Grey limestone	3⅝	1¼
133	Grey limestone	2	....	144	Hornstone....	5	2¼
134	Clouded quartz	6½	2	145	Common flint..	3½	....
135	Brown flint	3¼ *b*	....	146	Bent arrow		
136	Brown "	3¼	....		form......	......	....

Spades or hoes

FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES	FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES
147	Bluish grey			149	Grey flint.....	4	....
	stone....	11¼	5¼	150	Orange jasper	5	3½
148	Common flint	3¼	....	151	Red sandstone	5⅞	3⅜

Chipped stone axes

FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES	FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES
152	Brown sand-			156	Drab flint....	2¼	....
	stone.......	5⅝	....	157	*c*	......	....
153	Ferruginous			158	*c*	......	....
	flint........	5⅛	3¾	159	Brown flint...	4	....
154	Common horn-			160	Common horn-		
	stone	2¾	⅞		stone.......	2½	1⅛
155	Grey flint....	2	1	161	Clouded quartz	2⅞	2

Perforators

FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES	FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES
157	Common flint	3	3+	169	Drab flint	1⅛	....
158	Bluish "	1—	....	170	Black "	2½	....
162	Brown "	3¾	....	171	Grey "	2½	....
163	Yellow shaded			172	*a*	......	....
	to red......	3¾	....	173	Drab flint	1½	....
164	Mottled flint	2½	....	174	Drab "	1¼	....
165	Grey "	3⅞	....	175	Dark "	1⅞	....
166	Light brown "	1⅜	....	176	Common horn-		
167	Common "	1¼	....		stone.......	2⅝	....
168	Brown "	2	2—				

a Not given *b* Fragment. Length unknown *c* See under *Perforators*

EXPLANATION OF PLATES, *concluded*

Scrapers

FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES	FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES
177	Broken arrow head	....	....	189	Common flint	1½	....
				190	Brown "	3	....
178	Brown flint	2⅝	....	191	Brown "	1⅛	....
179	Brown "	2⅞	....	192	Green jasper..	1⅞	....
180	Dark "	1	1	193	Grey flinty limestone ..	2	....
181	Hornstone....	....	1				
182	Hornstone....	....	1—	194	Brown flint	1⅛	....
183	Common flint	7/16	....	195	Hornstone....	⅞	1¼
184	Drab "	1⅜	....	196	Drab flint	1½	1½
185	Brown "	1⅛	....	197	Brown "	1⅛	1¾
186	Brown "	5½	....	198	Black "	1	1+
187	Brownish grey flint.........	4⅛	1	199	Dark "	⅞	....
				200	Dark "	1¼	1
188	Dark blue flint	2	....				

Serrate arrow

FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES
201	Translucent fl't	1¾	....

Flint hammers

FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES	FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES
202	....	....	2¼	204	....	1½	1½
203	....	1⅞	....				

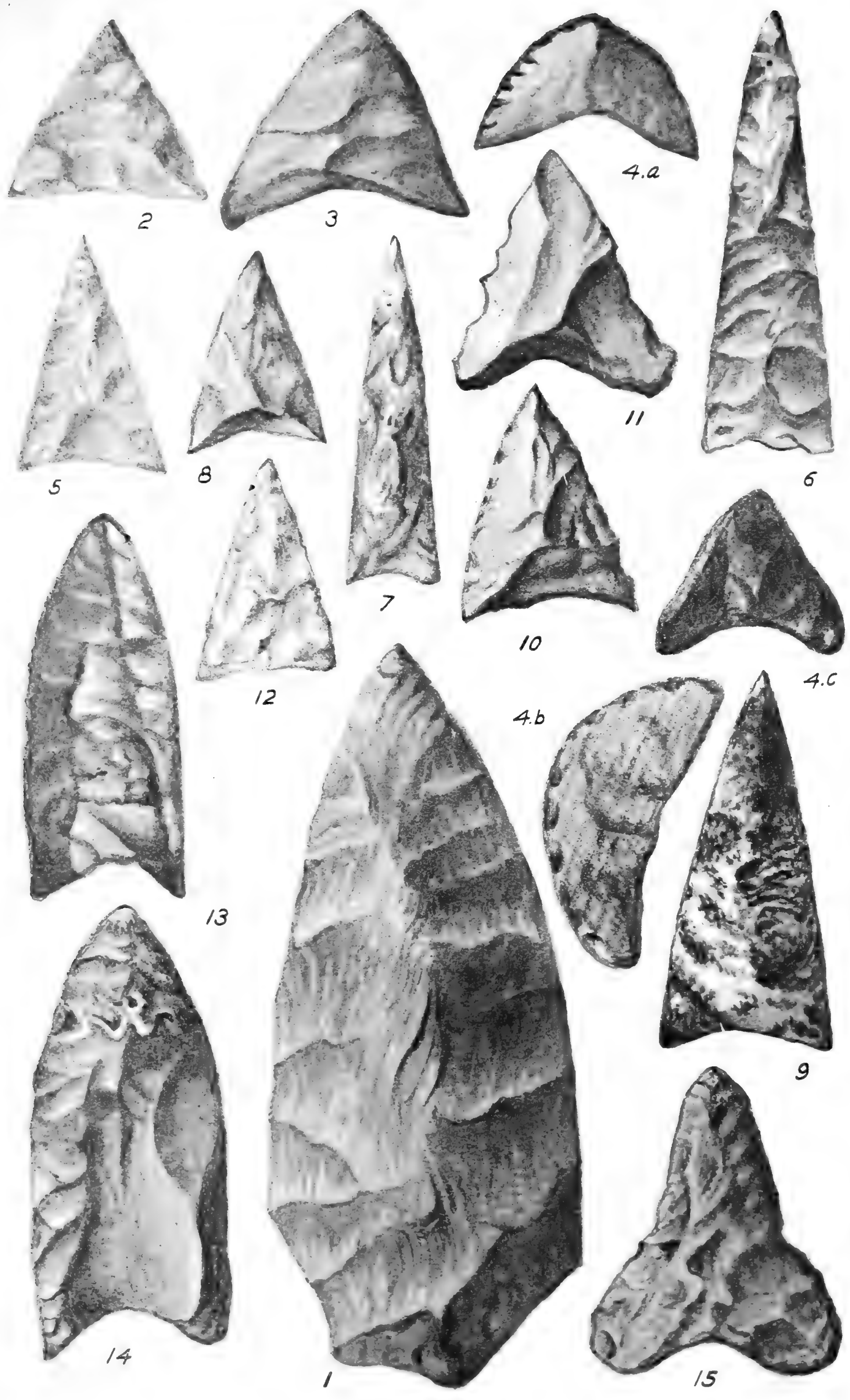
Miscellaneous

FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES	FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES
205	Drab flint....	3	....	208	Flint pebble..	....	....
206	Hornstone....	2⅜	....	209	Bird point arrow......	½—	....
207	Common flint	1½	....				

Stone sinkers

FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES	FIG.	MATERIAL	LENGTH IN INCHES	WIDTH IN INCHES
210	*a*	....	....	212	Grey sandstone	3⅞	4¼
211	Red sandstone	....	....				

a Not given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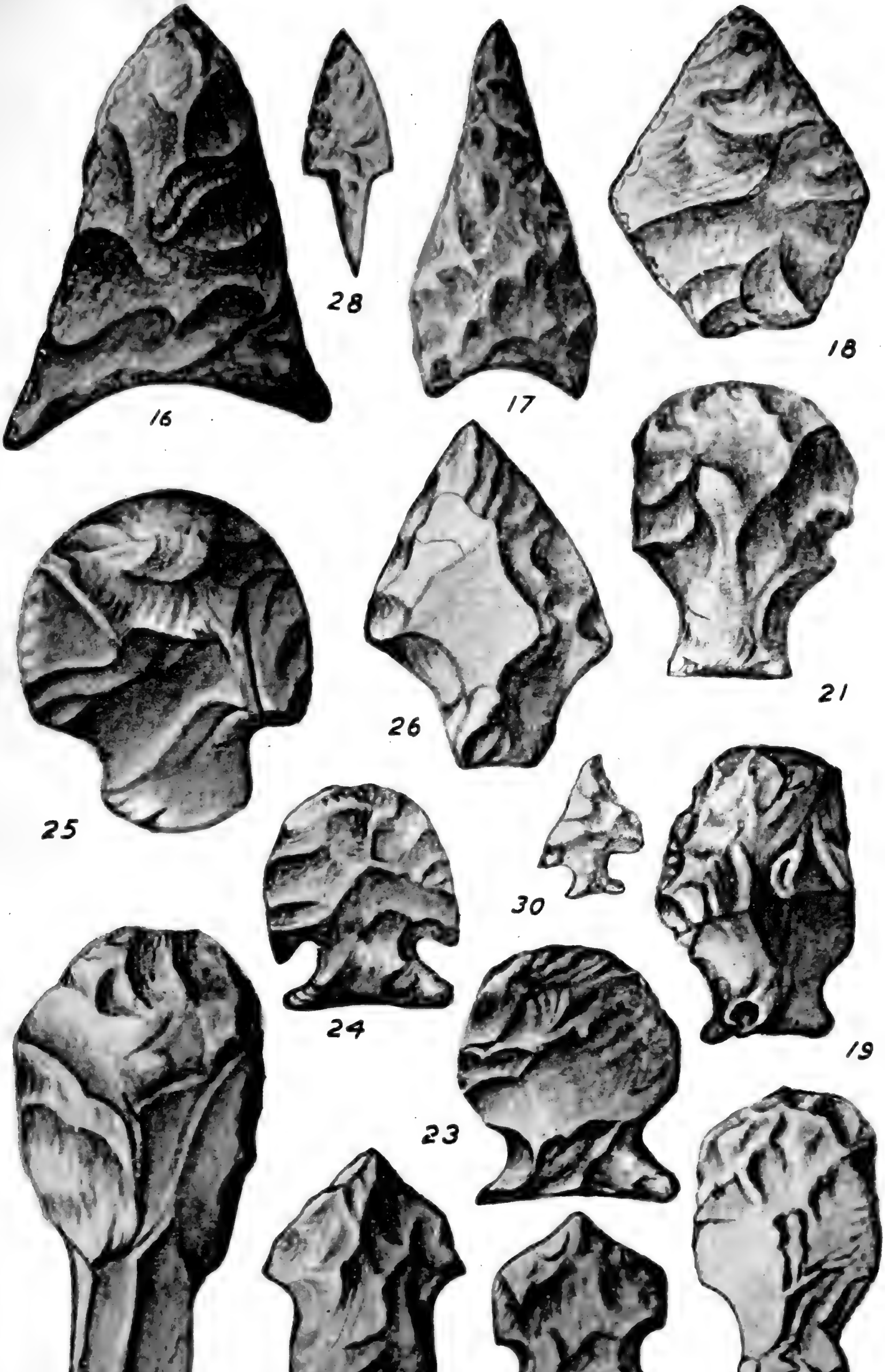
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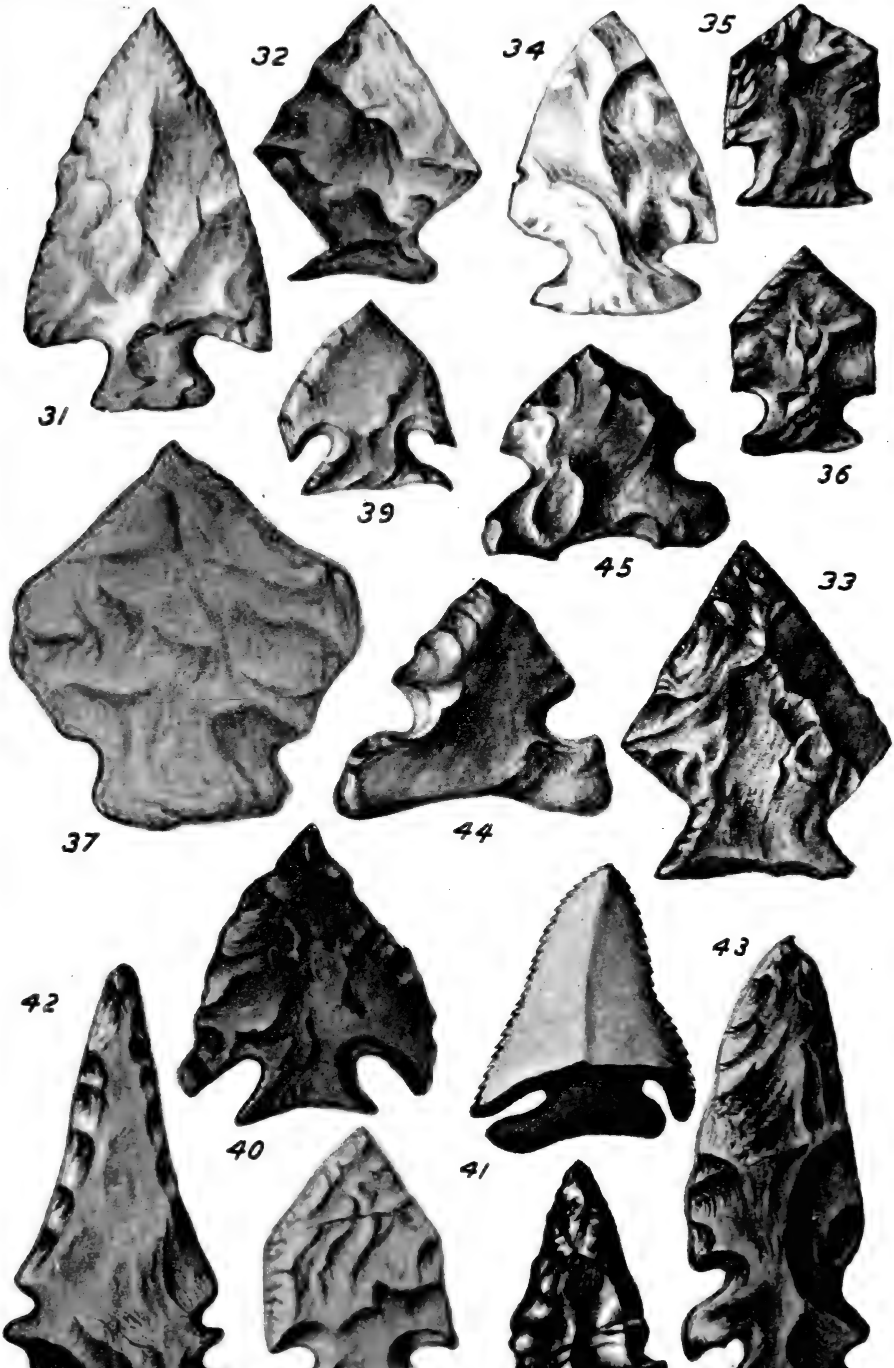
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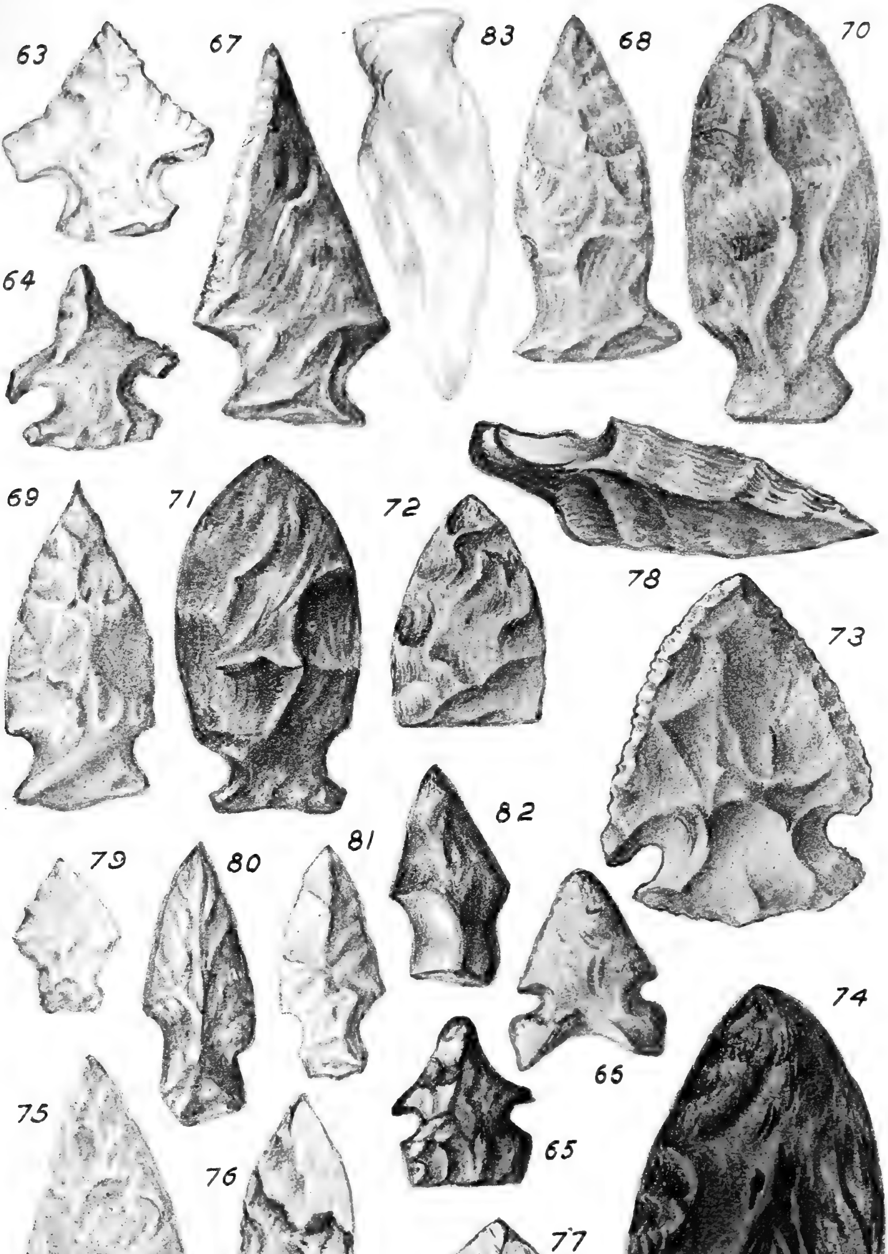
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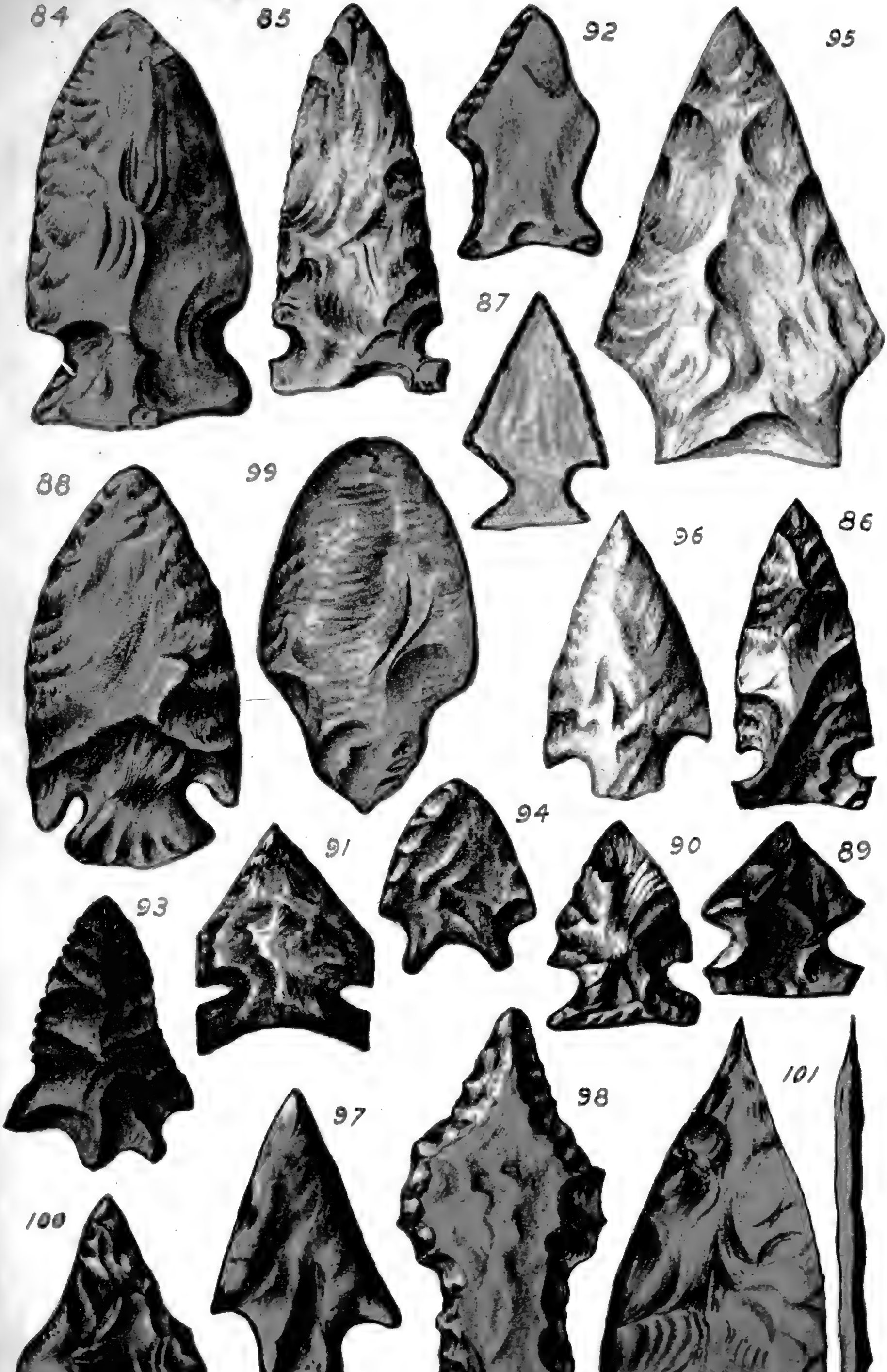
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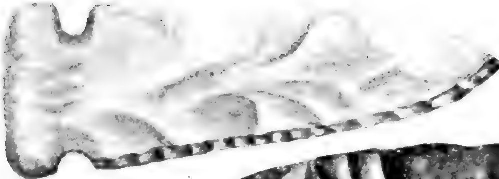

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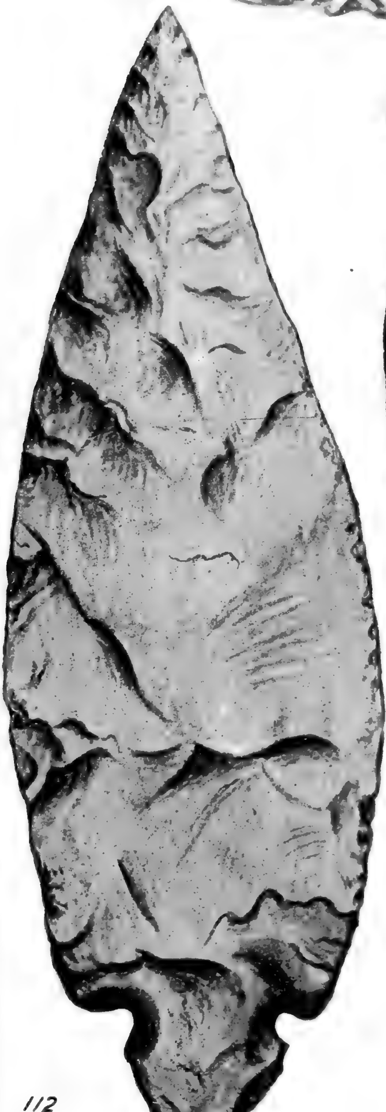

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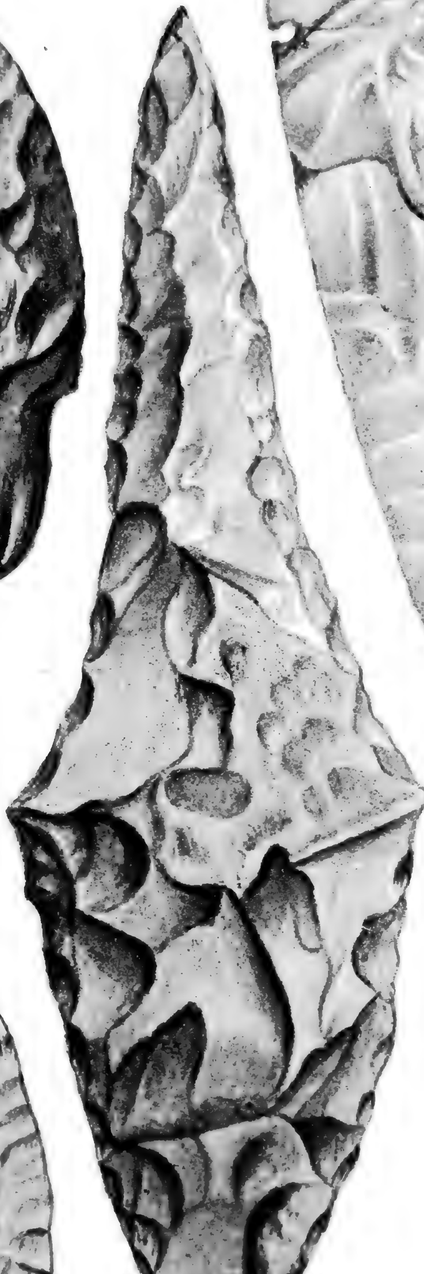

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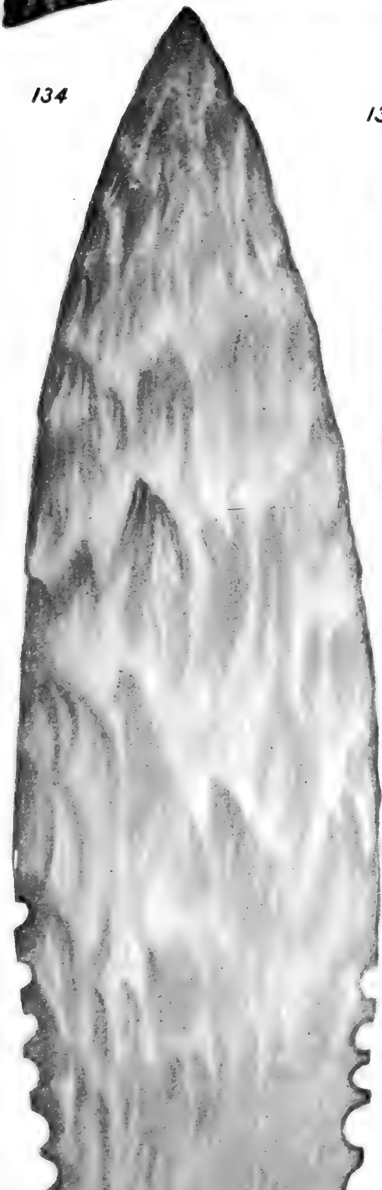

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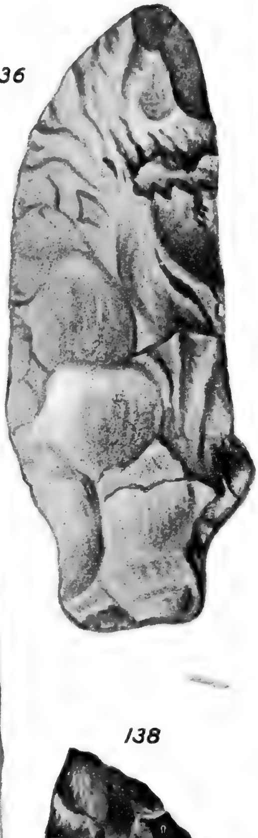

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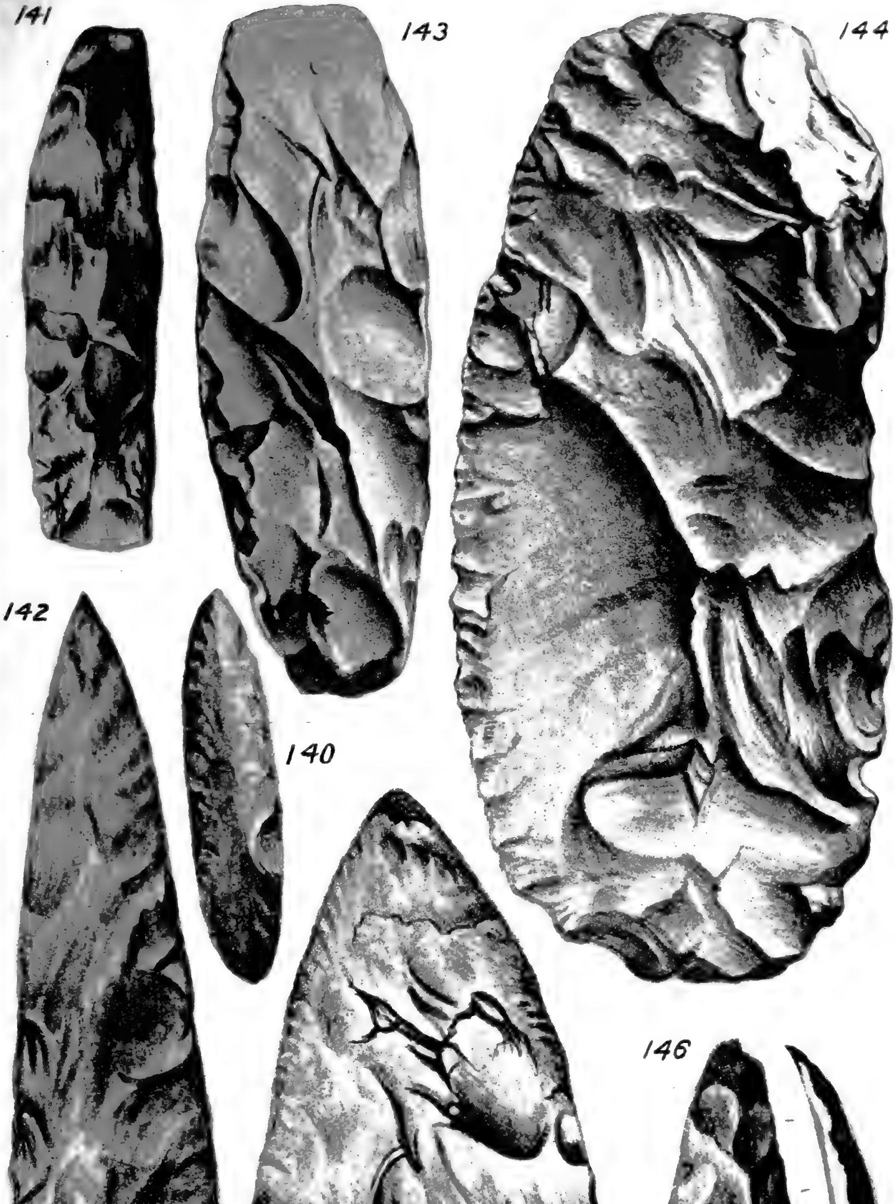
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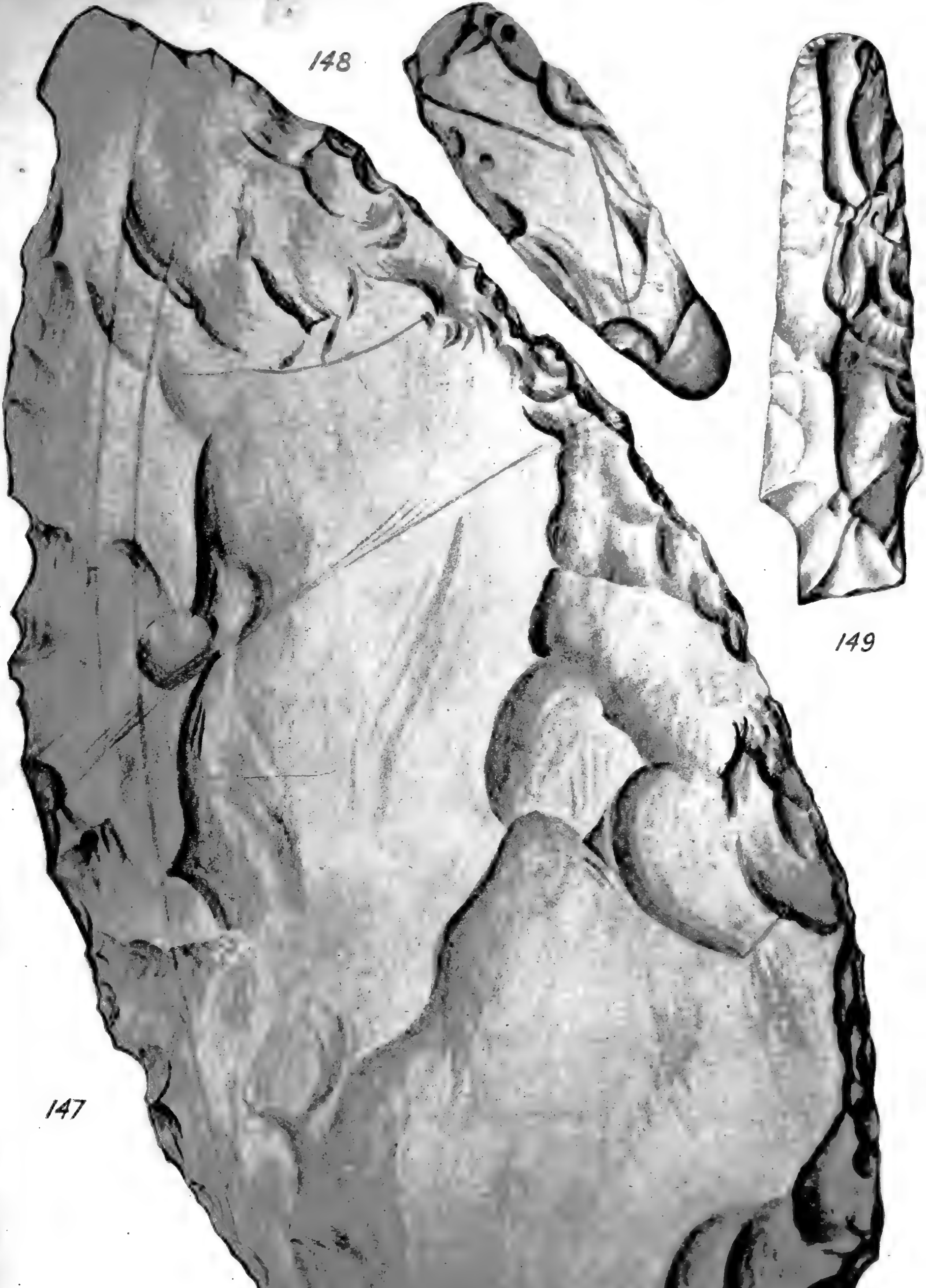

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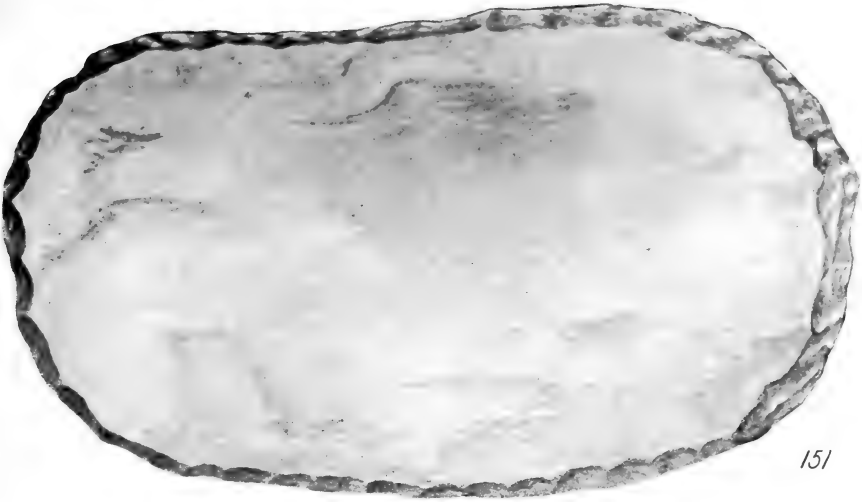

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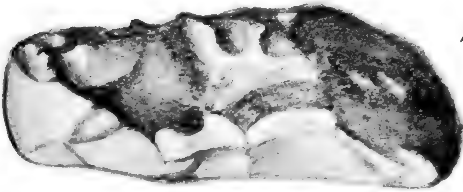

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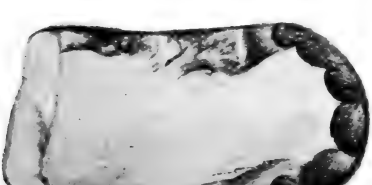

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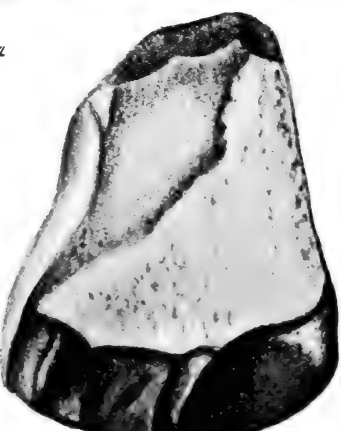

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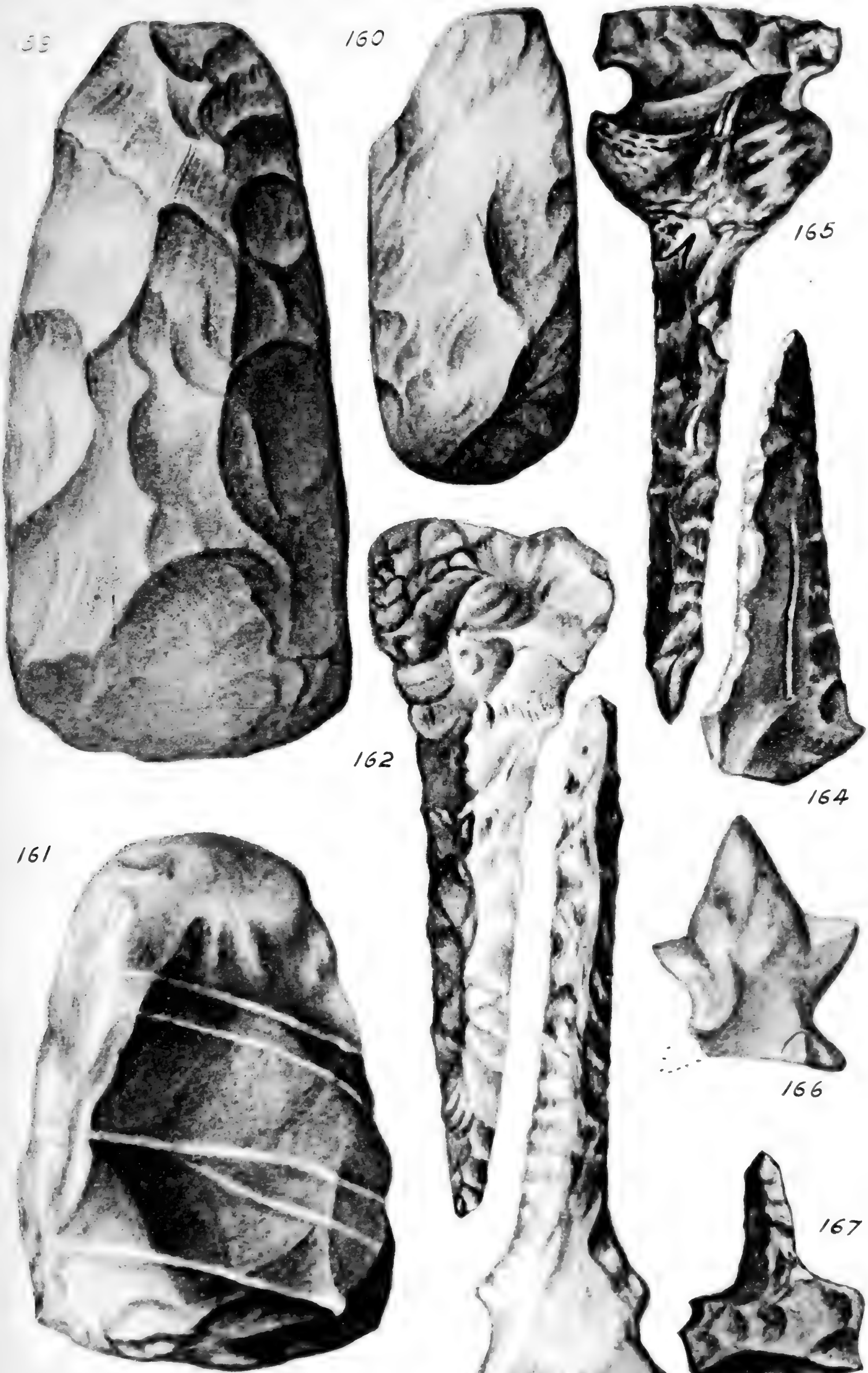
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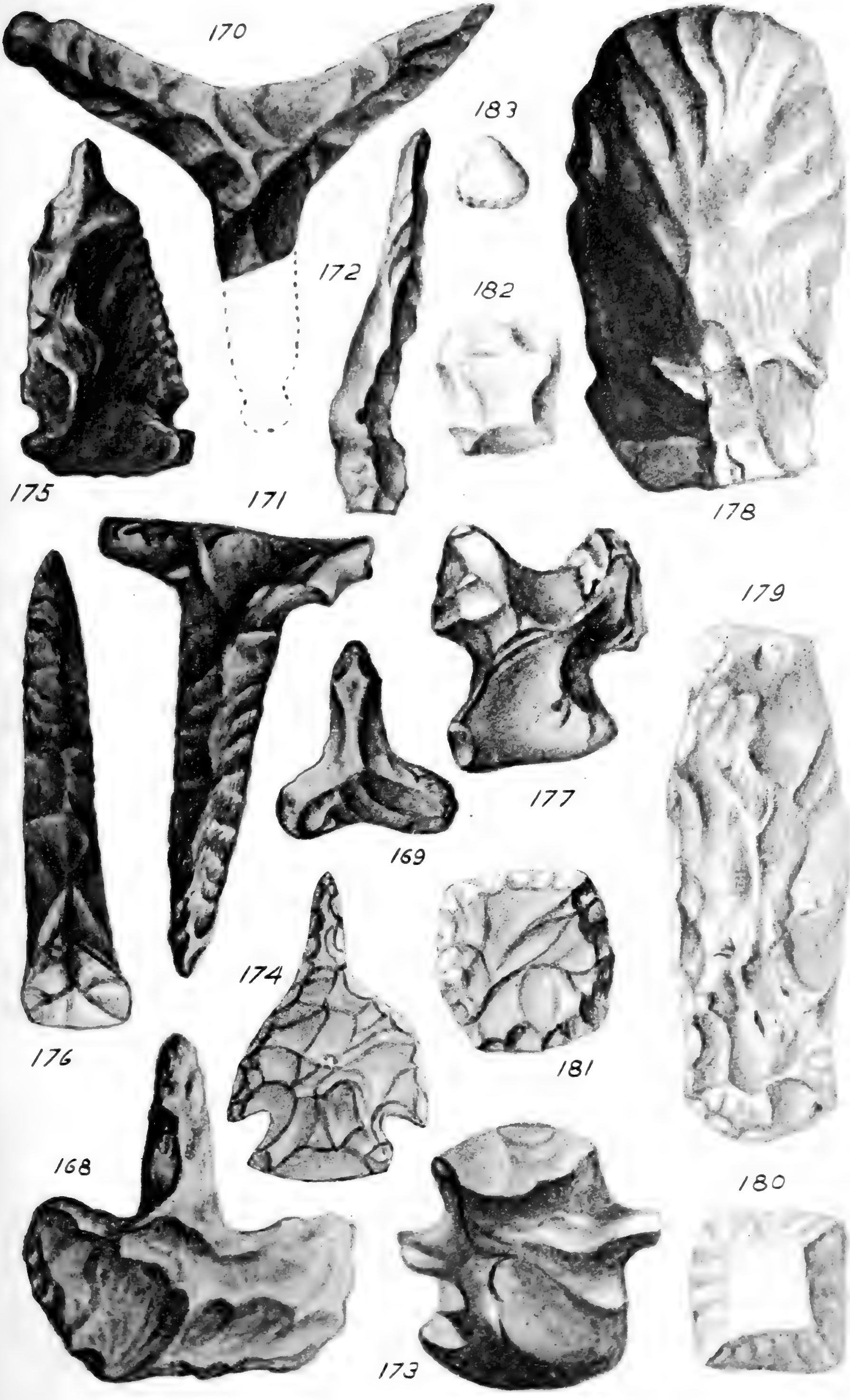
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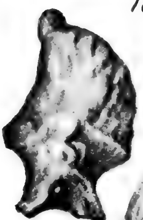

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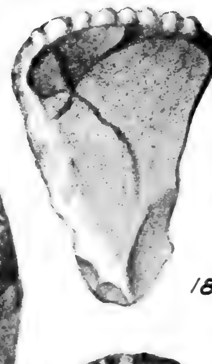

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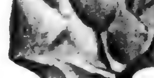

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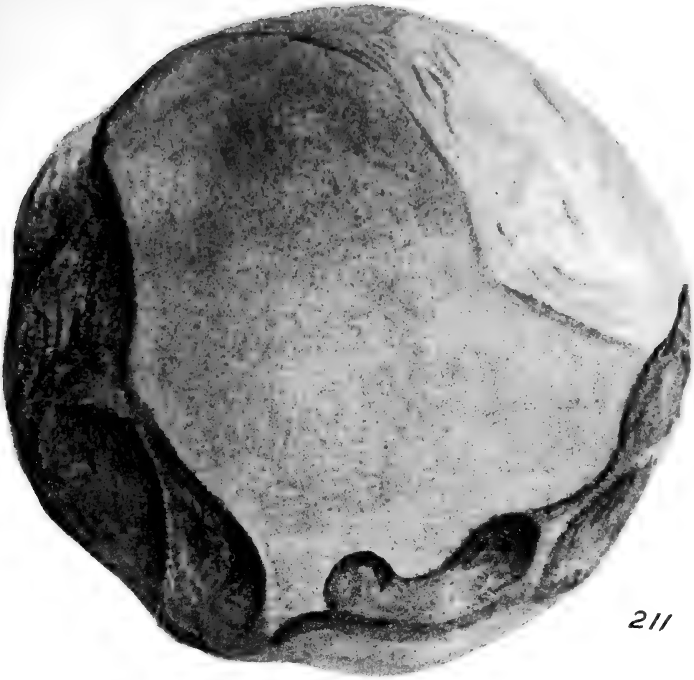

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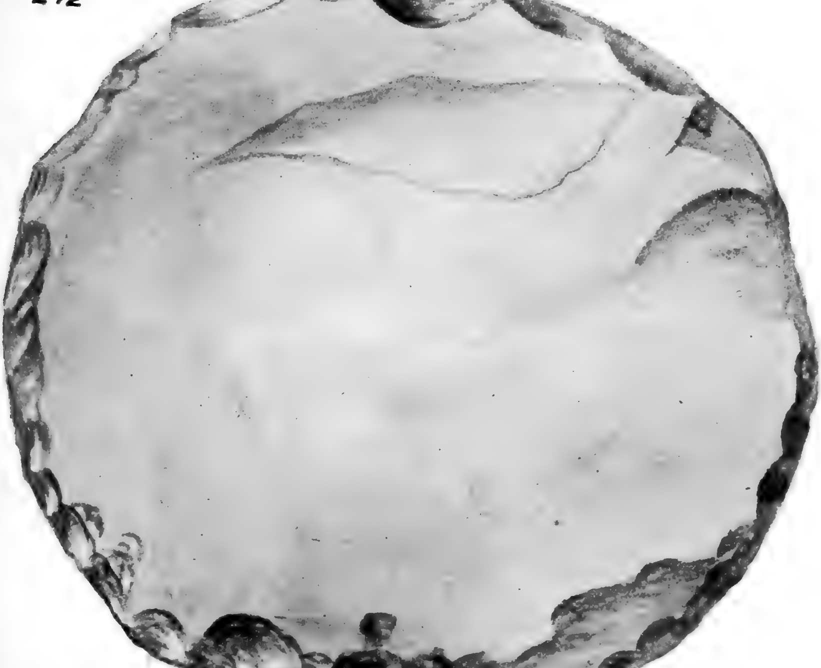

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The superior figure tells the exact place on the page in ninths; e. g. 5^3 means three ninths of the way down page five.

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University of the State of New York

BULLETIN

OF THE

New York State Museum

VOL. 4 No. 17

OCTOBER 1897

ROAD MATERIALS

AND

ROAD BUILDING

IN

NEW YORK

BY

FREDERICK J. H. MERRILL, PH. D.

Director New York State Museum

ALBANY

UNIVERSITY OF THE STATE OF NEW YORK

1897


UNIVERSITY OF THE STATE OF NEW YORK.
MAP
OF THE
STATE OF NEW YORK
SHOWING THE
LOCATION OF QUARRIES OF STONE USED FOR BUILDING AND ROAD METAL
BY
FREDERICK J.H. MERRILL
Director New York State Museum
ALBANY, N.Y.
1897.
SCALE : 1 INCH · 12 MILES
MILES
KILOMETRES
Quarry
Quarry with Crusher
Bluestone
Sandstone
Limestone
Trap or Granite
Slate
N.B. A few of the quarries located are not in operation at present
DOMINION OF CANADA
LAKE ONTARIO
LAKE ERIE
PENNSYLVANIA
NEW JERSEY
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS
CONNECTICUT
ATLANTIC OCEAN
79°00
78°00
77°00
76°00
75°00
74°00
72°00

Regents

Anson Judd Upson, D. D., LL. D., L. H. D., *Chancellor*
William Croswell Doane, D. D., LL. D., *Vice-Chancellor*

Frank S. Black, B. A., Governor	*Ex officio*
Timothy L. Woodruff, M. A., Lieutenant-Governor	
John Palmer, Secretary of State	
Charles R. Skinner, M. A., LL. D., Sup't of Pub. Inst.	

In order of election by the legislature

YEAR		
1873	Martin I. Townsend, M. A., LL. D.	Troy
1874	Anson Judd Upson, D. D., LL. D., L. H. D.	Glens Falls
1877	Chauncey M. Depew, LL. D.	New York
1877	Charles E. Fitch, LL. B., M. A., L. H. D.	Rochester
1877	Orris H. Warren, D. D.	Syracuse
1878	Whitelaw Reid, LL. D.	New York
1881	William H. Watson, M. A., M. D.	Utica
1881	Henry E. Turner	Lowville
1883	St Clair McKelway, M. A., LL. D., L.H.D., D.C.L.	Brooklyn
1885	Hamilton Harris, Ph. D., LL. D.	Albany
1885	Daniel Beach, Ph. D., LL. D.	Watkins
1888	Carroll E. Smith, LL. D.	Syracuse
1890	Pliny T. Sexton, LL. D.	Palmyra
1890	T. Guilford Smith, M. A., C. E.	Buffalo
1892	William Croswell Doane, D. D., LL. D.	Albany
1893	Lewis A. Stimson, B. A., M. D.	New York
1894	Sylvester Malone	Brooklyn
1895	Albert Vander Veer, M. D., Ph. D.	Albany
1897	Chester S. Lord, M. A.	Brooklyn

Elected by the regents

1888 Melvil Dewey, M. A., *Secretary* - - - - Albany

CONTENTS

PREFACE

This bulletin was prepared at the request of the chairman of the state museum committee for a report on the road materials of New York. Having ascertained what might be worth publishing on this subject, it appeared desirable to add a short discussion on the road problem in our state.

It has been the writer's aim to make the pamphlet as brief as possible and therefore easily read. He has endeavored to discuss concisely what appeared to him the salient points of the problem, and his purpose has been rather to bring to public attention, facts not generally appreciated than to discuss matters of common knowledge.

In preparing this report the writer has communicated with about two thousand quarrymen, and has acquired much information concerning local variations in rock used as road metal, but it does not seem pertinent to this preliminary publication to discuss details which might obscure the main points. It seems also inadvisable to publish statements which discriminate between the products of various quarries until further study has established their correctness beyond all possibility of criticism. These details are therefore reserved for future publication.

The report of the special committee on good roads, transmitted to the legislature Jan. 14, 1896, is recommended to the attention of all who wish to inform themselves on the details of the present situation in New York, Massachusetts, Connecticut and other states.

Attention is also called to the publications of the Bureau of Road Inquiry of the U. S. Dept. of Agriculture.

It being impossible with the museum funds at hand to erect a laboratory for the testing of New York road materials, the writer applied for assistance to the Massachusetts Highway Commission, which courteously and generously agreed to test some representative samples of New York road material.

In the following pages the Massachusetts Commission has been quoted exclusively, not from a desire to ignore the work in other states, such as New Jersey and Connecticut, but because the problems in Massachusetts are similar to those in New York, and the Commission in question seemed to have studied and reported on the situation it had to deal with in a more detailed and exhaustive way.

To Prof. N. S. Shaler and the other Highway Commissioners of Massachusetts, the writer desires to express his deep obligations for many favors received.

FREDERICK J. H. MERRILL

Albany, Sept. 1, 1897

INTRODUCTION

Good Roads in New York

The present condition of the highways of New York is about the same as that of the roads of England at the beginning of this century, when they were so bad and the toll rates were so high that the subject of their improvement forced itself upon the attention of the British public. From the investigations which ensued under the supervision of prominent engineers, certain rules for road building were formulated, the adoption of which led to the construction of the fine highways for which Great Britain has so long been famous.

At that time there were no railroads in England and all produce was transported by wagon or canal so that the subject of road improvement was one of great commercial importance. The necessities of the occasion brought to the front in Great Britain many road engineers, most prominent among whom were Macadam and Telford, advocates of two different systems of road building, which are now used variably, according to the nature of the ground where the road is to be built. Road building under state supervision has long been a feature of European government and the time has now come when it must be recognized as a necessary function of government in the United States.

The important reasons for road improvement throughout our country are three: 1st the desirability of reducing the cost of hauling; 2nd the importance of making most of our roads fit for pleasure driving, thereby attracting to the rural districts in summer, thousands of people who create a local market for various farm products; 3rd the economic principle of preventing the great waste of labor which is now fruitlessly expended in making bad roads.

The state of Massachusetts, which in our own country leads in systematic road building, has a highly organized highway commission, which has been at work since 1894. Under the direction of this commission the important highways of the state have been measured on the new topographic map and their total length determined to be 20,500 miles, exclusive of minor cross roads. The commission has projected the construction of a network of state roads amounting to 10 % of the whole, connecting the more important points throughout the state. At different points on this projected network the commission has constructed, by request of local authorities, short pieces of road a mile or more in length, according to the most approved methods of road building, to serve as object lessons and create by the experience of their high quality a public demand for farther construction. These short pieces are extended from year to year to carry out the general plan.

Through the courtesy of the commission I am enabled to make a statement of the appropriations and expenditures from 1894 to the present time. I quote the following from a letter written to me by Mr. A. B. Fletcher, secretary:

"In 1894 and 1895, 86.37 miles of road were laid out. These roads cost on an average, for actual construction expenses, about $9,612. per mile, and the engineering and inspection charged to them was $1,130. per mile, making a total of $10,742. the average cost of the roads per mile, exclusive of office expenses and salaries of the commission and clerks.

"In 1896 39.8 miles of road were laid out. These roads not being complete in all cases, the cost shown is to some extent an estimate. It is estimated that these roads will average about $7,900 per mile for the actual construction, and $741 for the engineering and inspection, a total of $8,641 per mile."

The appropriations for the use of the commission have been as follows:

1894	$300,000
1895	400,000
1896	600,000
1897	800,000
Total	$2,100,000

From this it will be seen that with three years of careful work, Massachusetts has built 126 miles of good road in different parts of the state to serve as object lessons to the people.

As this official statement shows, in 1896, with an appropriation of $600,000, Massachusetts constructed forty miles of high class road. Since the appropriation for 1897 is $800,000, it may be assumed that a much larger mileage will be completed. As a certain proportion of the money appropriated is used for official and clerical salaries and expenses, the whole of the appropriation is not available for road building alone, but assuming the number of miles to be constructed in 1897 at 80, it appears that the total mileage to be rebuilt (2,000) would be completed at this rate in 25 years. It will be seen that the plan of road improvement now adopted in Massachusetts, is not intended to provide for any general improvement in the 18,500 miles of public highway not included in the system to be rebuilt by the state, except through the influence of the object lessons furnished in the local examples of new state roads.

The Problem of Road Improvement in New York

It being generally conceded that better roads are a necessity in New York and there being no economical way of obtaining good roads except by building the best, the question arises as to the source of the money necessary to do this work.

High class roads, if not built by the state, can at present be afforded only in regions inhabited by persons of more wealth than the average farmer. Near the large cities are great areas tenanted by those who have business in the city, but prefer to live in the country. There the property values are much higher than in regions exclusively devoted to agricultural interests and the taxes being proportionately higher, it is possible to spend more money in road building. Under the present system of road tax prevalent over the greater part of the state, the equivalent of about $75 a mile per annum is supposed to be raised in each road district outside of the village corporation limits, and it frequently happens that the whole of the tax is not worked out. Moreover, in many districts the people work their road taxes without intelligent supervision and often not only is the labor wasted but the roads are made worse.

The state of New York having an area six times as great as that of Massachusetts, has probably six times as many miles of important roads; there being as yet no complete map of our state, it is impossible to make accurate measurement. The total mileage of important roads in New York may therefore be estimated at 123,000. This figure, while only an approximate maximum, is sufficiently accurate for purposes of estimate.

If it were decided to improve 10% of this total according to the Massachusetts plan, there would be 12,300 miles of road to build. While Massachusetts now appropriates $800,000 a year for road building, New York, if doing this work at the same rate in proportion to her size, would appropriate $4,800,000 a year. This sum would be more than one third of the total amount raised in New York by direct taxation, which is now in round numbers $12,033,651.80. This is undoubtedly too large a burden to be carried, but we could safely afford to spend from $600,000 to $1,000,000 per year in this work, which can not be avoided and must sooner or later be undertaken.

In senate bill no. 330 of 1897 introduced by Hon. Richard Higbie, it was proposed to levy 'in the general appropriation act of each year, a tax rated at one tenth of a mill upon the entire valuation of the state, which shall be known as the state highway tax.'

The total value of taxable property for the current year is stated by the comptroller to be $4,506,985,694. This sum when taxed at the rate of one tenth of a mill would yield an annual amount of $450,698.56 available for the construction of state highways. On this basis each taxpayer would contribute only 10 cents on each $1,000 of assessed valuation.

It is considered by many that the wiser method would be to divide the cost between the *state*, the *county* and the *locality benefited.*

The proportionate division suggested in senate bill no. 330 of 1897, is one half by the state and one half by the county; it being also provided that the amount paid by each county may be apportioned by the board of supervisors so that 35% of the cost shall be a general county charge and 15% a charge upon the town in which the improved highway is located, or to be assessed upon and paid by the owners of the lands benefited, according as the request for the improvement comes from the board of supervisors of the county or from the owners of one third the lineal feet frontage.

As it is to be expected that the cost of road building in New York would be about the same as in Massachusetts, viz, $10,000 per mile, the cost of rebuilding at state expense the great system of public highways mentioned above would be about $123,000,000.

If so large a sum as $4,800,000 a year were appropriated and it were found possible with this sum to build 480 miles of road per year, a period of 25.6 years must elapse before the completion of the work. On the other hand, if New York were to appropriate exactly the same amount as Massachusetts, viz, $800,000 per year and could build 80 miles per year, it would require 153.75 years to complete the system of 12,300 miles. During all of this time and for all time to come *there would remain in New York a vast network of 110,700 miles of road inadequately cared for, as at present, unless some plan for intelligent supervision and repair were provided in addition to that for the work of constructing state highways.*

The apparent difficulty of enacting legislation involving a work of such great expense and covering so long a period of time leads to the belief that the solution of the road problem in New York is to be found in the division of the expense of state road construction between the state, the county and the locality benefited as already mentioned. Even this would not be a rapid process; allowing $1,000,000 for the construction of 100 miles of road per year, 123 years would be required for the completion of the undertaking.

The foregoing statements of expense and time are not made as arguments against state roads, but to call attention to the magnitude of the project and the fact that the work must be carefully planned. It does not seem necessary that the facts should be concealed from the public in order that the work may be undertaken. It should not be assumed that the work can be started only by concealing the total cost.

The legislation hitherto proposed has chiefly aimed at a few state roads. This is insufficient. We need a trained supervision over all public roads.

In order to meet these requirements it is most important that a bureau or commission of road improvement be created by the state with, at first, a small appropriation for the practical study of the road problem in New York, and the development of plans for the building of state highways and the working of all other roads under trained supervision. If our next legislature, as all good citizens must hope, shall decide to create a commission or bureau of state highways or a superintendent of highways *the measures then enacted should provide not only for the formation of a plan to build certain state roads* which shall be models of engineering work *but for the intelligent supervision of the general repair work done on the other roads of the state* during the centuries which must elapse before our main roads are put in proper condition.

A bill was introduced into the legislature of 1897 to compel the payment of all road taxes in money. While this is a most important measure which should be made a law, it is insufficient as it provides no supervision over the manner in which the money is to be spent. According to the observation of the writer, there are large areas in New York where the people do not know how to spend their road taxes to advantage, and where the tax if actually paid in money would still be wasted, unless some trained supervision were provided by statute.

Not every civil engineer is competent to superintend road work, not every farmer is ignorant of road making; but it frequently happens that commissioners of highways have not the necessary experience and training to fit them for their office; and, serving without salary, they can not afford to give the necessary time to the road districts under their supervision. It seems indispensable that apart from and in addition to any system for the building of state highways, there should always be a corps of trained inspectors, men of experience and capacity in road building, selected solely for their qualifications and under the direction of a central bureau or commission, who would in each county, town and road district supervise the work on roads not yet being rebuilt under state supervision, in order that the road taxes may be economically and efficiently spent. Such inspectors must necessarily receive salaries commensurate with their qualifications. These salaries should be paid in part by the state to insure central control and the adoption of uniform standards and in part by the counties where the inspectors are stationed in order to lessen the general burden of taxation.

The League of American Wheelmen is doing much in New York to arouse public opinion in favor of good roads. It is to be hoped, however, that this influential organization will not confine its attention to state roads alone but will advocate some measure to improve the general system of road supervision and repair.

It has been suggested that a part of the excise revenue under the Raines law might be used for building roads. This practical question must be decided by the people and their representatives in the legislature.

Natural Roads

In the United States most roads have natural beds and the character of these beds is determined by the geology of the region in which they lie.

Hence the road beds consist of clay, sand, loam or gravel, or occasionally are on the surface of the country rock which may be shale, sandstone, limestone, etc.

From the fact that an unfertile soil is not good for road building, it usually happens that the poorest roads are in regions of poor farms where property values and consequently taxes are low and there is little money to spend on the roads. This is especially true in stony districts, for a stony soil is a most unmanageable material for a natural road.

Of the natural roads those on clay soil are best in dry weather, those on sand best in wet weather. When wet with a certain proportion of water, fine sand becomes hard and elastic as we see on the beaches of our Atlantic coast, where good natural roads are found near the water's edge.

Of the natural soils the best for road purposes are those variable mixtures of sand and clay called loams. Loam roads average better through the year than those of clay or sand. A limestone gravel makes a very good road, and also a fine quartz gravel mixed with clay.

From every-day experience, it is clear that natural road beds are not the best for heavy traffic when under varying conditions of moisture. It is also clear that for many centuries to come, large areas of our country can hope for nothing better than good natural roads.

The faults of our natural roads which could easily be remedied are mainly these:

1 The roads are too narrow and too high in the center, and on account of their narrowness the wheels all run in the same track and the extreme curvature of the road bed compels the wheels to run on the edge instead of the surface of the tires, the combination of the two faults causing the formation of deep ruts;

2 Loose stones are allowed to remain in the roads and the work of repair is not directed toward keeping the surface smooth;

3 Insufficient attention is given to the construction of drains and culverts.

Road Construction

The experience of over 2,000 years has shown conclusively that there are two essential points to be aimed at in the construction of a perfect road;

1 A hard, smooth, waterproof surface;

2 A thoroughly dry foundation.

These principles were known to the Romans three hundred years before Christ and used in the construction of their best highways.

The surface of a good road must be of sufficient strength to resist the wear and tear of traffic, and smooth enough to prevent undue strain and wear on vehicles. In connection with this *the soil beneath must be made dry and kept dry.* Therefore the subject of road drainage is as important as that of road metalling.

The best road covering is composed of angular fragments of some stone which will grind on the surface into a dust, which when wet will bind or in a measure cement the fragments together, so that water will not penetrate. The angular form is essential to make the fragments interlock. The sizes should be quite uniform, except that the surface layer may consist of fragments different in size from those in the bottom course.

The total thickness of this metalling must be at least six inches on a natural soil foundation. The fragments should not exceed two and a half inches in diameter, and should be rolled in two separate courses with a heavy steam roller until the surface is absolutely firm. This is the Macadam system.

Where the soil foundation is clay, or for any reason difficult to drain, the Telford method is used. In this case a course of flat stones about six inches deep, set on edge and closely wedged together, is placed upon the soil and crushed stone is placed over this four inches thick and rolled solid. In good practice it is customary to roll the earth before the stone is laid upon it and then roll the stone foundation. The Telford foundation forms a bridge which prevents the road from sinking in moist soil and is rendered completely effective by tile drains on each side of the road. *After the road is built it must be kept constantly in repair and the neglect of this principle is to a great extent responsible for the poor roads of the United States.*

The Macadam and Telford systems above described are necessary for roads designed for heavy traffic in all weathers, but roads for pleasure driving in summer only, do not need the same expensive preparation.

As an example of the methods adopted for the construction of high class roads I am permitted by the courtesy of the Massachusetts Highway Commission to quote the following extracts from its pamphlet of *Instructions to engineers*, published in 1896:

Gravel. You will use gravel for surfacing the road bed under telford; also for surfacing the sub-grade where the natural soil is clayey, loamy, or where ordered under other conditions by the chief engineer. The gravel must be practically free from sand and clay.

Broken stone. State highways are divided as follows with reference to the broken stone (sizes given are in inches):

1 All trap rock, 1 bottom 1st course to be 1¼ to 2½; top course to be ½ to 1¼;

2 All trap rock, both courses to be 1¼ to 2½;

3 Local stone other than trap, bottom course to be 1¼ to 2½; top course to be ½ to 1¼;

4 Local stone other than trap, both courses to be ½ to 2½;

5 Bottom course of local stone other than trap, ½ to 2½; top course of trap rock, ½ to 1¼;

6 Bottom course of local stone other than trap, ½ to 2½; top course of trap rock, 1¼ to 2½;

7 All trap rock, bottom course to be ½ to 1¼; top course to be 1¼ to 2½;

8 Local stone other than trap, bottom course to be ½ to 2½; top course to be 1¼ to 2½.

When 'local stone other than trap' is used you must not allow any soft or disintegrated rock to go upon the road; all such rock must be rejected before breaking. If the contractor fails to remove such rock, immediately report the fact in writing to the chief engineer.

All broken stone must be screened, and any broken stone which will not pass through a 2½ inch ring, or is more than 2½ inches in its largest diameter, must be rebroken or rejected.

In every case the screenings used on the surface as a binder course must be of the same kind of stone as the top course of the road.

Rolling. When possible roll the sub-grade with a steam roller.

If the sub-grade is too sandy to roll, cover with coarse gravel laid on to a depth of 3 inches, or as much more as may be needed to give a good foundation.

Fill any depressions with the same material until the surface is true and even.

All broken stone must be rolled in screened layers.

After spreading the first course of broken stone, begin rolling at the sides, and continue this by running ahead so as to allow from 2 to 5 inches of the driving wheel to pass over the shoulder, and backward with the outer edge of the driving wheel from 5 to 10 inches inside the edge of the broken stone. Roll until the stone ceases to 'wave' in front of the wheels, and until it seems firm under foot as you walk over it. Next begin on the other side and roll in the same manner. Then work toward the center until the stone is rolled. Roll each layer of stone in the same manner.

If the road shows a wavy motion after passing the roller over it three, four or more times, it may indicate too much moisture in the sub-grade. If, on examination, you find this to be true, stop rolling and move ahead, allowing time for the sub-grade to dry out.

With some coarse, hard granitic rocks it has been noted that after the roller passes over them a few times they begin to 'crawl' and the sharp edges break off. A slight sprinkling of sand or stone screenings, or water, may prevent this. Try one after another of these means, until the work progresses to your satisfaction. You must not expect to prevent the stone from shaking as you walk over it, but you need to continue the rolling until the fragments of stone adjacent to where the foot presses do not move as you walk. Most of the rolling must be done before you spread the screenings. After spreading the screenings, water and roll until the mud flushes to the surface. You can not expect to prevent the stone from kicking out if the teams pass over the road. Keep watch, and in a few days have the roller pass once or twice over the road, after watering, until the loose stones are pressed down out of sight.

Before spreading any broken stone, great care must be taken to have the sub-grade carefully shaped and thoroughly compacted.

All shoulders must be shaped and left sufficiently high to roll to the proper grade, before any broken stone is spread on the road.

In case of heavy fills you must not run the roller to the edge of the shoulders unless the fill has had time to settle. Work out slowly on this kind of work.

In every case the screenings used on the surface as a binder course must be of the same material as the top course of the road.

Excepting where it may be needed to compact hard, granitic rocks, as before referred to, you will use water only on the top, or binder course.

You will wet this binder course thoroughly before rolling, but not to the extent of saturating the foundation. You will get better results and prevent the screenings from being picked up by the wheels of the roller if you apply the water and allow it to settle down below the top surface before passing the roller over it. Too much water, or too little, will give trouble by causing the surface to be picked up.

You must not under any conditions roll the screenings while dry.

You must not under any conditions allow teams to pass over the road after the screenings are spread and before they are rolled.

In case of a deficiency in the water supply, you may have the screenings spread and await a rain before rolling; but in such case the road must be entirely closed to travel, and the rolling must be begun as soon as the road is wet and continue until the section covered with screenings is thoroughly compacted. In such cases it may be necessary to operate the roller day and night, and you must insist on this being done. In case you meet with any difficulty in compacting the stone, and fail to understand the cause, report immediately in writing to the office.

Telford. Telfording will be used in all cases where the road passes over clay, or wet soil. You will make a careful study of the road, and report in writing to the chief engineer where in your opinion telfording is needed, giving a description of the soil, together with the general scope of the adjacent ground. In your report you will note the stations between which the telfording may be needed.

Where telford is to be used, you will see that the road bed is excavated and carefully rolled, and left true and even, corresponding to the cross-section, and 12 inches below the established grade of the finished work. You will then cause 2 inches of gravel to be uniformly spread over the sub-grade. On this sub-grade you will place a foundation of stones, which may vary in size as follows: 4 to 10 inches in width, 6 to 20 inches in length, 5 to 6 inches in depth (not more than 10% of the stone to be less than 6 inches in depth). The stone must be sound, and of a quality approved by the chief engineer.

The telford stones shall be placed by hand, vertically, on the broadest edges and lengthwise across the road, so as to form a close, firm pavement. They shall be bound by inserting and driving down, in all places where it is practicable, stone of proper size and shape to wedge them in their proper position. No large stone will be left with a projecting point coming nearer than 4 inches to the finished grade and cross-section. If any such projection be found, it must be broken off to allow a clear depth of 4 inches of broken stone.

The telfording shall then be rolled with a steam roller, all depressions filled with stone chips or spalls, rolled and left true and even and 4 inches below the finished grade and cross-section. If a drain is to be put in, it must be finished after the excavation is made and before the gravel is spread.

Drains. Where telfording is used, or where ground water from a side hill may work injury to the road, you will build drains.

If the road passes through a cut, you will place a drain on each side.

If the road is on a side hill, you will place a drain on the up-hill side only.

All drains must be carried to a proper outlet, either to a culvert, to another drain or through the bank.

Where it is necessary to extend a drain to an outlet beyond the section needed to be drained, you will lay the pipe with cement joints on such extension, and omit the gravel or stone in the trench.

Where a pipe is carried through a bank, the outlet must be protected by masonry, as provided in pipe culverts.

All pipe must be laid true to the line and grade, and no pipe is to be laid on a grade of less than 3 inches in 100 feet.

If in laying out a drain you find the trench is likely to exceed 5 feet in depth below the finished grade, you will immediately report the conditions in writing to the chief engineer.

The center of the pipe in all drains will be placed 12 inches outside of the line of broken stone.

When the grade of the finished road is 3 inches or more to the 100 feet, the bottom of the drain trench must be 3½ feet below the finished surface of the road at that part of the cross-section.

The drain trench will be excavated to a width of 12 inches at the bottom and 15 inches at the top, and should be excavated only as fast as the drain can be finished.

On the bottom of this trench you will place 2 inches of gravel or broken stone which will pass through a 1¼ inch mesh and not through a half inch mesh.

All side drain pipe will be 5 inches salt-glazed vitrified clay pipe, with bell and spigot joint (unless stated to the contrary in the specification).

The pipe is to be laid on the grade hereinbefore mentioned, with open joints and the bell end toward the rising grade.

Gravel or broken stone of the sizes already described will be filled about the pipe and over it for a depth of 5 feet. This must be carefully tamped about and rammed over the pipe. The remainder of the trench is to be filled with stone which will pass through a 3 inch and not through a 1 inch mesh. Great care must be taken to prevent any sand, silt or earth from getting into the pipe or the interstices of the stone in the trench.

The sub-grade of the road is to have a regular slope to the edge of the drain.

Gutters. Paved gutters will be built where directed by the chiet engineer.

No gutter is to be laid until after the broken stone has been rolled.

In no case is the roller to pass over any part of any paved gutter.

Gutters not exceeding 400 feet in length shall be 3 feet wide with a shoulder 1 foot wide and a dish of 3 inches.

Gutters exceeding 400 feet in length shall increase the dish above this length at the rate of 1 inch to each 300 feet.

All stone used in gutters shall be rounded field, bank or river stone; no flat, shaky or rotten stone shall be used.

The stone may on the average lay from 4 to 6 square yards to the ton. A cubic yard may be estimated to weigh 1⅓ tons.

The larger selected stone will be laid in the gutter itself and on the edges to a true line and grade, with the largest diameters lengthwise of the road. All other stone will be laid with the longest diameters across the gutter.

The trench shall be excavated to a depth of 12 inches below the finished grade of the gutter; gravel shall then be spread and rammed to a depth of 4 inches. A layer of bedding sand or gravel free from stone larger than ½ inch in diameter shall then be spread of a sufficient thickness to bring the gutter stones which are bedded in it to the proper grade and cross-section after they are thoroughly rammed.

Each stone is to be rammed to an unyielding foundation. The surface shall then be covered with sand or screened gravel, which must be well broomed into all joints. The stone shall then be re-rammed and the surface left true and even. Sand or screened gravel shall then be spread over the entire surface of sufficient depth to fill all interstices.

The edge of the gutter toward the road shall be left ¼ inch below the surface of the adjoining broken stone; in no case must it project above it.

Any broken stone which may be disturbed during the paving of the gutter must be carefully replaced and thoroughly rammed.

The bank on the outside of the gutter must be sloped to the gutter, so as to have no bunches or depressions on its surface.

These extracts show the careful attention paid to small details of construction, in the state highway work of Massachusetts.

Earth Roads, Construction and Maintenance

It is not proposed, within the limits of this article, to go into further detail on the subject of road building, as there are already many books in which this subject is adequately treated, especially the construction of Macadam and Telford roads. It seems important however, to call attention to some of the difficulties encountered in maintaining earth roads. If there were no rainfall it would be comparatively easy to make and maintain roads of clay, loam or gravel. Rain, snow and frost are the chief sources of trouble. *Theoretically* by a curved cross-section of road bed the water is caused to flow off, *practically* as soon as the road bed is softened by rain, wheel tracks quickly form longitudinally and prevent the water from escaping except at long intervals. It therefore is of little value to give an earth road a cross-section of pronounced curvature. The nearer flat it is without approaching concavity the wider the bearing of the wheels on the road bed and the less the cutting by them. A slight convexity is desirable to balance the wear along the central line.

In hilly districts where grades are steep, it is of the greatest importance to prevent the water from flowing lengthwise of the road. This is effected inexpensively by making a ridge of earth across the road which turns the water to one side or the other. These ridges, which are called breaks or breakers and in some localities 'thank you ma'ams,' are uncomfortable to drive over and have little durability. On very steep ascents these breaks are of use in supporting heavily laden wagons while the teams are resting.

The practice of chaining a wheel in descending a steep hill with a loaded wagon, which method provides an inexpensive substitute for a brake, rapidly wears deep ruts in hill roads and in the 'breakers' built across them. This practice is far more destructive than the use of narrow tires and should be prohibited by law as soon as possible. On hill roads where the ascent is not too steep to permit the maximum load to be drawn continuously so that it is not necessary for the team to stop and rest, a very satisfactory substitute for 'breakers' is found in a wooden box drain or sluice placed across the road at a slight angle with the perpendicular, the top consisting of oak slats about 3 in. x 4 in. with a space of about 2 in. between them. These transverse gratings intercept and carry off the water flowing lengthwise of the road, which if allowed to go far would gain in volume and erosive power until serious damage would be done.

A part of the work of the Massachusetts Highway Commission has been to eliminate steep grades from the roads built at state expense. In many cases a change of location has been found necessary to accomplish this end.

A serious cause of wear on roads is the filling of the gutters with snow and ice which often accumulates to such a height as to make the center of the road the principal line of drainage. When this occurs on earth roads, in early spring a large volume of snow-water follows this channel, seriously damaging the road and necessitating much expense in its repair. Even the best type of Macadam or Telford road would eventually be damaged in this way. I am informed by the Massachusetts Highway Commission that it has been found necessary in that State to have the snow removed from the gutters in order to prevent damage of this character. When the gutters are open it is not a difficult matter to remove the snow and ice if sufficient money is provided for the purpose. It is however, the custom in our rural districts to have gutter bridges and box or stone drains at the junction of private roads or minor cross roads with the main highways. When these become clogged with ice as they invariably do, it is impossible to clear them without taking them apart and this is rarely practicable.

In Massachusetts these gutter bridges are prohibited on the new roads, the lateral roads being made to meet the main roads at a very gentle slope, leaving an open gutter which may be driven over without discomfort. With an earth road it would be difficult to maintain such an open gutter at road intersections unless some person were detailed to keep it in continuous repair. As this has not yet been found practicable on public roads, the gutter bridge is everywhere in use, and in the spring it is a fruitful source of injury to the road. It will be seen from every day observation and from the details stated above that the earth road while as yet all that the people have agreed to have in New York has necessarily many elements of self-destruction and can never be regarded as permanent. The development of the wheel scraper or road machine has made it possible however to keep an earth road in good condition if intelligently used.

For speedways and pleasure driving in general, a well kept earth road in dry weather is superior to all others. The perfect Macadam or Telford road is too hard to permit of very fast driving without injury to the feet of horses.

Road Materials and their Distribution

In New York the best materials for road metal are trap, granite and magnesian limestone.

Trap is a general term for some of the basic eruptive rocks, the word being related to or derived from the German *Treppen* which signifies a flight of steps and is suggested by the somewhat regular manner in which the rock is jointed.

The trap which is used in New York for a road metal is a diabase and consists chiefly of the minerals augite and labradorite, the former being a silicate of iron and magnesia and the latter being a lime-soda feldspar. Other minerals are present in small quantity but do not influence the properties which make the rock valuable as a road metal.

While sufficiently hard to resist the wear of heavy traffic to a satisfactory extent it possesses a high degree of binding or cementing power. This means that the dust produced by wear when moistened unites quite firmly and forms a cement which binds the larger fragments to a considerable extent.

This property is most noticeable in rocks containing much lime, magnesia and alumina.

Good trap is known only in Richmond and Rockland counties, and in the intermediate area of New Jersey bordering the Hudson river. Its very prominent outcrop is known as the 'Palisades.'

Granite consists chiefly of quartz mixed with one or more of the feldspars and hornblende or a mica. Hornblende has essentially the same composition as augite which occurs in trap; and a hornblende granite should be a very good road metal. Where hornblende is absent one would expect to find less binding power.

Granite is harder than trap and therefore should resist wear better, but this quality is offset by its usually smaller binding power due to the presence of quartz so that trap should be preferred as a rule.

Granite is found in the Adirondack region and in the Highlands of the Hudson, also in Westchester county. The commercial term granite includes various kinds of gneiss.

Magnesian limestone has great binding power but is quite soft and therefore not very durable for heavy traffic. Chemically, this rock is chiefly a carbonate of lime also containing carbonate of magnesia, alumina and silica. Limestone entirely free from magnesia is rare.

It has been suggested that this stone may be used profitably as a binder over stone of less binding power.

Limestone is found chiefly in areas parallel to and near the main line of the New York Central railroad and in a zone around the Adirondacks.

Sandstone consists chiefly of quartz, has usually no lime, magnesia or alumina and therefore has no binding properties and never makes a first rate road, as the fragments continually break loose.

In New York the best road materials occur in certain limited areas, and at points distant from these the cost of transportation is the controlling feature in the question of their use.

The accompanying map shows the distribution of the areas of rock already mentioned which are available for road construction in New York.

For high class road building, trap and granite will be preferred and used in all places where their cost is not prohibitory. Experience shows, however, that unless these materials are used under the direction of experienced road engineers, they are less satisfactory than limestone, and when it is proposed to macadamize a road by simply covering it with broken stone, the latter though less durable, will be more satisfactory.

When granite and trap are properly laid, on a well prepared bed and rolled with a heavy steam roller to the proper standard of firmness, nothing can be better, but where no steam roller is available and the subgrade is not properly prepared, the trap and granite are liable to afford only an unpleasant and uneven surface of hard angular fragments which ceaselessly roll about on the surface of the road injuring the horses and making pleasure driving impossible.

Limestone from its softness and greater binding power is more easily rolled into an even surface under the wheels of vehicles, and while not having the durability to support heavy traffic for a long time, can be cheaply renewed if the source of supply is not far distant. This fact has been recognized for a long time at points within easy reach of the limestone quarries. In Onondaga county at many points a portable crusher has been used to crush for road metal the blocks from the limestone fences which are cheerfully donated by the residents for the improvement of the roads. There are many other counties in which this might be done as may be seen from the map which shows the distribution of the limestone areas. In most of these areas limestone will be found in the fences and may be crushed for road metal at small expense.

The lists of quarrymen and the maps at the end of this bulletin explain the distribution of materials available for road building.

The distribution of road materials may also be studied in greater detail on the Economic Map of New York by F. J. H. Merrill which shows both the geology and the mineral deposits on a scale of 12 miles to 1 inch and on the Preliminary Geologic Map of New York by the State Geologist which shows the geology on a scale of 5 miles to 1 inch.‡

In addition to the outcrops and ledges where quarries may be opened the deposits of boulders and gravel whrch we call glacial drift often yield good materials for road metal at a long distance from the original source. These deposits cannot as yet be mapped but they are usually well known in the regions where they occur.

Tests of Road Material

The most practical test of road metal is actual use, and this has been the principal guide in the past; but as the demand becomes greater for new localities of road metal in order to reduce transportation charges, it has become necessary to devise physical tests which may be used in the examination of new materials offered for road building.

The following description quoted from the report of the Massachusetts Highway Commission for 1896, describes in detail the methods in use by that organization.* †

LABORATORY EXPERIMENTS ON ROADBUILDING STONES

The following described results were obtained in the highway laboratory of the engineering department of the Lawrence Scientific School of Harvard University. Those under the head 'Coefficient of abrasion were obtained by the Deval method, which has been employed for some time by the French engineers for determining the relative value of the

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* Pp. 86–91. † In this quotation, metric weights and measures have been reduced to common forms.

‡ For Westchester Co. see A Geological Map of a Part of Southeastern New York by F. J. H. Merrill, in Bulletin 15, N. Y. State Museum; also in 48th Ann. Rept. N. Y. State Museum.

stone used in the construction and maintenance of the national highways of France. These results are said to agree well with those obtained in actual practice.

The apparatus used in the tests consists of a cast-iron cylinder 8 in. in diameter and 13.6 in. in depth. At one end is an opening which can be closed with a tightly fitting iron cover. This cylinder is mounted on an axle at an angle of 30° with the axis of the cylinder, and is supported on an iron frame. At one end of the axle is a pulley wheel by which the cylinder is revolved; at the other is an instrument which records its revolution.

The stone to be tested is first broken into pieces, between 2½ in. and 1¼ in. in diameter, which are carefully washed, to remove any foreign matter. In the cylinder are placed 5 kilograms (13⅓lbs.) of this stone. The top is then bolted on, and the cylinder is made to revolve for 5 hours at the rate of 2,000 revolutions an hour, making in all 10,000 revolutions. By this process the stones are thrown from one end of the cylinder to the other, and at the same time are rolled against the sides of the vessel and against one another. When 10,000 revolutions are completed, the cover is removed, and the contents emptied into a tray. The cylinder is then thoroughly washed, to remove the dust that adheres to its sides. Each stone above 1¼ in. in diameter is then washed under the same water. This water is then filtered, and the filtrate when dry is mixed with the detritus taken from the cylinder. The detritus is then put into a sieve, by which it is separated automatically into seven sizes. These seven sizes, together with the stones that have not been worn below 3.18 cm. in diameter, are each carefully weighed, and their weights recorded.

The amount of detrition under 1-16 im. is rarely less than 20 grams per kilogram of stone used 2 %, therefore 20 has been adopted as the standard, and the coefficient of quality is obtained by the following formula:

$$q = 20 \times \frac{20}{u} = \frac{400}{u} \quad u = \text{per cent}$$

in which u represents the weight in grams 15.43 grs. of detritus per kilogram (2 2-3 lbs) of stone.

It seemed well, in beginning this work, to be guided as far as possible by the experience of others, and for this reason the Deval test was adopted, for it appeared to be the only practical method of testing road metals yet devised. After a number of trials were completed with the Deval apparatus, and their results studied, it was recognized that all the valuable properties possessed by a good road metal were not embraced in this test. The value of any good stone as a road metal is due to certain properties possessed by it. Among these there are three which stand prominent—cementing value, toughness and hardness. It is evident that the Deval apparatus does not test the very important property of cementing value in the different road metals. The commission, recognizing this deficiency, accordingly directed its attention to devising some means of supplying it. As no previous attempt has been made in this direction, the commission had to invent its own method, which is as follows:

The stone to be tested is ground to a powder, and passed through a sieve of 100 meshes to 1 m. The powder is then put in a slightly tapered steel die of circular section, about 1 1/4 in. diameter, mixed with water, and subjected to a pressure of 2,300 kilograms (about 3 tons). The resulting briquette is then put aside for at least one week, so that it may thoroughly dry.

It was at first thought that a test by direct compression would determine the cementing power of the stone. A number of briquettes were tried in this way, but the results were not very satisfactory. On further consideration, it appears that a test by impact would more thoroughly determine the cementing power of the stone then that by compression, and this method would have the further advantage of approximating more closely to the actual conditions obtaining on roads; accordingly a machine was devised for testing the briquettes by impact. With this machine a hammer one kilogram (2 2-3 lbs) in weight can be dropped freely from any desired height upon a plunger under which the briquette to be tested is placed. The hammer works automatically and is tripped at the desired height. Attached to the plunger is a lever, pivoted at one sixth of its length from the plunger, and carrying a pencil at its free end. The pencil has a vertical movement five times as great as that of the plunger, and its movement is registered on a drum against which the pencil presses. The drum rotates through a small angle at each stroke of the hammer. An automatic diagram is thus taken of the behavior of the briquette throughout the whole test.

An analysis of the diagram so taken shows at once the number of blows required to cause the destruction of the briquette. A very interesting point is brought out by these diagrams, viz. in every case the diagram shows that the plunger rebounded at each stroke until the briquette began to fail. This behavior is exactly analogous to the elastic phenomena observed in all material of construction; consequently the point at which the briquette ceases to rebound corresponds to the elastic limit of the material. Beyond this point the briquette falls to pieces rapidly.

Briquettes were made from many kinds of stone, and were tested in this machine. It was thought desirable to use a constant blow for all the briquettes, and a short experience indicated a fall of 1 1/4 in. as suitable, since it broke the most tenacious materials with a moderate number of blows, and yet was not too great to permit the careful determination of the properties of the poorer stones. All the briquettes were 1 in. high.

The surface of a macadamized road is constantly being abraded and recemented. Evidently a road made from a material which has the property of recementing in a high degree will keep in better condition than one made from a material of lower recementing power. It was therefore desirable to determine the recementing properties of the stones tested. A new set of briquettes was made, differing from the former only in that they were of constant weight instead of constant height. These were tested in the manner described above, and then were remade and retested.

It has not been thought desirable to present herewith the complete data obtained from the impact test: as the series is not yet completed. The writer has, however, collected and shown in the accompanying table some of the more important results thus far obtained, a sufficient number to indicate the scope of the work done. In this table the stones are arranged in the order of their power of resisting abrasion. Column 1 contains the specific density of the stones; column 2, the coefficients of abrasion (determined in the manner previously described); the next column gives the number of blows required to stress the 1 in. briquettes to their elastic limits; column 4 gives the same data for the first testing of the 30 gram (463) briquettes prepared for the recementation test, and the next column gives the number of blows that the recemented briquettes will stand before reaching their elastic limits."

Through the courtesy of the commission six specimens of typical New York rocks were subjected to the abrasion test with results which are noted in the following table; which also gives the results of some tests of Massachusetts rocks.

Table showing specific densities, coefficients, cementing values and recementing values of stones tested

NAME OF STONE	City or town	1 Specific density	2 Coefficient of wear	3 Cementing value	4 Cementing value of 30 gram briquette	5 Recementing value of 30 gram briquette
**Massachusetts rocks* (*)						
Diabase	Lynn, Essex co., Mass	3 03	20 37	....	56	29
Felsite	Boston, Suffolk co., Mass	....	16 06	23	109	31
Hornblende granitite	Duxbury, Plymouth	2 68	13 46	....	....	....
" "	Waltham, Middlesex co., Mass	2 62	12 16	16	....	....
Gneiss	Lee, Berkshire co., Mass	....	11 43	23	....	....
Limestone	Pittsfield, Berkshire co., Mass	2 82	9 38	15	....	....
Quartzite	Diamond Hill, Cumberland, R. I.	....	9 07	9	....	....
Marble	Lee, Berkshire co., Mass	2 74	2 85	....	....	....
†*New York rocks*						
Diabase, Bouker	Guttenberg, N. J.	....	30 40	....	....	....
" Conklin & Foss	Rockland Lake, N. Y	....	17 79	....	....	....
Norite	Cortland, Westchester co	....	7 46	....	....	....
Granite, D. Donovan	Round Island, Rockland co	....	23 02	....	....	....
Silicious sandstone	Lockport, Niagara co	....	17 48	....	....	....
Sandstone	Duanesburg, Schenectady co	....	10 53	....	....	....
Limestone	Howes Cave, Schoharie co	....	9 64	....	....	....
"	Tomkins Cove, Rockland co	....	6 31	....	....	....

* From the Report of the Mass. Highway Com. 1896. † Tests made for the New York State Museum by the Mass. High. Com.

As shown by the preceding table, the New York rocks tested in the laboratory of the Massachusetts Highway Commission were only subjected to the abrasion test and therefore the results can not be fully compared with the tests of the Massachusetts rocks which are given above. Two samples of traps were tested, one from the Bouker quarry at Guttenburg and one from the quarry of Conklin & Foss at Rockland Lake. The specimen tested from the Bouker quarry proved to be very much harder than that from the Conklin & Foss quarry. There are two varieties of trap found in the Bouker quarry; one being considered of inferior quality and known by the quarrymen as "*false trap*." It is part of the lower portion of the trap mass and being near the sandstone which forms its lower foundation, it cooled more rapidly and assumed a finer texture and a harder condition than the mass above. Although this so-called false trap has not been subjected to a cementation test, one would expect it to prove equally valuable with the rest in this respect, as its chemical composition is probably nearly identical with that of the softer trap immediately adjoining. It was a sample of the "false trap" which was tested.

It is stated that where used at some points on Long Island it has proven unsatisfactory, the fragments not holding together and forming an even surface, but frequently flying out.

The attention of the writer has been called to this fact, but he has not sufficient information to warrant a full expression of opinion. The difficulty may be due to improper construction in building the road. It might also be due to the mixture of this harder variety of trap and softer material from the same quarry, it being well established by experience that unless the road-metal in the surface layer is of uniform hardness, it will not wear uniformly. To establish the truth in this case would involve a good deal of experimental work for which no funds are available, but theorizing on the facts accessible, there seems no reason why the harder trap or false trap should not make a good road provided it is kept separate from material of different hardness and is laid under the supervision of a competent engineer.

As a rule when it is not possible to make numerous tests and experiments, it will be cheaper to use those materials which have proven satisfactory in actual use.

Owing to the press of state work it was not possible for the Massachusetts commission to make cementation tests of the specimens submitted. The tests made, confirm the results of practical experience and show that granite, trap and sandstone are harder and offer more resistance to abrasion than the limestones. The cementation test, when made, would unquestionably show the highest cementing value to be in the limestone, trap and granite and the lowest in the sandstone.

Producers of road-metal in New York state

Limestone

P. C. denotes that the stone is crushed in a public crusher owned or hired by the town or village. The number in the column headed *test* is the coefficient of abrasion as determined in the laboratory of the Massachusetts Highway Com.

NAME	Test	Town or village	County	
Allter Bros	......	St Johnsville	Montgomery	
Alvord, A. E	......	Manlius	Onondaga	
Babcock, Dwight	......	Waterloo	Seneca	
Barber Asphalt Paving Co	......	Buffalo	Erie	
Behan's Estate, James	......	Manlius	Onondaga	
Bennett, J. & Son	......	Auburn	Cayuga	P. C.
Britton & Clark	......	Onondaga	Onondaga	
Brown & Fleming	......	Verplanck	Westchester	
Buffalo Cement Co	......	Buffalo	Erie	
Callanan Road Imp. Co	......	South Bethlehem	Albany	
Chaumont Co. (The)	......	Chaumont	Jefferson	
Chazy Marble Lime Co	......	Chazy	Clinton	
Conley, F. E	......	Oriskany	Oneida	
Driscoll Bros. & Co	......	Ithaca	Tompkins	
Dunlap & Co., R	......	Jamesville	Onondaga	P. C.
Foery & Kastner	......	Rochester	Monroe	
Hibbard, John P	......	East Onondaga	Onondaga	
Howard, John F	......	Ogdensburg	St Lawrence	P. C.
Howe's Cave Association	4.15	Howe's Cave	Schoharie	
Hudson River Stone Supply Co	......	Stoneco	Dutchess	
Jones, Hadley	......	Littlefalls	Herkimer	
Lauer & Hagaman	......	Rochester	Monroe	
Lynde, B. A	......	Bellevue	Erie	
Miller, Geo. W. & D. C	......	Newburgh	Orange	
Mohawk Valley Stone Co	......	Palatine Bridge	Montgomery	
Newark Lime & Cement Mfg. Co	......	Rondout	Ulster	
Ransier, Huestis B	......	Manlius	Onondaga	
Roberts, R. W	......	Collinsville	Lewis	P. C.
Shute & Rightmyer	......	Hudson	Columbia	
Smith, W. T	......	Sharon Springs	Schoharie	
Snyder, C. G	......	Aquetuck	Albany	
Solvay Process Co	......	Onondaga	Onondaga	
Stainthorpe, C. N	......	Lockport	Niagara	
Tomkins Cove Stone Co	6.34	Tomkins Cove	Rockland	
Wagar, Isaac F	......	Milton	Saratoga	
Whitmore, Rauber & Vicinus	......	Rochester	Monroe	
Worlock, Cyrus	......	Perryville	Madison	

Granite

Ausable Granite Co., B. B. Mason, agent	......	Keeseville*	Essex	P. C.
Bellew & Merritt Co	......	Tuckahoe	Westchester	
Donovan, Dan'l E	1.73	Round Island [a] town of Stony Point	Rockland	
Rampe Bros	......	Pine Island, town of Warwick	Orange	
Smith, Hay	......	Garrison	Putnam	
Thousand I. Granite Co	......	Grindstone Island town of Clayton	Jefferson	

* This rock is technically a *norite*

a Near Iona Island

PRODUCERS OF ROAD-METAL, Etc., concluded.

Trap

NAME	Test	Town or village	County
Bennett, Frank	......	Port Richmond	Richmond
Conklin & Foss	2.25	Rockland Lake	Rockland
New York firms having quarries in New Jersey			
Bouker Contracting Co	1.31	Guttenberg	Hudson Co., N. J.
Carpenter Bros	......	Guttenberg	" N. J.
Lane, John S. & Son	......	Fort Lee	Bergen Co., N. J.

Sandstone

NAME	Test	Town or village	County
Albion Stone Co	......	Albion	Orleans
Conley, F. E	......	Higginsville	Oneida
Fowles, Joseph	......	Ithaca	Tompkins
Shear, Albert & Co	3.80	Duanesburg	Schenectady
Swett, A. L	......	Medina	Orleans
Whitmore, Chas	2.29	Lockport	Niagara

Directory of Quarrymen in New York State

Arranged in alphabetical order by post-office addresses

† Proprietors of quarries operating previous to 1897; now idle.
* Proprietors of quarries operating in 1897.
Parties not marked with dagger or asterisk have not been heard from directly, but are reported to be operating.
B. S. = Building stone

R. M. = Road metal
L. = Lime
C. = Cement
M. = Marble
P. C. = Public crusher

Granite

POST-OFFICE ADDRESS	NAME	Location of Quarry: Town or village nearest to the quarry	Location of Quarry: County	
Cold Spring	Bailey, C. W.*	Phillipstown	Putnam	B. S.
"	Bailey, James E.†	"	"	"
Garrison	Smith, Hay*	"	"	B. S. & R. M.
Gloversville	Edel, John*	Johnstown	Fulton,	B. S.
"	Wright, John	?	"	....
Goshen	Empire State Granite Co.*	Pine Island	Orange	B. S.
Keeseville	Ausable Granite Co. (B. B. Mason, agt.)*	Chesterfield	Essex	B. S. & R. M., P. C.
New York	Donovan, Daniel E.*	On Round Island, town of Stony Point	Rockland	B. S. & R. M.
Montreal	Thousand I. Granite Co.†	Thurso	Jefferson	B. S. & R. M.
Peekskill	Mohegan Granite Quarrying Co*	Cortland	Westchester	B. S.
Pine Island	Rampe Bros*	Warwick	Orange	B. S. & R. M.
Suffern	Rice Bros	Ramapo	Rockland	
Thurso	Kelly Granite Co*	Clayton	Jefferson	B. S.
"	Potter, O. L†	"	"	B. S.
"	White, Burgess & Co*	"	"	B. S.
Tuckahoe	**Bellew & Merritt Co***	Tuckahoe	**Westchester**	**B. S. & R. M.**

Gneiss (Granite)

Croton Falls	Ganung, Edwin C †	Carmel	Putnam	B. S.
Hartsdale	Butler, C	Hartsdale	Westchester	B. S.
"	Dobbs, G. W	"	"	B. S.
"	Hitchcock, Welcome G	"	"	B. S.
"	Landers, J. H	"	"	B. S.
"	Wilson, J. C*	"	"	B. S.
Hastings	Nichols Henry *	Greenburg	"	B. S.
Littlefalls	Littlefalls and Dolgeville R. R.†	Littlefalls	Herkimer	R. M.
Scarsdale	Seely, Henry S †	"	"	B. S.
Tarrytown	Sackett, Stephen J. (estate)*	"	"	B. S.

Trap

Haverstraw	Conklin & Foss *	Rockland Lake	Rockland	R. M.
Port Richmond	Bennett, Frank*	Northfield	Richmond	R. M.

New Jersey quarries supplying New York

Guttenberg, N. J	Lane, John S. & Son *	Guttenberg	Hudson	R. M.
New York city	Bouker Contracting Co*	"	"	R. M.
Port Chester, N. Y	Carpenter Bros *	Fort Lee	Bergen	R. M.

Limestone

Accord	Bennett, John*	Rochester	Ulster	B. S.
"	Krom, George*	"	"	L.
"	Longendyke, A. N	"	"	
"	Rose, W. H	"	"	
"	Wakeman, J.*	"	"	B. S.
Akron	Akron Cement Co.*	Newstead	Erie	C.
"	Newman, H. L. & W. C.*	"	"	B. S., C.
Albany	Callanan Road Imp. Co.*	South Bethlehem	Albany	R. M.
Albion	Staines, Thomas F.*	Barre	Orleans	L.
Amsterdam	Hewitt, D. C.*	Amsterdam	Montgomery	B. S., L.
"	Vanderveer, T. B.*	"	"	B. S., L.
Aquetuck	Snyder, Carl*	Coeymans	Albany	R. M.
Auburn	Bennett, J. & Son*	Auburn	Cayuga	B. S., R. M., P. C.
"	Goodrich, L. S. & Son	"	"	B. S.
Batavia	Berthum, August	Batavia	Genesee	
"	Merrill, John*	"	"	B. S., L.
Bigelow	Williams, Charles & Co.*	De Kalb	St Lawrence	L.

DIRECTORY OF QUARRYMEN IN NEW YORK STATE — LIME-STONE — (*Continued*)

POST-OFFICE ADDRESS	NAME	LOCATION OF QUARRY: Town or village nearest to the quarry	LOCATION OF QUARRY: County	
Boonville	Lee, Albert J.*	Boonville	Oneida	B. S., L.
Brasie Corners	Fleming, Walter	Macomb	St Lawrence	L.
"	Hall, R. G.	"	"	L., B. S.
Bellevue	Lynde, B. A.*	Bellevue	Erie	R. M.
Brooklyn	Flynn, P. H.*	Saugerties	Ulster	B. S.
Buffalo	Ambrose, E. J	Buffalo	Erie	....
"	Armbruster, Joseph*	"	"	B. S.
"	Barber Asphalt Paving Co.*	"	"	R. M.
"	Buffalo Cement Co. (lim.)*	"	"	R. M. & C.
"	Consumer's Lime Co.	Clarence	"	B. S.
"	Cumming's Cement Co.	Newstead	"	C.
"	Cutter & Bailey*	Buffalo	"	B. S.
"	Fogelsanger, D. R. & H	Amherst	"	B. S.
"	Gehres, Anna*	Buffalo	"	B. S.
"	German Rock Asphalt Co.	Lockport	Niagara	
"	Gesl, John Jr	Buffalo	Erie	B. S.
"	Grattan & Jennings	"	"	
"	Kabel, Martin*	"	"	B. S.
"	Kehr, A. P.*	Clarence	"	B. S.
"	Straub, Peter G	"	"	L.
Burlington, Vt.	Burlington Mfg. Co.†	Port Henry	Essex	M.
Canajoharie	Allen, William	Canajoharie	Montgomery	L.
"	Rapp, G	"	"	B. S.
"	Shaper, A. E. & D. C	"	"	B. S.
Canandaigua	McNulty, Frank*	Canandaigua	Ontario	B. S.
Canton	Stevens, E. E	Canton	St Lawrence	M.
Catskill	Palmer, H. P.*	Catskill	Greene	L.
Cazenovia	Burr, J. T.	Fenner	Madison	
Chaumont	Adams & Dufort	Chaumont	Jefferson	
"	Chaumont Company	Lyme	"	B. S., R. M., L.

Chazy	Chazy Marble-Lime Co.*	Chazy	Clinton	B. S., R. M., L.
"	Goss, L. M	"	"	L.
Cherry Valley	Bastian, William	Cherry Valley	Otsego	L.
"	Eldridge, O. H.†	"	"	L.
Chittenango Falls	Keeler, Charles	Fenner	Madison	L. & C.
"	Tooke, D. J.*	"	"	B. S.
"	Winchell, W. M.	"	"	
Clayton	Denney, Leander*	Clayton	Jefferson	B. S.
Climax	Haswell, D. G	Coxsackie	Greene	
Cobleskill	Baard, Frank*	Cobleskill	Schoharie	L.
"	Brandenstein, John*	"	"	B. S.
"	Reilly, William*	"	"	B. S.
Collinsville	Jones, Hugh D	West Turin	Lewis	L.
"	Potter, M. N	" "	"	
"	Roberts, R. W.*	" "	"	R. M., L.
"	Whittlesey, Walter	" "	"	
"	Williams, B. B	" "	"	L.
Columbia	Manning, A	Columbia	Herkimer	
Coxsackie	Day, Ambrose	Coxsackie	Greene	L.
Cranberry Creek	Kegg, Willard	Northampton	Fulton	L.
"	Warren, Willis E	?	"	
Crary Mills	Church, Ashley	Potsdam	St Lawrence	L.
Dolgeville	Dolge, Alfred*	Oppenheim	Fulton	B. S.
Dover Plains	Bensen, Geo. V	Dover	Dutchess	
East Onondaga	Hibbard, John P.*	Onondaga	Onondaga	B. S. & R. M.
East Pitcairn	Van Patten, F. A.*	Pitcairn	St Lawrence	L.
Ellenville	Van Dermark, B	Wawarsing	Ulster	L.
Fayetteville	Bangs & Gaynor*	Manlius	Onondaga	C.
"	Ransier, Huestis B.*	"	"	B. S. & R. M.
"	Sheedy, Thomas W	"	"	C.
Fort Edward	Harris, John F.*	Whitehall	Washington	B. S.
Franklin Iron Works	Juhl, M.*	Augusta	Oneida	B. S.
Glens Falls	Glens Falls Co.*	Queensbury	Warren	L., B. S., M.
"	Jointa Lime Co.*	"	"	L., B. S.
"	Morgan Lime Co.*	Moreau	Saratoga	L.
"	Reynolds & Riordan*	Queensbury	Warren	B. S.
"	Sherman Lime Co	"	"	L.
Gloversville	Mayfield Lime Co	Mayfield	Fulton	L.

DIRECTORY OF QUARRYMEN IN NEW YORK STATE — LIMESTONE — (*Continued*)

POST-OFFICE ADDRESS	NAME	LOCATION OF QUARRY		
		Town or village nearest to the quarry	County	
Gouverneur	Abbott, J. B	Gouverneur	St Lawrence	L.
"	Empire Marble Co.*	"	"	M.
"	Gouverneur Marble Co.*	"	"	M. B. S.
"	Northern New York Marble Co.*	"	"	M.
"	Potter, Charles A	Fowler	"	M.
"	St Lawrence Marble Co	Gouverneur	"	M.
"	Wright, H. J.	Fowler	"	L.
Greenwich	Bennett, H. C.*	Greenwich	Washington	B. S.
Harris Hill	Fiegle, August	Clarence	Erie	L.
Harrisville	Brady, Mary*	Diana	Lewis	L., B. S.
Hart Lot	Carrigan, P. C.	Elbridge	Onondaga	
"	Heavern, Charles	"	"	
"	Gorham, Aaron	"	"	
"	Keenan, John	"	"	
Hickory	Ingram, Vilast	Macomb	St Lawrence	L.
"	Perin, Wm	"	"	L.
Holland Patent	Hillidge, James G	Trenton	Oneida	B. S.
Hoosick Falls	Carey, William	Hoosick	Rensselaer	B. S.
"	Dolan, John*	"	"	B. S.
"	McCaffrey, Cornelius*	"	"	B. S.
Howe's Cave	Howe's Cave Assn.*	Cobleskill	Schoharie	R. M., B. S., L. & C.
"	Howe's Cave Lime & Cement Co.*	"	"	B. S. L. & C.
Hudson	Shute & Rightmyer	Jonesburg & Hudson	Columbia	B. S., R. M.
Ingham Mills	Butler, Sherman	Manheim	Herkimer	
Ithaca	Driscoll Bros. & Co.*	Ithaca	Tompkins	B. S. & R. M.
Jamesville	Alvord, E. B. & Co.*	Dewitt & Lafayette	Onondaga	B. S., L. & C.
"	Dunlap, R. & Co.*	Dewitt	"	R. M. & C., P. C.
Johnson	House, Samuel*	Johnson	Orange	L.
Jonesburg	**Jones, Fred W.***	Greenport	Columbia	B. S. & M.

Joy	Horn, William	Sodus	Wayne	
Kattsbaan	Fiero, William*	Saugerties	Ulster	L.
"	Valk & Beers*	"	"	L. & B. S.
Kerhonkson	Gordon, E. H	Rochester	"	L.
Kingston	Noone, Luke†	Kingston	Ulster	B. S.
LeRoy	Heinlich, John	LeRoy	Genesee	L.
"	Holmes, George H.*	"	"	B. S.
"	Howell, Livingston H.*	"	"	B. S.
"	Morris & Strobel	"	"	B. S.
"	Pangrazio Bros.*	"	"	B. S.
Leyden	Auer, Melchior*	Leyden	Lewis	B. S.
Lincoln	Gould, T. O	Walworth ?	Wayne	
"	Hanson, William	"	"	
Littlefalls	Jones, Hadley*	Manheim	Herkimer	B. S. & R. M.
Lockport	Heary, M. F	Lockport	Niagara	B. S.
"	Levalley, W. B	"	"	
"	Lockner, William E.*	"	"	B. S.
"	Lockport Stone Co.*	"	"	B. S.
"	Stainthorpe, C. N. & Co	"	"	B. S., R. M.
"	Tuohey, P. H.*	"	"	B. S.
"	Upson, W. H	"	"	
"	Watson, T. G.*	"	"	B. S.
"	Whitmore, Charles*	"	"	B. S.
"	Wilson, John H.*	"	"	B. S.
"	Woodward & Son	"	"	
Lowville	Babcock, William L	Lowville	Lewis	B. S.
"	Carter, L. H	"	"	B. S.
"	Gowdy, Hiram*	"	"	B. S.
"	Lyman, M. M.*	"	"	B. S.
"	Waters, John M	"	"	B. S. & L.
Lyon's Falls	Post, Orville	West Turin	"	
Manlius	Behan, James, estate of*	Manlius	Onondaga	B.S. & R. M., L. & C.
"	Brown Cement Co	"	"	
Marcellus	Malley, William*	Marcellus	"	B. S. & L.
Marcellus Falls	Walker, Laura E	"	"	C.
Mayfield	Warner, S. B	Mayfield	Fulton	L.
Mettacahonts	Gray, Stephen	Rochester	Ulster	L.
Middle Falls	Bates, H. B.*	Greenwich	Washington	B. S. & L.
"	Cipperly, John	"	Washington	

DIRECTORY OF QUARRYMEN IN NEW YORK STATE — LIMESTONE — (*Continued*).

POST-OFFICE ADDRESS	NAME	LOCATION OF QUARRY	
		Town or village nearest to the quarry	County
Middle Falls	Grouty, James M	Greenwich	Washington B. S.
"	Kenyon, Ambrose	"	"
"	Sullivan, Patrick	"	"
Middleville	Mosher, W. W.*	Newport	Herkimer B. S.
Mill Grove	Shoff, B. O.*	Mill Grove	Erie L.
Mohawk	Humphrey, J. W.*	Columbia	Herkimer L.
Munnsville	Adams, Frank*	Stockbridge	Madison B. S.
"	Palmiter, Amos*	"	" B. S. & L.
Natural Bridge	Ashcraft, F. E.*	Diana	Lewis L.
"	Hall, E. & W.*	Wilna	Jefferson L.
Newark, N. J.	Anderson & Moynehan*	Newcomb	Essex L.
Newburgh	Brown, David*	Newburgh	Orange B. S. & L.
"	Miller, Geo. W. & D. C.	"	" L. R. M.
Newcomb	Sayre, James R. jr. & Co*	Kingston	Ulster B. S., L.
Newport	Higgins, Gilbert	Newport?	Herkimer
"	Morey, Newell	"	"
"	O'Connor, George H.*	"	" B. S.
"	Sherman, John	"	"
"	Toumey Daniel	"	"
New York	Duryee Portland Cement Co	Montezuma	Cayuga C.
"	Newark & Rosendale Lime & Cement Co.*	Whiteport	Ulster L. & C.
"	O'Connell & Hillery	Tuckahoe	Westchester L.
"	Snowflake Marble Co.*	Pleasantville	" M. & L.
Niagara Falls	Messing, Bernard	Niagara	Niagara L.
"	O'Rourke, Michael	"	"
North Litchfield	Davies, Albert R	Litchfield	Herkimer L.
"	Dickson, Charles	"	" L.
"	Holland, George E.*	"	" L.
"	Salisbury, John E.*	"	" L.

North Western	Vale, John D	Western	Oneida	L.
"	Van Dyke, John H.*	"	"	B. S.
Norwood	Hale, George W.*	Potsdam	St Lawrence	B. S.
"	Murray, James L.	" ?	"	
Ogdensburg	Howard, John F.*	Oswegatchie	St Lawrence	R. M., B. S. & L.
"	Nevin, John H.	"	"	B. S.
Onondaga Castle	Kelly Bros	Onondaga	Onondaga	B. S.
" "	McElroy & Sons	Onondaga	Onondaga	
" "	Storrier Bros*	"	"	B. S.
Oriskany Falls	Putnam estate	Augusta ?	Oneida	
Palatine Bridge	Mohawk Valley Stone Co*	Palatine	Montgomery	B. S. & R. M.
Perryville	Hodge, Mrs. F. W	Sullivan	Madison	
"	Worlock, Cyrus*	"	"	L. & C. R. M.
Phelps	Edson, B	Phelps	Ontario	
"	Johnson, William H	"	"	B. S.
Pine Island	Brown, B. T	Warwick	Orange	L.
"	Elston, Charles†	"	"	L.
Plattsburg	Behan, Hugh	Plattsburg	Clinton	B. S.
"	Pray, G. W	Peru	"	L.
"	Robinson, Thomas	Plattsburg	"	B. S.
Pleasant Valley	Russell, Evert†	Pleasant Valley	Dutchess	L.
Pleasantville Station	Cornell Lime Co*	Mount Pleasant	Westchester	M. & L.
Prospect	Talcott, Charles L.	Russia	Herkimer	L.
"	Thomas, Evan T*	Trenton	Oneida	B. S.
Poughkeepsie	Bain, F. R	Dover ?	Dutchess	B. S.
"	Hufcut, H. D	"	"	
"	Lawlor, Michael	"	"	
Ravena	Day, Abraham	Coeymans	Albany	
"	DeFriest, W. V. D. H*	"	"	B. S.
"	Hotaling, David	"	"	B. S.
.	Hughes, William*	"	"	B. S.
"	McCullock, Conrad	"	"	B. S.
Rochester	Foery & Kastner*	Rochester	Monroe	R. M. & B. S.
"	Lauer & Hagaman*	"	"	R. M. & B. S.
"	Nellis, J. B. (administrator)†	"	"	B. S. & L.
"	Neuman, R. G.*	Gates	"	L.
"	Smith, B. P.*	Union Springs	Cayuga	B. S.
"	Whitmore, Rauber & Vicinus*	Rochester	Monroe	B. S. & R. M.

DIRECTORY OF QUARRYMEN IN NEW YORK STATE LIMESTONE — (*Continued*).

POST-OFFICE ADDRESS	NAME	LOCATION OF QUARRY		
		Town or village nearest to the quarry	County	
Rondout	Gross, F. W	Kingston	Ulster	B. S.
"	Lawrence Cement Co.*	"	"	C.
"	Newark L. & C. Mfg. Co.*	"	"	R. M. L. & C.
"	New York & Rosendale Cement Co.*	Rosendale	"	C.
Rossie	O'Brien, John*	Rossie	St Lawrence	L.
Sandy Hill	Drake & Stratton Co. (limited)†	Queensbury	Warren	B. S.
"	Monty, Higley & Co.*	Kingsbury	Washington	B. S.
"	Sturtevant, D	South Glens Falls	Saratoga	B. S.
Saratoga Springs	Slade, Charles G.*	Greenfield	"	B. S.
"	Wagar, Isaac F.*	Milton	"	B. S.
"	Wing, Prince; estate	"	"	L.
Sauquoit	Thurston, W. W	Paris	Oneida	
Schoharie	Becker, Clinton L.	Schoharie	Schoharie	B. S.
"	Brown, Albert*	"	"	B.S., R.M.& C., P.C.
Seneca Falls	Fisher, John	Fayette	Seneca	B. S. & L.
Sharon Springs	Mallett, F. C	Sharon	Schoharie	
"	Smith, Henry S.*	"	"	L.
"	Smith, Jefferson†	"	"	B. S.
"	Smith, W. T.*	"	"	B. S. & R. M.
Shelby	Simonds, E. B.†	Shelby	Orleans	L.
Sing Sing	Ossining Lime Co.*	Ossining	Westchester	L.
Skaneateles Falls	Starr, Levi	Sennet	Cayuga	B. S.
Smith's Basin	Keenan Lime Co.*	Kingsbury	Washington	L.
"	Nichols, D. & Son	Hartford	"	L.
Smith's Landing	Gould, J. H.*	Catskill	Greene	B. S.
"	Massino, William	"	"	B. S.
Sodus Center	Mather, E. B. & Co.*	Sodus	Wayne	L.
"	Munn, Gardner A.*	"	"	L.
South Greenfield	Wing, Elihu	Milton	Saratoga	L.
Split Rock	Connors, James	Onondaga	Onondaga	B. S.

Split Rock	Crowley, Cornelius*	Onondaga	Onondaga	B. S.
Springfield Center	McDonough, William*	Springfield	Otsego	B. S.
St. Johnsville	Allter, Bros.*	St Johnsville	Montgomery	B. S., R. M.
"	Fitzer, C.*	"	"	B. S.
"	Hilligar, Chas.	"	"	
"	Fox, D.	"	"	
"	Nagle, Thomas	"	"	
"	Place, Daniel	"	"	
"	Smith, Albert A.	"	"	L.
"	Smith, W. C.*	"	"	B. S.
Stoneco	Hudson R. Stone Supply Co.	Stoneco	Dutchess	R. M.
Stone Ridge	Basten, John*	Marbletown	Ulster	B. S. & L.
"	Davenport, Solomon*	"	"	L.
Syracuse	Alvord, A. E.	Manlius	Onondaga	L., C., R. M.
"	Britton & Clark	Onondaga	"	L. & R. M.
"	Hughes Bros.*	"	"	B. S.
"	Thomas, C.*	"	"	B. S.
"	Solvay Process Co.*	"	"	B. S. & R. M.
"	Wadsworth, George*	"	"	B. S.
Three Mile Bay	Barron, John J.*	Lyme	Jefferson	B. S.
Thurman	Pelletier, John	Thurman	Warren	M.
Ticonderoga	Joubert, Israel*	Bolton	"	B. S.
Tomkins Cove	Tomkins Cove Stone Co.	Tomkins Cove	Rockland	R. M.
Towner's	Penny, P. D.*	Patterson	Putnam	B. S.
Tribe's Hill	Hurst, Henry & Son	Mohawk	Montgomery	
"	Putman, J. G	"	"	
"	Shanahan, James	"	"	B. S.
Troy	Cheney, W. D. & Son	Smith's Basin	Washington	L.
Tuckahoe	New York Quarry Co.	Eastchester	Westchester	M.
"	Norcross Bros.	"	"	M.
"	Tuckahoe Marble Co.	"	"	M.
"	Young, James S.	"		
Union Springs	Shalebo, J. L.	Springport	Cayuga	L.
"	Wood, George P.*	Hamburg	"	B. S.
Utica	Callahan, Ed.*	Trenton	Oneida	B. S.
"	Conley, F. E.*	Oriskany Falls	"	R. M.
Verplanck	Brown & Fleming*	Verplanck	Westchester	R. M.
Walworth	Mann, Owen	Walworth	Wayne	L.

DIRECTORY OF QUARRYMEN IN NEW YORK STATE — LIMESTONE — (*Continued*).

POST-OFFICE ADDRESS	NAME	LOCATION OF QUARRY		
		Town or village nearest to the quarry	County	
Walworth	Read, John*	Walworth	Wayne	L.
Waterloo	Babcock, Dwight*	Fayette	Seneca	B. S. & R. M.
Warwick	Burt, Thomas*	Warwick	Orange	B. S.
Watertown	Cory, Henry S.*	LeRay	Jefferson	L., B. S.
"	Gould, A	Watertown ?	"	
"	Hunting, S. E	Pamelia	"	B. S.
"	Phillips, Patrick*	Watertown ?	"	
"	Williams, E.	" ?	"	
Wawarsing	Hoornbeck, Charles*	Warwarsing	Ulster	L.
West Troy	Mark, George*	Glens Falls	Warren	B. S.
West Walworth	Hanson, William	Walworth	Wayne	
West Winfield	Bradley, A. P.*	Winfield	Herkimer	L.
Whitfield	Barley, Albert*	Rochester	Ulster	L.
"	Dixon, Benjamin C.*	"	"	L.
Whitehall	Adams, Terry	Whitehall	Washington	
"	McLaughlin, John	"	"	B. S.
Williamsville	Young, J. B. & F. H.*	Williamsville	Erie	L. & B. S.
Willsboro Point	Frisbie, C. W.*	Willsboro	Essex	B. S.
Wolcott	Post, Alonzo*	Butler	Wayne	L.
"	Walker, Charles J.†	"	"	B. S. & L.
Wolcottville	Luckman, William J.*	Royalton	Niagara	L.

Sandstone

Albany	Fuller's Son's Wm.*	New Baltimore	Greene	B. S.
Albion	DeGraff & Roberts	Barre	Orleans	B. S.
"	Garrett & Atkinson	"	"	B. S.
"	Goodrich & Clark Stone Co.	"	"	B. S.
Belfast	Lang, James†	Belfast	Allegany	B. S.

Belmont	Johnson, James	Amity	Allegany	B. S.
Belvidere	Dibble, Albert	"	"	B. S.
Canajoharie	Shaper, A. E	Canajoharie	Montgomery	B. S.
Clayton	Wilber, S. H.	Clayton	Jefferson	B. S.
Cleveland, Ohio	Albion Stone Co*	Barre	Orleans	R. M., B. S.
Clinton	Dawes, Charles*	Kirkland	Oneida	B. S.
"	McCabe, John	"	"	B. S.
"	Moore, Richard	"	"	B. S.
Cooperstown	Wood, John	Middlefield	Otsego	B. S.
Corning	Bedient, James H	Corning	Steuben	B. S.
"	Kelley, John	"	"	B. S.
Dansville	Schubmehl, Martin J*	Dansville	Livingston	B. S.
Dormansville	Stewart, William	Westerlo	Albany	B. S.
East Guilford	Miller, Wm.†	Guilford	Chenango	B. S.
Elmira	Symonds, A. D	Elmira	Chemung	B. S.
Fort Ann	Holmes, Andrew D	Fort Ann	Washington	B. S.
"	Parrish, Franklin	"	"	B. S.
"	White, Jenkins	"	"	B. S.
Fort Jackson	Downey Bros	Hopkinton	St Lawrence	B. S.
Frankfort	Joslin, M. T.*	Frankfort	Herkimer	B. S.
Fulton	Granby Brownstone Co	Granby	Oswego	B. S.
"	Jennings, Orvill J	Volney	"	B. S.
Goodyears	Barger, J. G †	Genoa	Cayuga	B. S.
Grand View	Brown, Wm. H	Orangetown	Rockland	B. S.
Hammond	Finegan, John C*	Hammond	St Lawrence	B. S., F.
"	Foster, H. A	"	"	B. S.
"	Parmeter, D. E	"	"	B. S.
"	Stanley, W. H	"	"	B. S.
Haverstraw	Demarest, P. E	Haverstraw	Rockland	B. S.
Highland	Clearwater, F. S	Lloyd	Ulster	B. S.
Himrod	Cheney, Louis A.*	Himrod	Yates	B. S.
Hindsburg	Baldwin & Hinds	Murray	Orleans	B. S.
"	Burns, L. G	"	"	B. S.
"	Chadwick Bros	Albion	"	B. S.
"	Chadwick, Thos. Jr	Murray	"	B. S.
Holley	Downs & Bowman †	Clarendon	"	B. S., F.
"	O'Brien & Co	Murray	"	B. S.
Hornellsville	Cobb, J. F	Hornellsville	Steuben	B. S.
Hulburton	Fancher & Newsome*	Murray	Orleans	B. S., F.

DIRECTORY OF QUARRYMEN IN NEW YORK STATE — SANDSTONE — (*Continued*).

POST-OFFICE ADDRESS	NAME	LOCATION OF QUARRY: Town or village nearest to the quarry	LOCATION OF QUARRY: County	
Hulburton	Ford A. H	Murray	Orleans	B. S.
"	Gwynne, C. F	"	"	B. S.
"	Hamilton Chas. J	"	"	B. S.
"	Hebner, John	"	"	B. S.
"	Lardner, Thomas	"	"	B. S.
"	Phillips, Marcus	"	"	B. S.
"	Squire, A. J	"	"	B. S.
"	Sturaker & Sullivan	"	"	B. S.
"	Von York, Constantin	"	"	B. S.
Ithaca	Fowles, Joseph *	Ithaca	Tompkins	R. M., B. S.
"	Mc. Clune, G. C †	"	"	B. S.
Jamestown	McVeigh, John	Ellicott	Chautauqua	B. S.
Lewiston	Hotchkiss, L. W	Lewiston	Niagara	B. S.
Lockport	Kinney, Rebecca	Lockport	"	B. S.
"	Spalding Wm	"	"	B. S.
"	Whitmore, Chas.*	"	"	R. M., B. S.
Malden	Ulster Bluestone Co *	Quarryville	Ulster	B. S. & F.
Malone	Bashaw, Levi	Malone	Franklin	B. S.
"	Morris, Antoni	"	"	B. S.
"	Paddock, S. A	"	"	B. S.
Medina	Garrett, Thos	Ridgeway ?	Orleans	
"	Gorman, Chas. A *	Murray, Barre, Ridgeway	"	B. S. & F.
"	Gorman & Stork	Barre	"	B. S.
"	Gotts & Stork	"	"	B. S.
"	Horan, Patrick	Ridgeway	"	B. S.
"	Horan, Mrs. S. J	"	"	B. S.
"	Kearney & Barrett	"	"	B. S.
"	McCormick, A. J.	"	"	B. S.
"	Mooney Bros.	"	"	B. S.

Medina	Noble & Lyle	**Ridgeway**	**Orleans**	B. S.
"	O'Reilly, Bernard	Murray	"	B. S.
"	Scanlon, Martin	Barre	"	B. S.
"	Slack, Michael	Murray	"	B. S.
"	Stark, Joseph	Ridgeway	"	B. S.
"	Swett, A. L.*	Medina	"	R. M., B. S.
"	Wall, Wm. H. Sup't Holloway Quarries†	Ridgeway	"	B. S.
Middleburg	Bishop, Amberson	Middleburg	Schoharie	B. S.
Monroe	Davison, John G.*	Monroe	Orange	B. S. & F.
New Hudson	Searle, Mr.	New Hudson	Allegany	B. S.
North Cohocton	Whitney, Theo.	Cohocton	Steuben	B. S.
Nyack	Puff, Nelson	Orangetown	Rockland	B. S.
"	Smith, Dan F.	"	"	B. S.
Olean	Olean Bluestone Co	Olean	Cattaraugus	B. S.
Olive	Bogart, E. H.*	Olive	Ulster	B. S. & F.
Oswego Falls	Faulkner, James	Granby	Oswego	B. S.
Oxford	Burns, Edward	Oxford	Chenango	
"	Clark Bluestone Co. F. G.*	"	"	B. S. & F.
"	Coman, Wm.*	"	"	B. S. & F.
"	Hogan & Britt	"	"	
"	Johnston & Kertsner	"	"	
"	Keeley Bros.	"	"	
"	Oldfield, James	"	"	
"	Woods, Theodore	"	"	
"	Young, Richard	"	"	
Penn Yan	Cornwell, Geo. R.	Milo	Yates	B. S.
Portageville	Genesee Valley Bluestone Co*	Genesee Falls	Wyoming	B. S.
Port Henry	Bond, L. W.	Moriah	Essex	B. S.
Potsdam	Clarkson Quarries*	Potsdam	St Lawrence	B. S., F.
"	Merritt & Tappan	"	"	B. S.
"	Potsdam Red Saudstone Co	"	"	B. S.
Rexford Flats	Benedict, Levi	Aqueduct	Schenectady	B. S.
Rochester	Brady, Gilbert*	Albion	Orleans	B. S.
"	Brown, Henry S.	Rochester?	Monroe	
Rockville	Searl, Abram*	Belfast	Allegany	B. S.
Saugerties	Burhans & Brainard*	Saugerties	Ulster	B. S., F.
Schenectady	Shear, Albert & Co*	Aqueduct & Duanesburg	Schenectady	R. M., B. S.
Shelby Basin	LeValley, John*	Ridgeway	Orleans	B. S. & F.
South Berne	Bailey, David*	Westerlo	Albany	F.

DIRECTORY OF QUARRYMEN IN NEW YORK STATE — SANDSTONE — (*Continued*).

POST-OFFICE ADDRESS	NAME	LOCATION OF QUARRY		
		Town or village nearest to the quarry	County	
South Hammond	Seymour & Edgar	Hammond	St Lawrence	B. S.
St Johnsville	Smith, W. C	St Johnsville	Montgomery	
Trumansburg	Biggs, D. S. & Sons.*	Ulysses	Tompkins	B. S. & F.
Utica	Conley, F. E.*	Higginsville	Oneida	R. M. & B. S.
Warsaw	Warsaw Bluestone Co	Rock Glen	Wyoming	B. S.
Washington Mills	Griffiths, Wm	New Hartford	Oneida	B. S.
"	Mallory, J. P	"	"	B. S.
"	Thompson, E. F	"	"	B. S.
"	Trimbey, H. J.*	"	"	B. S.
Watkins	Higgins, D. H.*	Dix	Schuyler	B. S.
Watts Flats	Gould Fred H.*	Harmony	Chautauqua	B. S.
Waverly	Boget, M. L.*	Barton	Tioga	B. S.
"	Fleckenstine, J. W	"	"	
"	Murray, John H	"	"	
Whitehall	McLaughlin, John	Whitehall	Washington	B. S.

Bluestone

Bluestone is a variety of sandstone, which, by reason of its even texture can be cut or sawed into any desired form and is therefore peculiarly available for house trimmings of various kinds. In general, the layers in the quarries vary from an inch to several feet in thickness; the thinner of these are used for flag stones and the thicker are cut into dimension stone for building purposes.

The bluestone industry is chiefly located in Ulster county and the quarries are almost innumerable but the business is controlled by a few large dealers who are located at points favorably situated for shipment and who, to a considerable extent, buy stone from the men who quarry it. Bluestone is also produced in the counties of Albany, Greene, Sullivan, Delaware and Chenango in Eastern New York and in Cattaraugus and Wyoming counties in Western New York.

The geological horizon of the commercial bluestone is very near the dividing line between the Hamilton and Portage groups. It is, however, not usually possible to determine in which of these groups a given quarry belongs owing to the great scarcity of fossils.

*Producers of Bluestone

POST OFFICE ADDRESS	NAME	Town or village nearest to the quarry	
	Albany county		
Reidsville	Otto Bennet*	Berne	F.
South Berne	Bailey, David*	Westerlo	F.
	Cattaraugus county		
Olean	Olean Bluestone Co	Olean	B. S.
	Chenango county		
Oxford	Clarke Bluestone Co. F. G.	Oxford	
Tyner	Loomis, Perry*	Smithville	B. S.
	Delaware county		
Fish's Eddy	Martin, Geo	Hancock	
Hales Eddy	Kingsbury, O. M. & Co.*	Tompkins	B. S., F.
Hamden	Kenny, James*	Hamden	F.
Hancock	Cotter Bros.*	Hancock	
"	Kirkpatrick Bros	"	
Long Eddy	Kenny Bros	"	
" "	Peak, Cyrus*	"	F.
Lordville	Curry, John	"	
Peakville	Merritt, Geo. W.*	"	B. S., F.
"	Staib, J. J	"	
Rock Rift	Huntington, E	Tompkins	
Stockport Station	Morse, J & Co	Hancock	
Walton	Gray & Marvin†	Walton	
"	St John, H. E.*	"	
"	Warner, G. T.*	"	B. S., F.

* PRODUCERS OF BLUESTONE — *concluded*

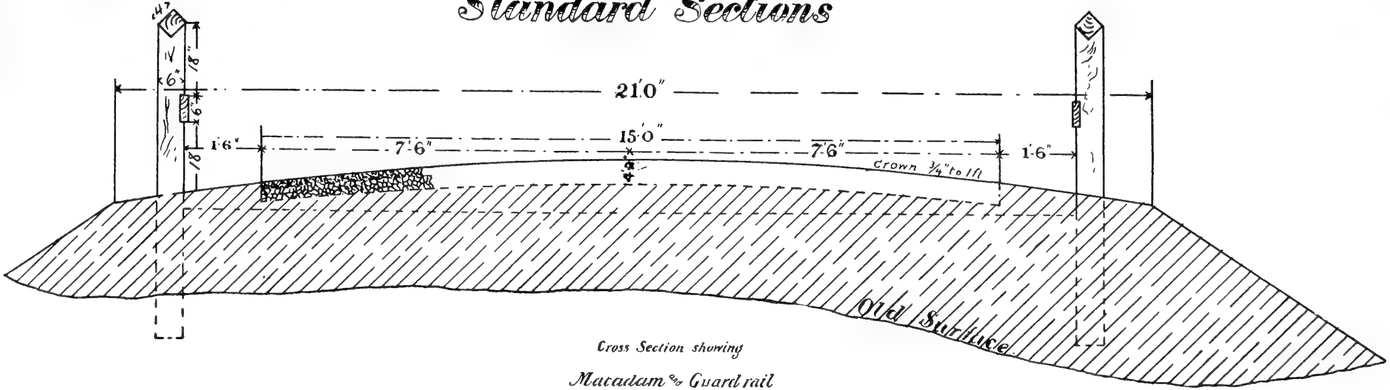
POST OFFICE ADDRESS	NAME.	Town or village nearest to the quarry	
	Greene county		
Palenville	Lamouree, F. & Co.*	Catskill	F.
"	Newkirk, Isaac*	"	
	Sullivan county		
Callicoon	Persbacker Bro's & Co.*	Callicoon	B. S., F.
Callicoon Depot	Dering, John	"	
Hankins	Manny, Anthony*	Fremont	B. S., F.
Long Eddy	Dunn & Co	"	
Narrowsburg	Engelman, Geo. W	Tusten	
Roscoe	Gregg & Miller	Rockland	
	Ulster county		
Allaben	McGregor, S	Shandaken	
Brodhead	Hungerford, Alonzo	Olive	
"	Lyons L	"	
Glenford	Burton, H	"	
"	Krom, Wm	"	
Hurley	Ostrander, Samuel	Hurley	
Kingston	Roger & Tappan, dealers only		
Lomontville	Dunn, Patrick	Marbletown	
"	Rose, Andrew	"	
Malden	Ulster Bluestone Co.*	Quarryville	B. S., F.
Marbletown	Clearwater, Jacob	Marbletown	
"	De Graff, Wm	"	
Olive	Bogart, E. H.†	Olive	F.
Olive Bridge	Gemmell, James B.	"	F.
Phœnicia	Simpson, A. J	Phœnicia	
Plattekill	Longendyke & Co	Plattekill	
"	Sheffell, F. & Co	"	
Quarryville	Carnwright, Alphonso	Saugerties	
"	Fitzpatrick, Daniel	"	
Rondout	Boice, Hewitt, dealer only		
Sawkill	Peppard, Michael*	Kingston	B. S.
"	Walsh, Wm. & Sons*	"	B. S.
Stone Ridge	Turner, C. C.*	Marbletown	
Stony Hollow	Cassidy, Owen	Kingston	
"	Murtha, Michael	"	
West Hurley	Connors, Thomas*	Hurley	
West Saugerties	Carn, J. & Sons	Saugerties	
West Shokan	Boice, Lemuel	Olive	
Wilbur	Osterhoudt, Julius*	Kingston	B. S., F.
Woodstock	Lasher, D.*	Woodstock	F.
	Wyoming county		
Portageville	Warsaw Bluestone Co	Gainesville	B. S.
"	Genesee Valley Bluestone Co.	Genesee Falls	B. S.

* For a complete list of all persons engaged in quarrying bluestone see Bulletin No. 15, New York State Museum.

The foregoing directory of quarries and quarrymen, while probably not complete is very nearly so. As already indicated in the chapter on road materials, only a part of the quarries yield stone which is entirely satisfactory for road building. The reports of the Massachusetts Highway Commission, however, show that where the best material is not obtainable, other material can be put to a very good use, and a sandstone may make a very satisfactory foundation, when covered with trap or even with limestone, if nothing more desirable is available. Roads built in this way probably require more engineering skill in their construction and more careful watching in maintenance and repair. The local problems must be worked out in the future by actual experiment under the supervision of competent road engineers.

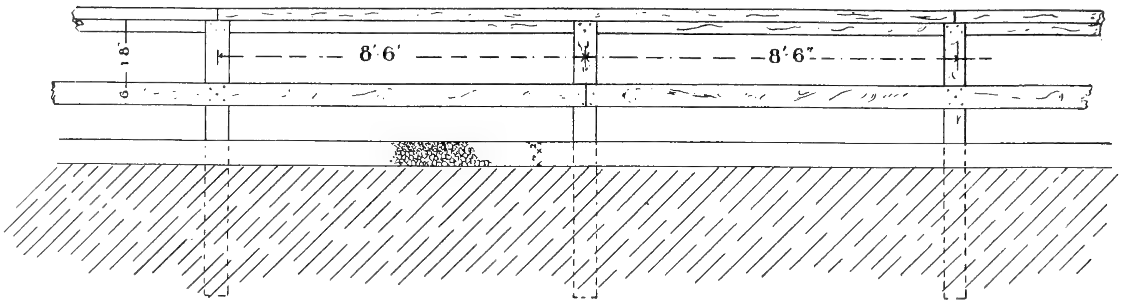
PLATE I.

Standard Sections



Cross Section showing

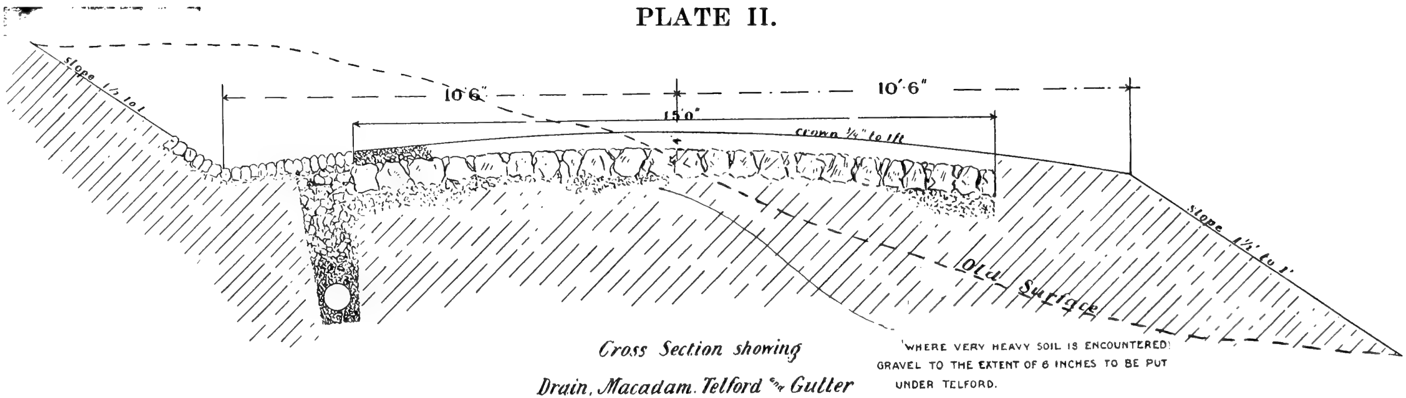
Macadam and Guard rail



Longitudinal section thro centre showing Macadam and rail

MASSACHUSETTS HIGHWAYS.

PLATE II.

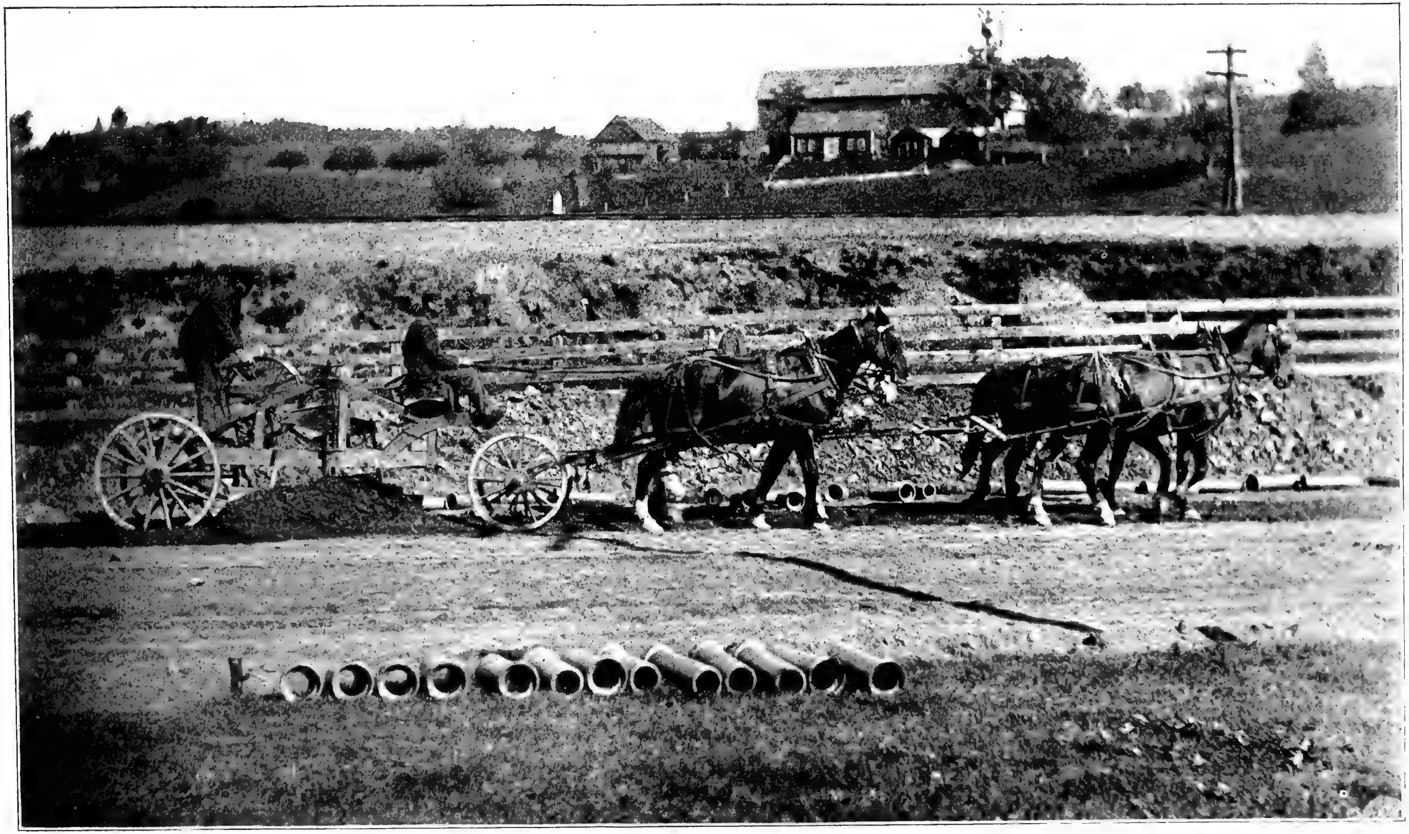


Cross Section showing

Drain, Macadam, Telford and Gutter

MASSACHUSETTS HIGHWAYS.

PLATE III.

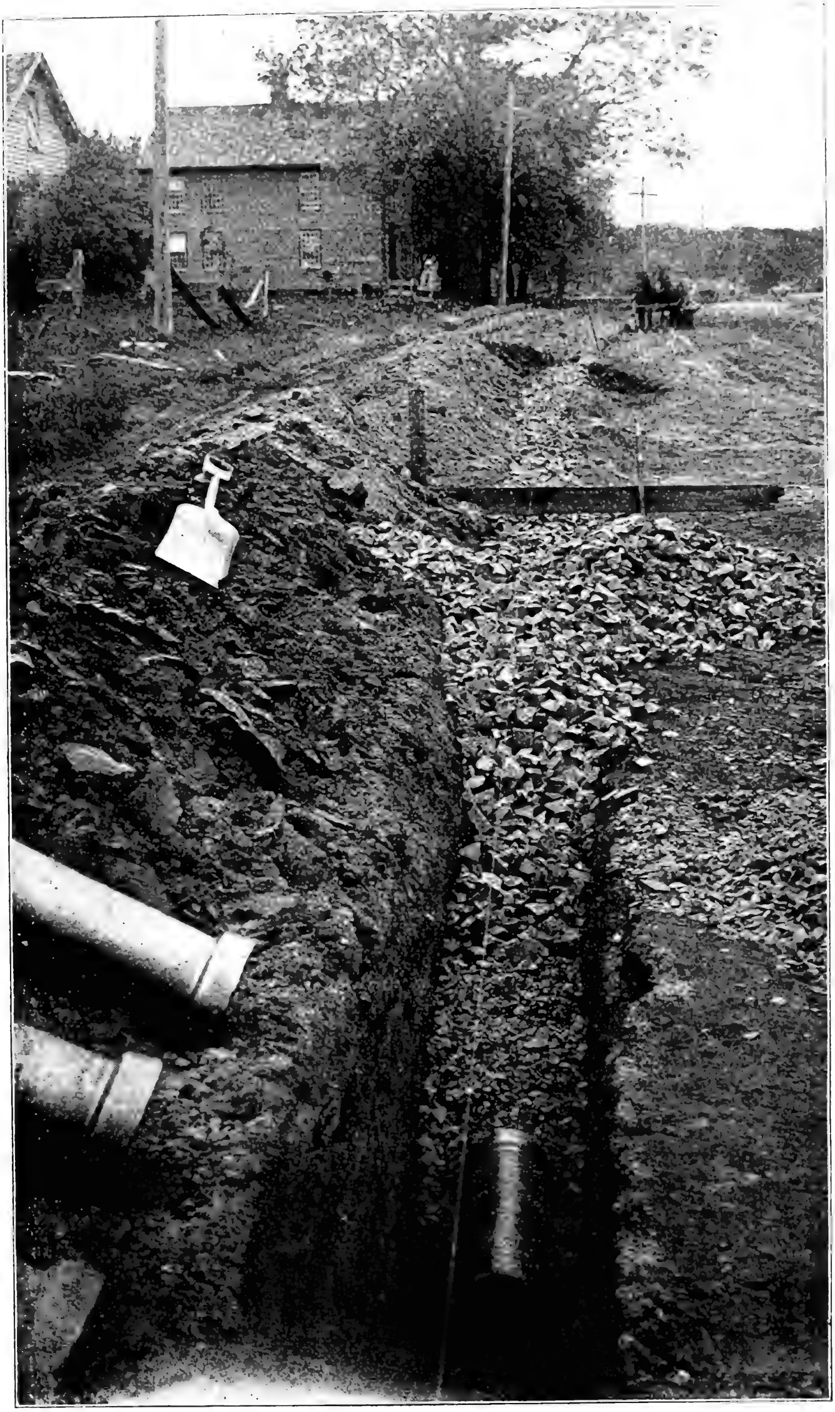


Westfield Road, Mass., 1894.
View showing the road maehine at work grading the sub-grade.

PLATE IV.

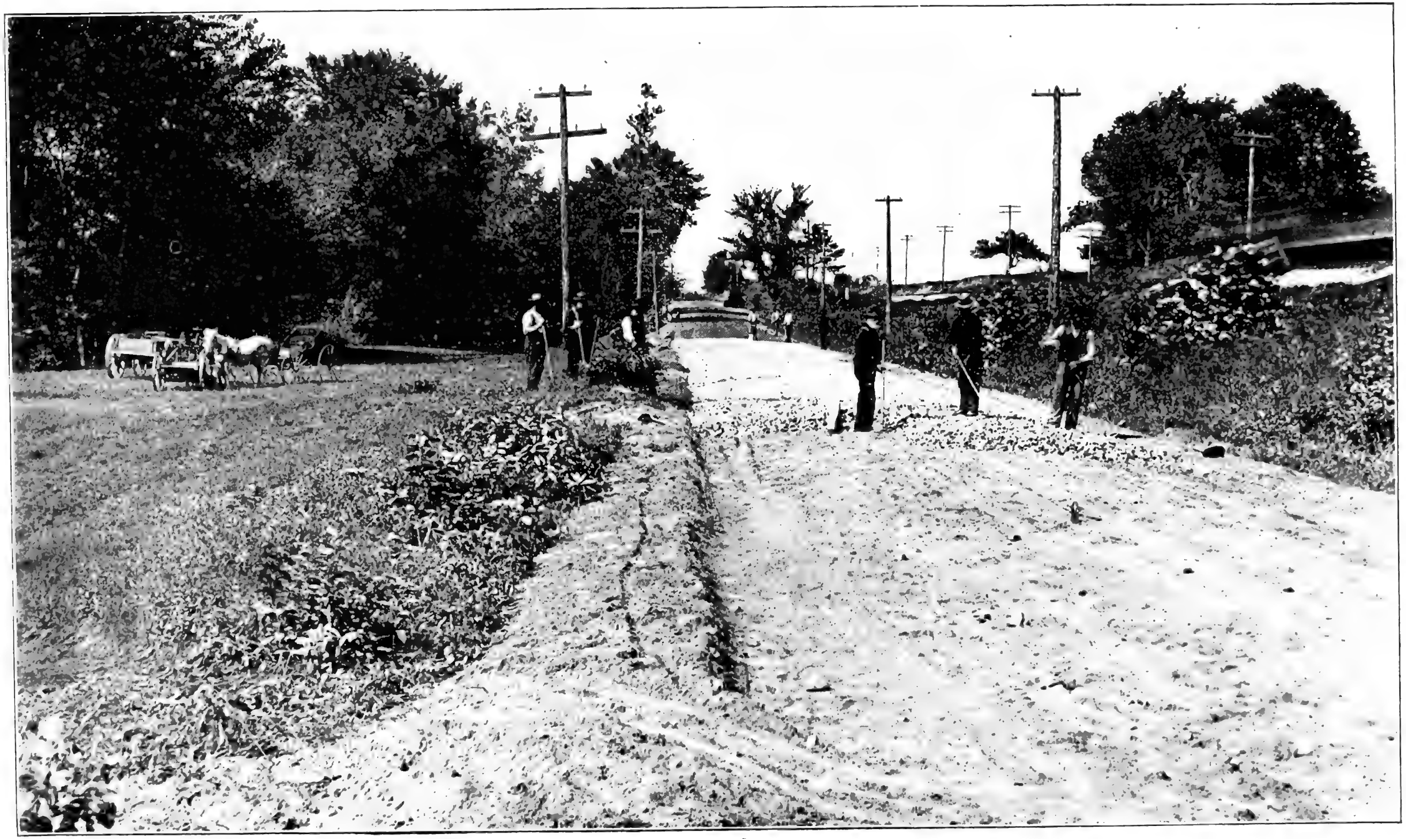
Westfield Road, Mass., 1894.
View showing the method of constructing a drain in clay or other wet soil.

PLATE V.



Westfield Road, Mass., 1894.
View showing details of drain.

PLATE VI.

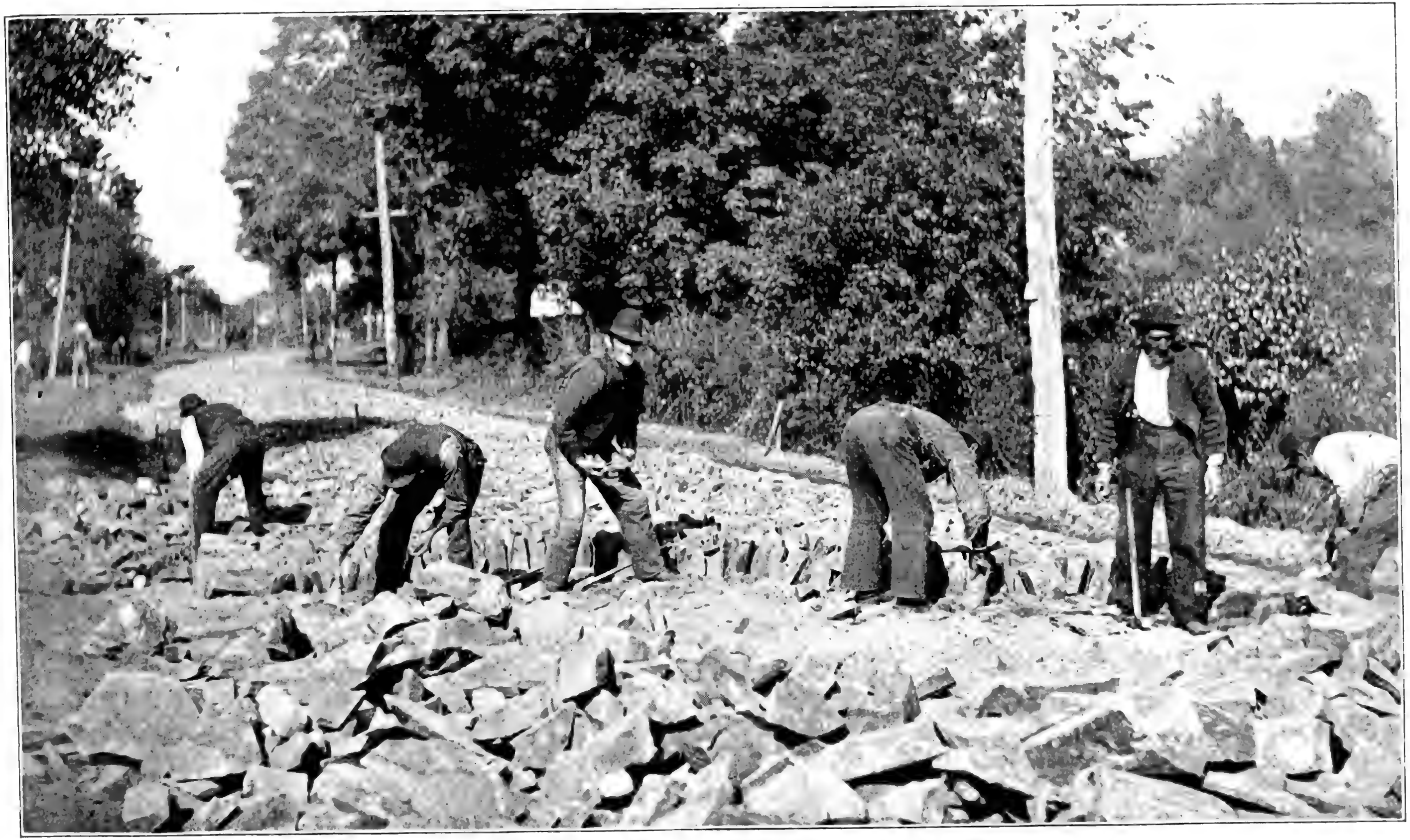


Westfield Road, Mass., 1894.
View showing sub-grade graded and rolled, also the broken stone in place.

PLATE VII.

Westfield Road, Mass., 1894.
View showing sub-grade graded and rolled, also the broken stone being put in place and steam roller at work

PLATE VIII.



WESTFIELD ROAD, MASS., 1894.
View showing method of laying Telford foundation on a gravel bed.

PLATE IX.

WESTFIELD ROAD, MASS., 1894.
View showing Telford road in process of construction.

PLATE X.

Westfield Road, Mass., 1894.
View showing the finished roadway, together with steam roller at work.

PLATE XI.

WESTFIELD ROAD, MASS, 1894.
View showing completed road.

PLATE XII.

Westfield Road, Mass., 1894.
View showing completed road.

PLATE XIII.

Westfield Road, Mass., 1894.
View showing completed road with guard rail.

PLATE XIV

Westfield Road, Mass., 1894.
View showing completed road with bridge and guard rail.


ACKNOWLEDGMENT.
The boundaries of the granite and gneiss and of the Calciferous-Trenton limestone in the vicinity of the Mohawk Valley, and the outcrops of the Niagara and Helderberg limestones are from the Preliminary Geologic map of New York prepared under the direction of James Hall, LL.D., by W J McGee.
The outcrop of the Tully limestone is from the work of S. G. Williams, 6th Annual Report, State Geologist of New York.
The Calciferous-Trenton limestone outcrops in the St. Lawrence and Champlain Valleys and in the region east of the Hudson River as well as in Ulster and Orange Counties; the areas of granite, gneiss and trap in southeastern New York, and the north boundary of the Adirondack granite and gneiss area, are from the Economic and Geologic map of New York compiled by F. J. H. Merrill.
ONTARIO
LAKE ONTARIO
LAKE ERIE
PENNSYLVANIA
VERMONT
MASS.
CONN.
NEW JERSEY
LONG ISLAND SOUND
ATLANTIC OCEAN
ADIRONDACK MOUNTAINS
CATSKILL MOUNTAINS
CLINTON
ST. LAWRENCE
FRANKLIN
ESSEX
JEFFERSON
LEWIS
HAMILTON
WARREN
HERKIMER
OSWEGO
ONEIDA
FULTON
SARATOGA
WASHINGTON
NIAGARA
ORLEANS
MONROE
WAYNE
CAYUGA
ONONDAGA
MADISON
MONTGOMERY
SCHENECTADY
GENESEE
ONTARIO
SENECA
WYOMING
LIVINGSTON
YATES
SCHUYLER
TOMPKINS
CORTLANDT
CHENANGO
OTSEGO
SCHOHARIE
ALBANY
RENSSELAER
ERIE
CHAUTAUQUA
CATTARAUGUS
ALLEGANY
STEUBEN
CHEMUNG
TIOGA
BROOME
DELAWARE
GREENE
COLUMBIA
ULSTER
SULLIVAN
DUTCHESS
ORANGE
PUTNAM
ROCKLAND
WESTCHESTER
QUEENS
SUFFOLK
KINGS
RICHMOND
UNIVERSITY OF THE STATE OF NEW YORK.
MAP OF THE
STATE OF NEW YORK
SHOWING THE
DISTRIBUTION OF THE ROCKS MOST USEFUL FOR ROAD MATERIAL
BY
FREDERICK J. H. MERRILL
Director New York State Museum
ALBANY, N.Y.
1897.
Scale of Miles
LEGEND
Triassic — Triassic trap.
Devonian — Tully limestone.
Upper Silurian — Helderberg limestones
Niagara limestone.
Lower Silurian — Calciferous-Trenton limestone.
Precambrian — Granite, norite and gneiss.
NOTE.
In the uncolored areas the prevailing rocks are shales, slates and sandstones except on Long Island, where sand and gravel predominate.
There are many areas of limestone too small to be shown on the map.
Within all the rock areas are local variations of quality. These must be determined by actual experience.
JULIUS BIEN & CO. LITH. N.Y.

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The superior figure points to the exact place on the page in ninths; e. g. 93^7 means seven ninths of the way down page 93.