Prof Alex. Agassiz
with the sincere regards
of James Hall

Cabinet of Natural History.

1867.

TWENTIETH ANNUAL REPORT

OF THE

REGENTS OF THE UNIVERSITY

OF THE

NOTE.—This Revised Edition was completed in 1870, and the imprint should have been so dated, instead of 1868, the date of the First Edition.

AND THE

HISTORICAL AND ANTIQUARIAN COLLECTION ANNEXED THERETO.

REVISED EDITION.

PRINTED BY ORDER OF THE ASSEMBLY.

ALBANY:

PRINTING HOUSE OF CHARLES VAN BENTHUYSEN & SONS.

1868. 70

TWENTIETH ANNUAL REPORT

OF THE

REGENTS OF THE UNIVERSITY

OF THE

STATE OF NEW YORK,

ON THE CONDITION OF THE

STATE CABINET OF NATURAL HISTORY,

AND THE

HISTORICAL AND ANTIQUARIAN COLLECTION ANNEXED THERETO.

REVISED EDITION.

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1868.

REGENTS OF THE UNIVERSITY.

(Ex Officio Trustees of the State Cabinet of Natural History.)

CONTENTS OF APPENDIX.

REPORT.

To the Hon. the Legislature of the State of New York:

The Regents of the University, as Trustees of the State Cabinet of Natural History, respectfully submit this their

TWENTIETH ANNUAL REPORT.

The Report of the Curator gives the details of the work done in the State Cabinet during the year 1866, and presents a general view of its condition under the following heads:

1. The Library.
2. The Geological Collection.
3. The Palæontological Collection.
4. The Economic Collection, ores, building stones, marbles, etc.
5. The Mineralogical Collection.
6. The European Palæontological Collection.
7. The Zoölogical Collection.
8. The Botanical Collection.
9. Fossil and recent bones, skulls, etc.

In respect to the Zoölogical Collection, the Curator has stated the condition of the several departments, and indicated their leading deficiencies. Some portions of the Marine fauna have but few representatives, and the Collection of Fresh-water fishes also needs to be increased.

The cases provided for the exhibition of the Conchological collection are inadequate to its proper arrangement and display, and many specimens are left packed in drawers. This department has been greatly augmented by donations from the Smithsonian Institution, one consignment of which was received and acknowledged in 1865, and another in 1866; the former of which numbers 1,068 species and 1,680 specimens; the latter, 702 species and 1,206 specimens. Catalogues of both of these donations accompany the present report.

The number of distinct contributions to the several collections during the past year is forty-three, besides several volumes of books for the Library. Some of these contributions are of great interest and value. The Trustees take special pleasure in acknowledging the addition of the bones of a Mastodon recently found at Cohoes and presented to the Museum by the Harmony Mills Company, through their agent, Mr. Alfred Wild. The peculiar circumstances under which this animal must have been imbedded, unlike those of most, if not all, the other skeletons found in this country, are believed to be of great importance in determining the natural history and geological relations of this species. The Regents and the Curator, from the first announcement of the discovery of fossil remains in that locality, employed every means in their power to secure their entire excavation and final transfer to the State Cabinet. The success of these endeavors, in view of opposing pecuniary inducements from parties in other States, is a tribute alike to the generosity of the donors and to the attractive power of our own State collection, from which no unique specimens of natural history found within the State should be diverted. A full description of this Mastodon, so far as the parts have been secured, and of the locality and circumstances in which it was found, is in course of preparation, and may be expected to accompany the next Report of the Regents.

A valuable collection of fossils, which was deposited some years since in the State Cabinet, by the late Ledyard Lincklaen, of Cazenovia, has been donated during the past year by Mrs. Lincklaen, through the Hon. Horatio Seymour, of Utica.

Several additions to the Economic collection are due to the earnest coöperation of Dr. R. L. Allen, of Saratoga Springs, and of others whose names appear in the annexed list of donations.

All the larger specimens of the Economic collection have been arranged and labeled. Although yet necessarily incomplete, this department of the Cabinet is evidently one of great interest to visitors. Many smaller specimens remain to be arranged in cases whenever these shall be provided, while others may be incorporated into the general Geological collection. A complete catalogue of the arranged specimens is included in the Appendix.

The labeling of the Palæontological collection has progressed as fast as the other duties of the Curator would permit. The entire series has been reärranged, and under each group of rocks the classes have been separated and a class label placed at the head of the division. Labels of about six hundred species have been prepared, with the reference to author, place of publication, rock formation and locality. Many of these have been printed and placed upon the cards of specimens within the cases.

It will appear from the annexed catalogue of books belonging to the State Cabinet, that while the nucleus of a Library has been formed, it is very inadequate to the wants of an institution in which scientific investigations are to be conducted. While the means at the disposal of the Trustees may not enable them to purchase desirable standard works to any considerable extent, it is hoped that the Annual Reports on the Cabinet will generally be regarded as an equivalent in exchange for the transactions of learned societies, and for many works of individual authors. It is not improbable that, in addition to the annual reports, other publications may hereafter be issued to advise the public more fully and frequently in regard to the condition of the several collections and the progress of scientific investigations.

The Cabinet has been for several years in possession of a quantity of duplicate fossils and geological specimens from the various formations of the State, which might be very advantageously employed for the purposes of exchange, and for distribution to institutions of learning throughout the State, were an adequate force employed to classify, arrange and label them. The Trustees are of opinion that a small appropriation may properly be made by the Legislature for this object.

A large portion of the Appendix to the present Report consists of papers which were communicated with previous reports, but which have thus far remained unpublished in consequence of inadequate provision for the public printing and the necessity of completing the legislative documents of each year at a specific date. The Trustees have been greatly disappointed and embarrassed by these repeated failures on the part of the State printer to fill the orders of the Legislature, and they earnestly recommend the adoption of measures to ensure the timely appearance of the entire report hereafter. It is believed that fewer new papers than usual have been furnished for the present Report, on account of the uncertainty of their early appearance in print.

Besides the acknowledgments already made in this report, and in the annexed list of donations, the Trustees would also mention the courtesy of the Freight Agent of the Rensselaer and Saratoga railroad, in transporting several blocks of stone free of charge. Hon. J. H. RAMSAY, President of the Albany and Susquehanna railroad, has also tendered the free transportation over that road of any articles intended for the State Cabinet.

The usual account current for the fiscal year 1865–6 is hereto appended.

Respectfully submitted,

By order of the Regents.

JOHN V. L. PRUYN,

Chancellor of the University.

ALBANY, *April* 15, 1867.

APPENDIX.

ACCOUNT CURRENT,

WITH

APPROPRIATION FOR THE STATE CABINET OF NATURAL HISTORY.

1865-6.	*Dr.*	
To balance from 1864–5	$2,291.96	
To appropriation for 1865–6	800.00	
		$3,091.96
	Cr.	
By collections	$44.84	
By chemicals	127.65	
By books and stationery	93.93	
By boxes and cases	121.65	
By expressage and freight	29.29	
By contingents	3.00	
By balance to new account	2,671.60	
		$3,091.96

I have examined the preceding account, and the vouchers in support thereof, and find them correct.

ALEXANDER S. JOHNSON.

ALBANY, *December* 3, 1866.

(A.)

ADDITIONS TO THE STATE CABINET DURING THE YEAR 1866.

I. BY DONATION.

I. To the Zoölogical Department.

From the SMITHSONIAN INSTITUTION.

A box of marine, land and fresh-water SHELLS, numbering 663 species and 51 varieties; in all 714, represented by 1,206 individual specimens, many of which are broken. Catalogue appended (C).

From WILLIAM C. JOHNSON, Newburyport, Mass.

A specimen of *Gerbillia canadensis*,—deer mouse,—jumping mouse,—in alcohol.

From L. H. MORGAN, Rochester (through Hon. J. V. L. PRUYN).

A fine collection of specimens of BEAVER-GNAWED WOOD, some of them being trunks of trees of large size. From the south side of Lake Superior.

II. To the Botanical Department.

From Mrs. M. A. BUSH, Cohoes.

A fine collection of MARINE ALGÆ. 98 specimens, from Long Island Sound.

III. To the Geological and Mineralogical Department.

From W. H. McCAMMON, Little Falls.

Two specimens of rocks of the Chemung group, from Oil Creek, Pa., containing *Spirifera disjuncta* and *S. præmatura*.

From THOMAS EVERSHED, Medina.

COPPER PYRITES and QUARTZ with MICA, from Belmont township, Northumberland county, Canada West. Several specimens.

From Dr. R. L. ALLEN, Saratoga Springs.

Two blocks of GNEISS or GRANITE from a quarry near Saratoga, and two blocks of GNIESS and one of GRANITE from Sacondaga river, Luzerne, Warren Co.

From S. VISCHER TALCOTT, Albany.

A small specimen of SPATHIC IRON ORE, from near Poughkeepsie.

From Hon. P. W. NICKERSON, Rockland County.

Some specimens of SILICO-MAGNESIAN LIMESTONE for chemical examination. Specimens of CONCRETIONARY IRON ORE—limonite—from Rockland county.

From Hon. A. C. McGOWAN, Herkimer County.

Two small dressed blocks of BROWN SANDSTONE, from the town of Frankfort, Herkimer county.

From H. A. PUTNAM, Elizabethtown.

PYRITOUS IRON ORE, from Essex county (particular locality unknown).

From W. F. GOOKIN, Port Henry.

OCTOHEDRAL CRYSTALS of MAGNETIC IRON ORE, and a specimen of SMOKY QUARTZ in MAGNETIC IRON ORE, from the new bed at Moriah, Essex county.

From ALMERON PHELPS, Moriah.

CALCAREOUS SPAR in LENTICULAR CRYSTALS; some faces covered with minute crystals of Iron Pyrites, from the new bed at Moriah.

From F. C. CROWLEY, Moriah.

Specimens of MAGNETIC IRON ORE and ILMENITE in QUARTZ, from mines of Crowley & Co., Bent-lot, Moriah.

From WILLIAM PHINNEY, South Cairo.

Specimens of ARENACEOUS SHALES of the Hamilton group, filled with *Spirifera mucronata*, from loose masses of the rock six miles west of Catskill.

From J. T. HOGAN, Albany.

Specimens of GRANITE, FELSPAR, MICA, etc., from excavations made in grading Central Park, New York, above 53d street.

From THOMAS WALTON, Port Henry.

One block and one slab of SERPENTINE or VERDE ANTIQUE MARBLE, from his quarry, in Port Henry.

From the CHEEVER ORE BED COMPANY, Port Henry (through WALTER MERRILL).

A large block and smaller specimens of MAGNETIC IRON ORE, and a large mass of CRYSTALLINE HORNBLENDE, etc., from a vein cutting the ore bed and enclosing pieces of the ore.

From E. H. SCOTT, Albany.

Specimens of IRON ORE from Western Virginia, and a specimen of CANNEL COAL from Ulster county, W. Va.

From Prof. —— ORTON ———.

Ten specimens of ROCK containing fish remains, from the Chemung group at Franklin, Delaware county.

From Dr. E. BOSTWICK, Hudson.

Specimens of QUARTZ with Chlorite, TALCOSE SLATE with crystals of Ilmenite and fine Scales of Specular Iron Ore; also separate crystals of ILMENITE, from Hillsdale, Columbia county.

From REUSS HITT, Roxbury, Delaware County.

Five specimens of RED SHALY SANDSTONE, with fucoidal markings (for examination).

From JOHN T. LANSING, Arica, Peru, South America.

A fine specimen of NATIVE COPPER from the mines of Peru.

From Hon. R. G. RANKIN, Newburgh.

Specimens of CLAYSTONES. (Localities not given.)

From the HIGH ROCK SPRING COMPANY, Saratoga Springs.

Specimens of CALCAREOUS TUFA, cut from the lower side of the High Rock on its removal; also, specimen from a pine tree found seven feet below the base of the High Rock, and a piece of oak from a depth of seventeen feet below.

From Mr. PRESTON, Superintendent of Edwards Mine, Canaan, N. Y.

A specimen of SILVER-LEAD-ORE, from the mine.

From JOEL TIFFANY, Albany.

Specimens of CLAY and PEBBLES (drift earth), from the Lake Tunnel at Chicago, Illinois, 1866.

From the N. Y. STATE AGRICULTURAL SOCIETY (through Col. B. P. JOHNSON, Albany).

Forty-four specimens from different GEOLOGICAL FORMATIONS, and eight specimens of CLAYS from different parts of the State.

From the MORIAH MINING COMPANY (through MARCUS T. SMITH, Moriah).

A specimen of MAGNETIC IRON ORE, one foot long by nine inches wide and high.

From HERBERT JUDD, Franklin, Delaware County.

Specimens of CALCAREOUS SANDSTONE, with remains of fossil fishes, from the Chemung group at Franklin.

From Mrs. LEDYARD LINCKLAEN, Cazenovia (through Hon. HORATIO SEYMOUR).

A valuable collection of FOSSILS, formerly deposited in the State Cabinet by the late LEDYARD LINCKLAEN of Cazenovia.

From B. and J. CARPENTER, Lockport.

A block of NIAGARA LIMESTONE, of one cubic foot, finely dressed, one face showing rock fracture; from Lockport.

From J. L. and A. RANDALL, Albany.

Two blocks of MAGNETIC IRON ORE, from French Mountain, near Lake George.

From Mr. KNAPP, ——.

Two specimens of Roofing Slate, from the U. S. Roofing Slate quarries, Washington county.

From H. R. and Z. J. BROWN, Schoharie.

A polished specimen of Black Marble two feet four inches long, with a base of the same stone dressed as an ordinary building stone, with one face showing rock fracture; from Schoharie.

From SHERMAN, WETHERBEE & CO., Port Henry.

A large block of Magnetic Iron Ore from the new bed in Moriah, and two large and several small specimens of Iron Ore from the old bed in Moriah, Essex county.

From JACOB GOEWAY, Albany.

A Piece of Wood found with the remains of the Mastodon at Cohoes.

From the HARMONY MILLS COMPANY, Cohoes (through Alfred Wild, Albany).

Bones of a Mastodon, found at Cohoes in September and November, 1866.

IV. To the Antiquarian Department.

From Dr. J. H. ARMSBY, Albany.

A part of a Stone Mortar Pestle (aboriginal); locality not given.

V. To the Library.

From the ROYAL NORSK UNIVERSITY OF CHRISTIANIA, Sweden.

An Account of the Fossils of the Quaternary Period; by Dr. Michael Sars, Professor in the University of Christiania. Quarto, 134 pp. and four plates.

A Paper on the Brachiopoda; by George Ossian Sars. Quarto, 71 pp. and four plates. (This paper received the prize of the Royal Gold Medal.)

A Paper on the Sneebræen Folgefon; by S. A. Sexe. Quarto, 36 pp. and chart.

Through the SMITHSONIAN INSTITUTION

The Isis for 1864, complete; 1865, February to December; 1866, January to June.

II. BY PURCHASE.

I. To the Botanical Department.

Lesquereux's "Musci Americana Exsiccati."

(B.)

CATALOGUE OF SHELLS PRESENTED BY THE SMITHSONIAN INSTITUTION TO THE STATE MUSEUM.

LAMELLIBRANCHIATA.

NAME.	LOCALITY.	No.
OSTREA LURIDA, *Cpr.*	Vancouver	1
— — *Cpr.*, var. LATICAUDATA	do	1
— — *Cpr.*, var. RUFOIDES (broken)	do	1
— PLICATA, *Chem.*	do	4
— GLOMERATA, *Gld.*	New Zealand	--
— CIRCUMSUTA, *Gld.*	Fiji	1
— DISCOIDEA, *Gld.*, var.	New Zealand	1
— — *Gld.*	Pacific Island	1
— MORDAX, *Gld.*	Fiji	2
— CONCHAPHILA	San Diego	1
— SENEGALENSIS, *Gmel.*	do	1
— PHILIPPINARIUM, *Hanl.* (badly broken)	do	1
PLACUNANOMIA MACROSCHISMA, *Desh.*	Vancouver	2
PECTEN ALBOLINEATUS, *Sby.*	Fiji	1
— SQUAMOSUS, *Gmel.*	Japan	2
— MINIACEUS, *Rve.*	South Africa	2
— CRASSICOSTATUS, *Sby.* (crushed)	China	--
— RENETORIUS, *Ln.*	Indian Ocean	2
— ÆQUISULCATUS, var. VENTRICOSUS	California Survey	2
— HINDSII, var.	Vancouver	3
— HASTATUS, *Sby.*	do	3
— HASTATUS, var. (1 v. broken)	do	2
— DARWINI, *Rve.*	Rio Negro	1
— LENTIGINOSUS, *Rve.*	Tooloo	1
— LATI-AURITUS, var. (broken)	California Survey	2
— LŒTUS, *Gld.*	New Zealand	1
— ARGENTEUS, *Rve.*	do	1
— MONOTIMERIS, *Conr.* (and var.)	California Survey	3
— MADREPORARUM, *Petit*	Singapoor	1
— VENTRICOSUS	do	1

NAME.	LOCALITY.	No.
PECTEN SUBNODOSUS	St. Lucas	1
JANIRA PYXIDATUS, *Bow.*	China	1
— CREBRICOSTATUS, *Phil.* (broken)	Japan	2
— DENTATA, *Sby.*	St. Lucas	2
— MEDIA, *Lam.*	New Zealand	1
AMUSIUM CAURINUM, *Gld.*	Vancouver	1
HINNITES GIGANTEUS, *Gray.*	do	5
LIMA FRAGILIS, *Chem.*	Pacific Island	1
— FACIATA, *Sby.*	Fiji, Japan	1
SPONDYLUS MICROLEPAS, *Lam.*	C. Palmas	1
— OCELLATUS, *Rve.*	do	1
PLICATULA AUSTRALIS, *Sby.*	Australia	1
— PHILIPPINARIUM, *Sby.*	Singapoor	1
— ? DEPRESSA, *Sby.*	Rio Negro	1
AVICULA (MARGARITIPHORA) LURIDA, *Gld.* (1 broken).	Pacific	1
— (MARGARITIPHORA) PICA, *Gld.*	Tutisilla	2
— — LURIDA, *Gld.*, var.	Pacific	3
— — VIDUA, *Gld.*, variety (broken)	Pacific	2
— (MARGARITIPHORA) GLABRA, *Gld.*	New Zealand	2
— — FURCATA, *Gld.*	Australia	2
MARGARITIPHORA FLEXUOSA, *Rve.*	Ceylon	1
— LENTIGINOSA, *Rve.*	Cape Good Hope	2
— PULCHELLA, *Rve.*	Hobson's Bay	2
— FIMBRIATA	St. Lucas	1
ISOGNOMON COSTELLATUM, *Con.*	Sandwich Islands	4
PERNA ARGILLACEA, *Gld.*	Pacific Islands	1
ISOGNOMON FEMORALIS, *Lam.* v. IMBRICATUS (broken).	do	2
PERNA (ISOGNOMON) PARVA, *Gld.*	Fiji	1
— — NANA, *Gld.*	Pacific	2
ISOGNOMON INCISUS, *Con.*	Sandwich Islands	3
— SPATULATUS, *Rve.*	----	2
PINNA ASSIMILIS, *Hanl.* (broken)	China	1
MYTILUS CALIFORNIANUS, *Con.*	Vancouver	2
— HIRSUTUS, *Lam.*	----	1
— CUNEIFORMIS, *Rve.*	Patagonia	1
— MAGELLANICUS, *Chem.*	Orange Harbor	2
— — *Chem.*	Cape Good Hope	1
— ALGOSUS, *Gld.* (1 v. broken)	Peru	2
— OVALIS, *Lam.*	Rio Negro	1
— GRANULATUS, *Hanl.*	Chili	1
— LATUS, *Lam.*	New Zealand	1
— PERNA, *Ln.*	Orange Harbor	½
— TENUISTRIATUS, *Dkr.*	Chili	3
— PYRIFORMIS, *Gld.*	Callao	2
— HEPATICUS, *Gld.*	Kingsmill Island	1
— "EDULIS," *H. C.*	New Zealand	1

NAME.	LOCALITY.	No.
MYTILUS "EDULIS," *Linn.*, var.	Vancouver	2
— SMARAGDINUS, *Chem.*	Ceylon	1
— GRUNERIANUS, *Dkr.*	West Africa	3
— CREBRILIRATUS, *Con.*	Sandwich Islands	2
— (MODIOLA) AREOLATUS, *Gld.*	New Zealand	2
SEPTIFER CUMINGIANUS, *Dkr.*	St. Lucas	2
— CRASSUS, *Dkr.*	China	1
— INCISUS, *Welgm.*	do	1
— NICOBARIUS, *Chem.*		1
MODIOLA RECTA, *Con.*	California	2
— TULIPA, *Dkr.*	Fiji	1
— ELEGANS, *Gray.*	Hong Kong	1
— PHILIPPINARIUM, *Hanl.*		1
— MODIOLUS, *Linn.*	Vancouver	1
MYTILIMERIA NUTTALII, *Con.* (all fragments)		3
CERENELLA CUNEATA, *Gld.* (1 v. broken)		2
— IMPACTA, *Hel.*	New Zealand	1
LITHOPHAGUS ARISTATUS, *Dillw.*	West Africa	2
— CUMINGIANUS, *Dkr.*		2
— CORRUGATUS, *Phil.*	Tonga	1
— ATTENUATUS, *Desh.*	Patagonia	1
— APPENDICULATUS, *Phil.* (broken)	Rio Janeiro	2
— GRACILIS, *Phil.*		2
ADULA STYLINA	Vancouver	1
— FALCATA, *Gld.* (broken)	California Survey	2
ARCA GIBBOSA, *Rve.*		1
— SOBRIA, *Gld.*	Rio Janeiro	1
— HOLOSERICA, *Rve.*	Aden	1
— LOBATA, *Rve.*	Hobson's Bay	1
SCAPHARCA LABRATA, *Sby.*	China	1
— RHOMBIA, *Bom.*		1
— PILULA, *Rve.*	Fiji	2
BYSSOARCA IMBRICATA, *Brug.*	do	1
— CUNEATA, *Rve.*	Zanzebar	1
— TRUNCATA, *Sby.*	Pacific	1
BARBATIA FUSCA, *Brug.*		2
— VIRESCENS, *Rve.*		1
— DIVARICATA, *Sby.* (broken)	Pacific	1
— SYMMETRICA, *Desh.*	Java seas	1
— DECUSSATA, *Sby.*		1
— ? MAGELLANIATA, *Lam.*	New Zealand	2
TRISIS TORTUOSA, *Ln.*	China	4
NOETIA REVERSA.	Central America	2
PECTUNCULUS TENUISCULPTUS, *Cpr.* (? v. GIGANTEUS)		2
— UNDULATUS, *Lam.*	Rio Negro	1
— ASPEROSUS, *A. Ad.*	Hakodadi	1
— PECTENIFORMIS, *Lam.*	East Indies	1

NAME.	LOCALITY.	No.
PECTUNCULUS SUBOBSOLETUS	Vancouver	4
— SCRIPTUS, *Lam.*	North Africa	3
— HOLOSERICA, *Rve.*	New Zealand	1
— PERTUSUS, *Rve.*		1
— MACULATUS	St. Lucas	1
LEDA CŒLATA, *Hds.*	California Survey	1
UNIO VERECUNDUS, *Gld.*	Manilla	1
— LUTULENTUS, *Gld.*	New Zealand	1
— MENGIERII, *Grey* (broken)	do	1
— LUTULENTUS, *Gld.*		3
MARGARITANA MARGARITIFERA, *Lin.*	Oregon District	1
ANODONTA (GONIDEA) ANGUSTATA, *Lea.*	Sacramento R.	1
— ANGULATA, *Lea.*	Oregon District	1
— OREGONENSIS, *Lea.*	do	1
— WILLAMETTENSIS, *Lea.*	do	3
CHAMA OBLIQUATA, *Rve.*		1
— EXOGYRA, *Con.*	San Diego	2
— CARDELIFORMIS, *Rve.*		1
— ? LIMBULA, *Lam.*		2
— PELLUCIDA, *Brad.*	Chili	1
— ECHINATA	St. Lucas	1
— REFLEXA, *Rve.*	Singapoor	2
— CORRUGATA	St. Lucas	1
— JENKESII, *Rve.*		1
— PELLUCIDA, *Rve.*	Sta. Barbara	1
CARDIUM CORBIS, *Morh.*	Vancouver	2
— GREENLANDICUM	Puget Sound	2
— SUBRUGOSUM, *Sby.*		1
— CONSORS	St. Lucas	1
— BLANDUM, *Gld.*	Str. of St. Fuca	2
— RUGOSUM, *Lam.*		1
— BIRADIATUM, *Brug. Phil. ?*		1
LÆVICARDIUM AUSTRALE, *Sby.*		1
— PALLIDUM, *Rve.*	Australia	1
— APICIUM	St. Lucas	2
— LYRATUM, *Sby.*	Zanzebar	2
— SUBSTRICTUM, *Con.*	San Diego	1
HEMICARDIA CARDISSA, *Lin.* v. MONSTROSA, *Chem.*		1
— FRAGRANS, *Linn.*		1
— SUBRETUSA, *Sby.*		1
— TRIANGULATA	Panama	1
LUCINA COLUMBELLA, *Lam.*	Gambia	1
— EBURNEA, *Rve.*	St. Lucas	2
— LINGUALIS	do	2
— (CODAKIA) RAMULOSA, *Gld.*	Penmatoo Island	2
— (LORIPES) VESICULA, *Gld.*	Tongalatoo	1
— (DIPLODONTA) INCULTA (1 v. broken)	New Zealand	2

NAME.	LOCALITY.	No.
CODAKIA PUNCTATA, *Lin.*	Fiji	2
— INTERRUPTA, *Lam.*	do	1
LORIPES TUMIDA, *Rve.*	Loo Choo	1
— PHILIPPINARIUM, *Rve.*		1
DIPLODONTA CALCULUS, *Rve.*		1
— ORBELLA, *Gld.*		1
KELLIA LAPEROUSSII	Vancouver	2
CORBICULA CUMINGSII, *Desh.*	Japan	1
— CRASSULA, *Mons.*	Hong Kong	1
— SQUALIDA, *Desh.*	India	1
— ORIENTALIS, *Lam.*	Hong Kong	1
FISHERIA DELESSERTII, *Bern.*	West Africa	1
CIRCE ELLIPTICUS, *Sby.*	Akaba	2
— GIBBA, *Lam.*		3
— PECTINATA, *Lam.*		2
— SCRIPTA, *Lin.*		1
— DIVARICATA, *Chem.*	Indian Ocean	1
— DISPAR		2
— HEMIFACTA, *Sby.*	Akaba	1
— (LIOCONCHA) PICTA, *Lam.* (broken)		2
CRASSATELLA NANA, *Ad. & Rve.*		2
— VARIANS, *Cpr.*	Cape St. Lucas	1
VENERICARDIA, var. VENTRICOSA, *Gld.*		2
MIODON PROLONGATUS, *Cpr.*	Vancouver	2
VENUS PLICATA, *Chem.*	West Africa	1
— DOMBEYI, *Lam.*	Chili	1
— COSTELLATA, *Sby.* (badly injured)		2
— ASTARTEA, *Midd.*	Vancouver	1
— CRASSICOSTA, *Quoy.*	New Zealand	1
PSEPHIS LORDI, *Baird.*	California	2
— TANTILLA, *Gld.*		2
ANOMALOCARDIA MACRODON, *Desh.*	Rio Janeiro	1
— IMPRESSA, *Hanl.*	China	1
— ROSTRATA, *Sby.*		1
— SUBIMBRICATA	St. Lucas	1
— SQUAMOSA, *Lin.*		2
CHIONE SIMILLIMA, *Sby.* (? young)	California Survey	1
— NEGLECTA	St. Lucas	2
— STRICHBURGI, *Gray.*	New Zealand	1
— COCHINENSIS		1
— MESODERMA, *Quoy.*	New Zealand	4
— CALLOSA, V. FLUCTIFRAGA	California Survey	2
— CALLOPHYLLA, *Hanl.*	China	1
— ALTA, *Sby.*		1
— NUTTALI, *Con.*	California Survey	2
SAXIDOMUS NUTTALI	do	2
— OPACA, *Sby.*	Chili	1

NAME.	LOCALITY	No.
SAXIDOMUS SQUALIDUS, *Desh.*	Vancouver	2
CYTHEREA LEUCOSIA, *Lam.*		2
— PETECHIALIS, *Lam.*	Japan	1
— MORPHINA	Ceylon	1
— ZONATA		1
— CASTA, *Lam.* (young)		1
SUNETTA VAGINALIS, *Hanl.*	Cochin China	1
CALLISTA CITRINA, *Lam.*		3
— PUELLA	St. Lucas	several.
— PRORA, *Con.*	Kingsmill Island	2
— STRIATA, *Gray.*	Cape Palmas	1
— FORMOSA, *Sby.*	Peru	2
— INFLATA (broken)		1
— VULNERATA, *Brad.*	St. Lucas	2
— AFRICANA, *Gray.*	Sierra Leone	1
— (AMIANTIS) CALLOSA, *Con.*	Vancouver	1
TRIGONA CRASSATELLOIDES, *Con.*	Sta. Barbara	2
— (PACHYDUSA) CRASSATELLOIDES, *Con.*	California Survey	2
— NITIDULA, *Sby.*	St. Lucas	--
DOSINIA CURATA, *Rve.* (broken)	New Zealand	2
— AFRICANUS, *Gray.*	Cape Palmas	1
— PONDEROSA	St. Lucas	2
TAPES INFLEXA, *Gray.*	New Zealand	1
— STAMINEA, *Con.*	California Survey	2
— GEOGRAPHICA, *Chem.*	Australia	1
— PHILIPPINARIUM (1 v. broken)	Hakodada	2
— STAMINEA, var. DIOCŒSA, *Sby.*	California Survey	1
— JAPONICA, *Gmel.*		1
— RIMULARIS, *Lam.*		1
— STAMINEA var. PETITII, *Desh.*	Vancouver	2
— QUADRADIATUS, *Desh.*		2
— FLAMMULATA, *Lam.*		2
— TURGIDULA, *Desh.* (broken)	New Zealand	1
— INDICA, *Hanl.*		3
— — var. VARIEGATA	Japan	3
— STAMINEA, var. NUDATA, *Desh.*	Vancouver	4
— TUMIDA	do	1
— CORRUGATA, *Gmel.*	New Zealand	1
— SULCARIA, *Lam.*		1
— RIMOSA, *Phil*		1
— STAMINEA, var. ARBELLA	Vancouver	3
— — var. PETITII	do	3
— TENERRIMA, *Cpr.* (broken)	California Survey	1
PETRICOLA FORNICATA, *Sby.*	Patagonia	1½
— CALIFORNICA, *Con.*	California	3
RUPELLARIA CORRUGATA, *Desh.* (crushed)	Cape Good Hope	1
MACTRA POLITA, *Chem.*	Red Sea	1

NAME.	LOCALITY.	No.
MACTRELLA FRAGILIS, *C. S. Z.*	Cape St. Lucas	1
STANDELLA CALIFORNICA, *Con.* (badly broken)	Sta. Barb. I., Cal. Sur.	2
— PLANULATA, *Con.* (broken)	California Survey	1
SCHIZOTHŒRUS NUTTALI, *Con.*	Shoal-water Bay	1
TELLINA LATIROSTRA, *Lam.*	Ceylon	1
— LITHONIA, *Gld.*	Fiji	1
— CRUCIATA, *Spreng.*		1
— INCERTA, *Desh.*		1
— JUBAR, *Hanl.*		1
— MARGINALIS, *Dillw.* (1 broken)		2
— STAURELLA, *Lam.*		1
— EXILIS, *Lam.*		2
— STRIGOSA, *Gmel.* (crushed)	Gambia	1
— CONCENTRICA, *Gld.*	Singapoor	2
— VULSELLA, *Chem.* (crushed)	Ceylon	2
— OSTRACEA, *Lam.* (broken)		1
— PUNICEA, *A.*	Acapulco	2
— BLAINVILLEI, *Desh.*	Singapoor	1
— RUGOSA, *Lam.* (broken)	Loo Choo	2
— VIRGATA, *Ln.* (1 v. broken)		2
— (MACALIA) BRUGUIEREI, *Hanl.*	Singapoor	1
— (ARCOPAGIA) DISCULUS, *Desh.*	New Zealand	1
— (PERONÆA) DISPAR, *Con.* (1 v. broken)	Sandwich Islands	3
— — BODEGENSIS, *Hds.*	Vancouver	1
(TELLINA) MŒRA SALMONEA, *Cpr.*	do	3
TELLINIDES PURPUREUS, *Rve.*	Acapulco	1
ANGULUS OBTUSUS, *Cpr.*	Vancouver	2
STRIGILLA CARNEAREA, V. FURCATA	Acapulco	2
— ACROCULEA, *Phil.*		1
SANGUINOLARIA NUTTALII	San Diego	1
ASAPHIS DEFLORATA, *Lin.* (DICHOTOMA, *Anton*)		2
ASAPHIS DEFLORATA, *Lin.* (VIOLACEA) *Vorsk.*		2
PSAMMOBIA SOLIDA, *Rve.*	Pacific	2
— VARIEGATA, *Wood.*	Fiji	2
— RUBRARADIATA, *Nutt.* (broken)	Vancouver	2
— CONVEXA, *Rve.* (broken)	New Zealand	1
SOLETELLINA LIVIDA, *Lam.*	Hong Kong	1
— TUMERA, *Desh.*		1
— ADAMSII, *Desh.*	China	1
MACOMA RECTA, var. EDULIS, *Nutt.*	Vancouver	1
— INEQUINATA, *Desh.*	do	1
— CAYENNENSIS, *Lam.* (broken)	Rio Janeiro	2
— INDENTA, *Cpr.*	California Survey	1
— ? OBLONGA, var.	Rio Janeiro	1
— INCONSPICUA, var.	Vancouver	2
— — *Brod.* and variety		3
— NASUTA, *Con.*	San Francisco	1

NAME.	LOCALITY.	No.
SEMELE SUBTRUNCATA, *Sby.*	Rio Janeiro	3
— CORRUGATA, *Brod.*	Callao	1
— DECISA	California Survey	1
CUMINGIA CALIFORNICA, *Con*	do	2
SCROBICULARIA ALTA, *Con.*	do	1
— (CAPSA) LACUNOSA, *Chem.* (broken)	Singapoor	1
MESODESMA NOVAZEALANDICA, *Chem.*	New Zealand	1
ANAPA CUNEATA, *Desh.*	Fiji	3
ERYCINA (PAPHIA) CUNEATA, *Desh.*	New Zealand	1
— — GLABRATA, *Gmel.*		2
— — STRIATA, *Gmel.*		1
DONAX SERRA, *Chem.*	Cape Good Hope	1
— FLEXUOSA	Sta. Barbara	2
— ASPERA	Humboldt Bay	2
— CUNEATUS, *Lin.*	Ceylon	2
— CALIFORNICUS, *Con.*	California Survey	2
— SCORTUM, *Lin.*	Cape Good Hope	1
— PALLIDA, *Gld.* var.	Singapoor	2
— — —	do	2
— TINCTUS, *Gld.*	Fiji	2
— CŒLATUS, var.	Acapulco	2
— RUGOSUS, *Lin.*	Cape Palmas	1
HETERODONAX BIMACULATUS, var.	California Survey	2
— — var.	Acapulco	1
GALATEA RADIATA, *Lam.*	West Africa	1
AZARA FASCIATA, *Hds.*		1
SOLEN BREVIS, *Gray.*	China	1
SOLECURTUS DOMBEYI, *Lam.*	Callao	--
— RUFUS, *Bosh.*	Chili	1
— GIBBA, *Spengl.*	Gambia	1
— CALIFORNICUS, *Con.*	California Survey	1
— SUBTILIS, *Con.*	do	2
NOVACULINA SANGETICA, *Bens.*	Ganges	2
MACHÆRA (without labels and 1 broken)		2
MYA TRUNCATA (=M. PRÆCISA, *Gld.*)	Puget Sound	1
PLATYODON CANCELLATUS, *Con.*	California Survey	1
CRYPTOMYA CALIFORNICA, *Con.*	California	1
CORBULA LUTEA, *Cpr.*		1
— CRASSA, *Hds.*	Hong Kong	1
— OVULATA	Acapulco	2
PANOPEA GENEROSA, *Gld.* (broken)	California	1
(PANDORA) KENNERLIA FILOSA, *Cpr.*	Puget Sound	1
SAXICAVA PURPURASCENS, *Sby.*	Orange Harbor	2
— PHOLADIS, *Lin.* var.	Vancouver	4
LYONSIA CALIFORNICA, *Con.* (1 crushed)	California Survey	2
— (ENTODESMA) SAXICOLA, *Baird* (1 broken)	Vancouver	4
BARNEA SIMILIS, *Gray.*	New Zealand	2

NAME.	LOCALITY.	No.
Pholadidea penita, *Con.*	California 1,	2
— ovoidea, *Gld.* (fragment in rock)	California Survey	--
Gaimardia trapezina, *Lam.* (1 broken)	Terra del Fuego	2
Bryophila setosa, *Cpr.*	Cape St. Lucas	2

BRACHIOPODA.

Terebratula unguicula, *Cpr.*		1
Terebratella rubicunda, *Sel.*	New Zealand	1
— chilensis	Patagonia	1
— pulvinata		2
Eudesia grayii	Hakodadi	1
Lingula murphiana	Fiji	1
— anatina, *Lam.*		1
Discina lamellosa, *Brod.*	Callao	4
Waldheimia globosa, *Lam.*	Orange Harbor	1

Multivalves.

Tonicia lineata, *Wood.*	Puget Sound	2
Ischnochiton interstinctus, *Gld.*	Vancouver	1
— parallelus, *Xantus*	Cape St. Lucas	1
Mopalia grayi	Vancouver	2
— hindsii, *Sby.*	do	1
— merckii, *Midd.*	do	1
— grayi, var. swansii.		--
— muscosa, *Gld.*	Vancouver	1
Katharina truncata, *Sby.*		1
Acanthopleura scabra, *Rve.*	California Survey	1

GASTEROPODA.

Strombus epidromus		1
— urceus, *Lin.*		2
— vittatus		1
— floridus, *Lam.*	Akaba	2
— dentatus, *Lin.*		1
— — var.	Akaba	2
— canarium	Ceylon	1
— tricolor	Akaba	1
— fasciatus, *Gmel.*		1
Strombina maculosa	Cape St. Lucas	1
Murex tenuispina, *Lam.*		1
— (Muricidea) capucina, *Lam.*		1
Cerastoma foliatum, *Gmel.*	Vancouver	2
— nuttali, *Con.*	California Survey	1
Pteronotus senegalensis	Rio Janeiro	1
Pisania sanguinolenta, *Ducl.* var.	Cape St. Lucas	2
— rustica, *Rve*		2

NAME.	LOCALITY.	No.
Pisania variegata, *Gray.*	Rio Janeiro	1
— (Cantharus) d'orbignyi, *Rve.*	Callao	1
— — marmorata, *Rve.*		1
— — proteus, *Rve.*		2
— — undosus, *Lin.*		2
— — tranguebarica, *Mart.*		1
— — proteus, *Rve.*		1
— — variegata, *Gray.*	Cape de Verde Is	1
Euthria lineata, *Chem.*	New Zealand	1
— litorinoides, *Rve.*	do	2
— cingulata, *Rve.*	Loo Choo	1
— ferrea, *Rve.*	Orange Harbor	3
— lutea. *Gld.*	Kikaia	1
Ranella californica, *Hds.*	Cerros Island	1
— cruentala		1
— livida, *Rve.*		2
— tuberculata, *Brod.*		1
— gyrina, *Lin.*		1
— affinis, *Brod.*		1
Triton rubiculum, *Lin.*		2
— sinense, *Rve.*	China	1
— gemmatus, *Rve.*	Sandwich Islands	1
— brazilianum, *Gld.*	Rio Janeiro	1
— mundum, *Gld.*	Sandwich Islands	1
Distortio canaliculatus, *Lam.*	Ceylon	1
Trichotropis cancellatus, *Hds.*	Vancouver	1
Latirus picta, *Rve.*		1
— polygonus, *Lin.*		1
— prismaticus, *Mart.*		1
— craticulatus, *Lin.*		1
Siphonalia modificata, *Rve.*	La Pury	1
Ficula ventricosa, *Sby.*	Cape St. Lucas	1
— lævigata, *Rve.*		1
Pyrula galeroides, *Lam.*		1
Fusus annulatus, *Gld.*	Vanalopes Island	1
Trophon geversianus, *Pal.* v. philippinarium	Orange Harbor	1
— geversianus, *Pal.*	do	2
— — var. ambiguus	do	2
— pallidus, *Sby.*		1
— fimbriatus	Hong Kong	1
— orpheus, *Gld.*	Puget Sound	1
— multicostatus, *Esch.*	Vancouver	1
— laciniatus, *Mart.*	Orange Bay	1
Chrysodomus dirus, *Rve.*	Vancouver	2
Peristernia spinosa, *Mart.*		2
— nassatula, *Lam.*		1
— scabrosa, *Rve.*		1

NAME.	LOCALITY.	No.
PERISTERNIA CROCEA, *Gld.*		2
— NEWCOMBII (typical)		2
— — *A. Ad.*		2
— INCARNATA, *Desh.*		1
BUCCINUM (COMINELLA) FUNEREUM, *Gld.*	New Zealand	2
ARGOBUCCINUM OREGONENSE, *Redf.*	Vancouver	2
— RUDE, *Brod.*	Chili	1
? COMINELLA WAHLBERGI, *Kien.*	Cape Good Hope	3
COMINELLA LINEOLATA, *Lam.*	New Zealand	1
— COSTATA, *Quoy.*	Australia ?	1
— MACULATA, *Mart.*	New Zealand	1
— SUTURALIS, *A. Ad.*	Australia	1
— TESTUDINEA, *Mart.*	Cape Good Hope	1
— ALVEOLATA, *Kien.*	Australia	1
— LAGENARIA	Cape Good Hope	4
OCINEBRA LURIDA, *Midd.*	Vancouver	5
— — var. ASPERA	do	2
— — var. NUNDA	do	3
— INTERFOSSA, *Cpr.* var.	do	2
— — *Cpr.*	do	2
EPIDROMUS QUOYII, *Rve.*	Australia	1
— DIGITALIS, *Rve.*		1
— BRACTEATUS, *Hds.*		2
"? TRUNCARIA" CORRUGATA, *Rve.*	Vancouver	12
BULLIA GLOBULOSA, *Kein.*	Rio Negro	1
— GRADATA, *Desh.*	South Africa	1
— SEMINIFLAMMEA, *Rve.*	Cape Good Hope	1
— ARMATA, *Gray.*	Rio Negro	1
— LÆVIGATA, *Mart.*	S. G. Hope	1
— SQUALIDA, *King.*	N. Negro	1
— MAURITIANA, *Gray.*	Port Natal	1
PSEUDOSTROMBUS MALABARICUS, *Han.*		1
— VITTATUS, *Lin.*	Ceylon	1
TEREBRA CINGULIFERA, *Lam.*		1
— BABYLONICA, *Lam.*		2
— PEASEI, *Desh.*	Sandwich Islands	2
MYURELLA VARIEGATA	Cape St. Lucas	1
— JEWETTII, var.	Cerros Island	1
— CANCELLATUS, *Quoy.*	Mangee	1
— UNDULATA, *Gray.*		1
— BELCHERI, *Phil.*		1
— COPULA, *Hds.*		1
SUBULA DUPLICATA, *Lam.*		2
— PLICATELLA, *Desh.*		1
— STRIGELLATA, *Lam.*		1
— CÆRULESCENS, *Lam.*		2
— INCONSTANS, *Hds.*	Sandwich Islands	3

NAME.	LOCALITY.	No.
Subula senegalensis, *Lam.*	Gambia	7
— (Myarella) affinis		7
— chlorata, *Lam.*		1
— casta, *Hds.*		1
Mesalia subplanata, var	Nerah Bay	1
Nassa hirta, *Kien.*	Sandwich Islands	5
— antillaria, *Phil.*	Rio Janeiro	2
— thersites, *Brug.*	Hong Kong	1
— bronnii, *Phil.*		1
— tegula, var.	California Survey	2
— granifer, *Kien.*		1
— speciosa, *A. Ad.*	Cape Good Hope	1
— dentifer, *Rens.*	Callao	3
— albescens, *Dk.*		4
— canaliculata, *Lam.*		1
— cooperi, *Fb.*	California Survey	1
— coronata, *Brug.*		1
— crenulata, *Brug.*		1
— globosa, *Quoy.*		1
— lurida, *Gld.*	Samoa Island	1
— mendica, *Gld.*	Vancouver	3
— monila, *Kien.*		2
— nodata, *Hds.*		2
— nodifera, *Penn.*		1
— olivacea, *Brug.*	Australia	1
— perpinguis	California Survey	1
— rubricata, *Gould.*	Callao	2
— subspinosa, *Lam.*		1
— venusta, *Dk.*		4
Phos exilis, *Powis.*	Panama	2
Purpura aperta, *Lam.* var.	Sandwich Islands	1
— blainvillei, *Desh.*	Peru	2
— — *Desh.* var.	do	2
— canaliculata, *Ducl.*	Vancouver	2
— crispata, *Chem.*		22
— deltoidea, *Lam.*	Ceylon	1
— elongata, *Quoy.*	Sandwich Islands	1
— emarginata, var. saxicola	California Survey	1
— hæmastoma, *Linn.*	Brazil	1
— — *Linn.*	Madeira	1
— — *Linn.* var.	do	1
— haustrum, *Mart.*	New Zealand	1
— harpa, *Con.*	Sandwich Islands	1
— intermedia, *Kien.* var.		1
— laxicolor, var. fuscata, *Fbs.*	California Survey	3
— luteostoma, *Chem.*	Loo Choo	2
— mancinella, *Lam.*		1

NAME.	LOCALITY.	No.
PURPURA NERITOIDEA, *Lin.*	Cape de Verde	1
— NUX, *Rve.*	Cape Good Hope	1
— PLANISPIRA, *Lam.*	Socoro Island	1
— OSTRINA, *Gld.*	Puget Sound	2
— SAXICOLA, *Val.*		13
— SCOBINATA, *Quoy.*	New Zealand	2
— SQUAMOSA, *Lam.*	Cape Good Hope	1
— SUCCINCTA, *Ducl.*	Vancouver	2
— TEXTILOSA, *Lam.*	New Zealand	1
— FREYCINETII, *Desh.*	Niphon	1
MONOCERAS EUGONATUM, *Con.*	California Survey	1
— LAPILLOIDES, *Con.*	do	1
— LUGUBRA, *Sby.*	Guaymas	1
— — *Sby.* var.	Margarita 3,	1
CHORUS BELCHERI, *Hds.*	California Survey	1
— VIBEX, *Brod.*	Callao	1
— XANTHOSTOMA, *Brod.*	Chili	1
RHIZOCHEILUS CALIFORNICUS, *A. Ad.*	Cape St. Lucas	1
— VIOLACEUS, *Kien.*	Sandwich Islands	1
SISTRUM AFFINIS, *Rve.*		1
— ANAXARES, *Ducl.*		1
— ASPERATUM, *Lam.*		1
— CARBONARIUM, *Rve.*		2
— OCHROSTOMA, *Rve.*	Gallapagos	1
— — var. RUFONOTATA	Cape St. Lucas	1
— CONCATENATUM, *Blain.*		3
— DECUSSATUM, *Rve.*		1
— ELONGATUM, *Blain.*		1
— FISCELLUM, *Chem.*		1
— MARGARITICOLA, *Brod.*		4
— MORUS, *Lam.*		2
— PORPHYROSTOMA, *Rve.*		1
— SCROBICULATUM, *Dk.*	Cape Good Hope	1
— SPECTRUM, *Rve.*		2
— TUBERCULATUM, *Blain.*		6+1
— UNIFACIALIS, *Lam.* var.		1
CUMA IMPERIALIS, *Blain.*	Singapoor	1
— MURICINA, *Blain.*		1
— SABELLUM, *Lam.*		1
— TRIGONA, *Rve.*		1
MURICIDEA DUBIA	Acapulco	1
VITULARIA CRASSILABRA, *Gray.*	Chili	2
— SANDWICHENSIS, *Pease*		1
RICINULA ARACHNOIDES, *Lam.* var.		1
— CLATHRATA, *Lam.*		1
— DIGITATA, *Lam.*		1
— ELEGANS, *Lam.*		1

NAME.	LOCALITY.	No.
BEZOARDICA ABREVIATA, *Blain.*	Cape St. Lucas	1
— PILA, *Rve.*		2
LEVENIA COARCTATA	Cape St. Lucas	1
COLUMBELLA BACCATA, *Gask.*	do	1
— CARINATA, *Hds.*	California Survey	3
— FESTINA, *Kien.*	Cape St. Lucas	2
— FURCATA, *Sby.*	do	3
— HÆMASTOMA, *Sby.*	do	1
— HINDSII, *Gask.* var. CARINATA	California Survey	3
— MILLEPUNCTATA	Cape St. Lucas	1
— REEVEI, *Cpr.*	do	1
— SOLIDULA, *Rve.*	do	1
EUGINA ASTRICTA, *Rve.*		4
— FORTICOSTA, *Rve.*	Cape St. Lucas	1
— FULGURANS, *Lam.*		14
— LAUTA, *Rve.*		2
— LINEATA, *Rve.*		1
— MENDICARIA, *Lam.*		7
— OCELLATA, *Rve.*		2
— TRIFACIATA, *Rve.*		1
— ZONATA, *Rve.*		2
AMYCLA (COLUMBELLA) CHRYSALOIDES, *Cpr.*	California Survey	1
— ? CORONATA	Cerros Island	1
— GAUSAPATA, *Gld.*		4
— TUBEROSA, (fossil)	Sta. Barbara	1
NITIDELLA CREBRARIA, *Lam.*	Cape St. Lucas	2
— GOULDII, *Cpr.*	Vancouver	2
OLIVA BULLIFORMIS, *Ducl.*		1
— DUCLOSI, *Rve.*		2
— ELEGANS, *Lam.*		3
— — *Lam.* (dwarf. var.)		4
— FLAMMULATA, *Lam.*	West Africa	1
— INFLATA, *Lam.*		1
— — *Lam.* (dwarf var.)		1
— HISPIDULA, *Lin.*		3
— JULIETTA, *Ducl.*	Guacomayo	1
— MUSTELLINA, *Lam.*		1
— — *Lam.* var.		2
— PICTA, *Rve.*		1
— SUBANGULATA, *Phil.*	Cape St. Lucas	2
— (UTRICULINA) GIBBOSA, *Born.*		1
— — NEBULOSA, *Lam.*	West Africa	1
— — — *Lam.* var.	do	1
— — SUBULATA, *Lam.*	do	2
OLIVELLA ANAZORA	St. Lucas	1
— BÆTICA, *Cpr.*	California	5
— BIPLICATA, *Sby.*	do	2

NAME.	LOCALITY.	No.
OLIVELLA BIPLICATA, *Sby.* (fossil)	California	1
— GRACILIS, *Gray.*	St. Lucas	8
— — *Gray.* var.	do	7
AGARONIA HIATULA, *Lam.*	West Africa	2
TEREBELLUM SUBULATUM, *Lam.*		1
CONUS ABREVIATUS, *Jay.*		1
— ADANSONII, *Rve.*		1
— ARISTOPHANIS, *Ducl.*		2
— CALIFORNICUS, *Hds.*	California Survey	1
— CANONICUS, *Brug.*		1
— CAPITANEUS (jun.), *Lin.*		1
— CATUS, *Brug.*		2
— CIRCÆA, *Chem.*		1
— CINEREUS, *Rump.*		1
— COLUMBA, *Brug.*		1
— ELEGANS		1
— EPISCOPUS, *Lam.*		1
— ERMINEUS, *Born.*		1
— FUGULINUS, *Lin.*		1
— GABRIELLA, *Kr.*		1
— GUBERNATOR, *Kr.*		1
— GUINIACUS, *Chem.*		1
— HEBRÆUS, *Linn.*		1
— INTERRUPTUS, *Brod.*	Cape St. Lucas	1
— MAGUS, *Lin.*		1
— MINIMUS, *Lin.* var.		1
— MIMUS, *Lin.*		2
— MILIARIS, *Brug.*		3
— MUSICUS, *Brug.*		2
— NISUS, var.		1
— NUSSATELLA, *Lin.*		1
— PAPILIONACEUS, *Brug.*	Cape Palmas	1
— PLENATUS, *Bom.*		1
— PULCHELLUS, *Swain.*		1
— PUSILLUS, *Gld.* var. NUX.		1
— RADIATUS, *Rve.*		1
— RETIFER		2
— SPONSALIS, *Brug.*		3
— TORNATUS, *Brod.*	Cape St. Lucas	1
— VERRICULUM, *Rve.*		1
— VERMICULATUS, *Lam.*		1
— VINCTUS, *A. Ad.*		1
META CEDONULLI	Cape St. Lucas	1
PLEUROTOMA BABYLONICA, *Lin.*		1
— CARINATA, *Gray.*		1
— GEMMATA, *Hds.*		1
— GAMONSII, *Rve.*		2

NAME.	LOCALITY.	No.
PLEUROTOMA NODIFERA, *Lam.*		1
— UCOTROPSIS, *Ad. & Rve.*		1
— TUBERCULATA, *Gray.*	Hong Kong	1
CLIONELLA BUCCINOIDES, *Lam.*		1
— SEMICOSTATA, *Kien.*	Cape Good Hope	1
MANGELIA LEVIDENSIS, *Cpr.*	Neeah Bay	1
— INTERFOSSA, *Cpr.*	do	1
— TABULATA, *Cpr.*	do	1
DRILLIA ABREVIATA, *Rve.*		1
— BIJUBATA, *Rve.*		1
— DIGITALIS, *Rve.*		1
— INCISA, *Cpr.*		1
— INERMIS, *Hds.*	California Survey	1
— TOROSA, var. AURANTICA	San Diego	1
— MŒSTA, *Cpr.*	California Survey	1
— VIDUA, *Rve.*		1
CYMBIOLA BRASILIANA, *Sol.*	Brazil	1
ZIDONA ANGULATA, *Sol.*	do	1
SCAPHELLA ELONGATA, *Swain.*	New Zealand	1
MITRA CARDINALIS, *Gron.*		1
— PONTIFICALIS, *Lam.*		1
— PROPINQUA, *Ad.*		1
— (CHRYSAME) CUCUMERIA, *Lam.*		1
— — TABANULA, *Lam.*		1
— — TELESCOPIUM, *Rve.*		1
— (CANCELLA) FILOSA, *Lam.*		1
— (NEBULARIA) ADUSTA, *Lam.*		1
— — BADIA, *Rve.*		1
— — CHRYSOSTOMA, *Swain.*		1
— — DIGNA, *A. Ad.*		1
— — FERRUGINEA, *Lam.*		1
— — NITILINA, *Ducl.*		1
— — TICARONICA, *Rve.*		2
— (SCABRICOLA) SPHÆRULATA, *Mart.*		1
TURRICULA CORRUGATA, *Lam.*		1
— MELONGENA, *Lam.*		1
— PLICATA, *Lam.*		1
— VULPERULA, *Lam.*		2
— (CALLITHEA) PHILIPPINARUM		1
— — STIGMATARIA, *Lam.*		1
— (COSTELLARIA) ARMILLATA, *Rve.*	West Africa	1
— — CRUENTATA, *Rve.*		3
— — EXASPERATA, *Desh.*		2?
— (PUSIA) AMABILIS, *Rve.*		1
— — BUCCULENTA, *Rve.*		1
— — CONSANGUINEA, *Rve.*		1
— — CREMANS, *Rve.*		1

NAME.	*LOCALITY.*	*No.*
TURRICULA (PUSIA) LEUCODESMA, *Rve.*		2
— — NODOSA, *Rve.*		1
— — PORPHYRITICA, *Rve.*		1
STRIGATELLA AMPHORELLA, *Lam.*		1
— LIMBIFERA, *Lam.*		1
— LITERATA, *Lam.*		3
— PERONII, *Kien.*		1
— RETUSA, *Rve.*		1
— UNIFASCIATA, *Lam.*		2
— VIRGATA, *Rve.*		1
IMBRICARIA CONICA, *Schum.*		1
VOLVARINA VARICA, *Sby.*	California Survey	1
MARGINELLA REGULARIS, *Cpr.*	Sta. Barbara	1
CYPRÆA ADUSTA, *Lam.*		1
— CICERCULA, *Lin.*		2
— CLANDESTINA, *Lin.*		1
— CAURICA, *Lin.*		2
— CRIBRARIA, *Lin.*		1
— CUMINGII		1
— CYLINDRICA, *Born.*		1
— DILUCULA, *Rve.*		1
— ERRONES, *Lin.*		2
— FLAVEOLA, *Lam.*		4
— HELVOLA, *Lin.*	Sandwich Islands	1
— — *Lin.*		3
— HIRUNDA, *Lin.*		1
— INSECTA, *Migh.*		1
— INTERRUPTA, *Guy*		1
— IRRORATA, *Gray.*	Sandwich Islands	1
— ISABELLA, *Lin.*		3
— MADAGASCARENSIS, *Gmel.*	Sandwich Islands	1
— MILIARIS, *Lam.*		1
— MUS, *Lin.*	West Africa	5
— NEGLECTA, *Gray.*		3
— NUCLEUS, *Lin.*		2
— OCELLATA *Lin.*	Ceylon	1
— OCELLUS, *Lin.*		3
— PANTHERINA, *Sol.*		1
— PORARIA, *Lin.*		1
— PUNCTATA, *Lin.*		1
— SEMIPOLITA, *Migh.*	Sandwich Islands	1
— STAPHYLEA, *Lin.*	Ceylon	2
— — *Lin.* var.		3
— SULCIODENTATA		1
— TABESCENS, *Gray.*		3
— TURDUS, *Lam.*	Akaba	1
— TREMEZA, *Ducl.*		1

NAME.	LOCALITY.	No.
CYPRÆA VIRESCENS, *Schum.*		1
LUPONIA ALBUGINOSA, *Gray.*	Cape St. Lucas	1
— SOWERBYI	do	1
TRIVIA CALIFORNICA, *Gray.*	California Survey	1
— CANDIDULA, *Gask.*		1
— SCABRIUSCULA, *Gray.*		3
PERSICULA CORNEA, *Lam.*	Gambia	1
— PHRYGIA, *Sby.*	Cape St. Lucas	1
ERATO SCABRIUSCULA	Acapulco	1
NATICA CATENATA, *Phil.*	Cape St. Lucas	5
— CHINENSIS, *Lam.*		2
— CLAUSA, *Brod & Sow.*	Vancouver	1
— LABRELLA, *Lam.*	Gambia	1
— LINEATA, *Chem.*		1
— MAHEHENSIS, *Recl.*	Hong Kong	1
— MAROCEANA, *Chem.*	Gambia	1
— — *Chem.* var.		1
— — *Chem.* var.	Pacific Ocean	1
— SOLIDA, *Blain.*		1
— SPADICEA	Hong Kong	1
— STERCUS-MUSCARUM, *Chem.*		2
— VIOLACEA, *Sby.* (young)		1
— VITELLUS, *Lin.*		1
— ZONARIA, *Recl.*	Cape St. Lucas	1
POLINICES BIFACIATUS	do	1
— COLUMNARIS, *Recl.*		1
— CONICA, *Lam.*	Australia	1
— DUBIA, *Recl.*		1
— — *Recl.*	Patagonia	1
— EFFUSA, *Swain.*		1
— MAMILLA, *Lin.* var.	China Sea	1
— MAURAS, *Brug.*		1
— ? OTIS, var. FUSCA	Cape St. Lucas	1
— OTIS, var.	do	1
NATICELLA SEMIOIDES, *Recl.*	Sandwich Islands	1
NEVERITA CHEMNITZII, *Recl.*		1
— LAMARCKIANA, *Recl.*		1
— PATULA	Acapulco	1
— PETEVERIANA, *Recl.*		1
— — *Recl.* var.		1
— RECLUZIANA	California Survey	1
LUNATIA CASTANEA, *Lam.*		1
— LEWISII, *Gould*	Puget Sound	1
— PALLIDA, *Brod. & Row.*	Vancouver	1
— PLUMBEA, *Lam.*	New Zealand	1
AMPULLINA FLUCTUATA, *Sby.*		1
SIGARETUS CYMBA, *Mke.*	Peru	1

NAME.	LOCALITY.	No.
Velutina porrecta	Vancouver	1
Pyramidella mitralis, *A. Ad.*		1
Obeliscus maculosus, *Lam.*		1
— scitula, *A. Ad.*		1
— sulcatus, *Nutt.*		2
— terebellum, *Mull.*		1
— ventricosus *Quoy.*		1
Eulima micans, *Cpr.*	California Survey	1
Alaba supraliratus	Cape St. Lucas	1
Chemnitzia tennicula, *Gld.*	California Survey	1
Cerithium incisum, *Sby.*	do	1
— interruptum, *Mke.* v. gallopagosum		1
— interruptum, *Mke.*	Cape St. Lucas	2
— maculatum, *Kien.*	do	1
— stercus-muscarum, (jun)		2
— uncinatum, *Desh.*	Cape St. Lucas	1
Rhinoclavis vestagus, *Lin.*		3
Cerithidea albonodosa, *C.*	Guaymas	1
— sacrata, *Gld.*	California Survey	1
Bittium armillatum	do	1
— fastigiatum	Sta. Barbara	1
— filosum, *Gld.*	Vancouver	6
— ? — var. esuriens	do	2
— rugatum, (fossil)	do	1
Cerithiopsis columna	Neeah Bay	1
— purpurea	Sta. Barbara	1
— ? tuberculata	Neeah Bay	1
Struthiolaria inermis, *Sby.*	New Zealand	2
Melania (Tiara) bulbosa, *Gld.* (var. jun)	Oregon	2
— — cybele, *Gld.*	Fiji	2
— — — var.	Fiji	1
— plicifera, *Lea.*	Oregon	2
Turritella casperi, *Cpr.*	S. Pedro	1
— duplicata, *Lam.*	Aden	1
— baccillum, *Kien.*	Ceylon	1
— bicingulata. *Lam.*	Cape de Verd	2
— canalifera, *Lam.*	Cape Good Hope	2
— cingulata, *Sby.*	Chili	3
— rosea, *Quoy.*	New Zealand	2
— tigrina, *Kien.*	Cape St. Lucas	1
Cœcum cooperi, (label only)	California Survey	1
— crebricinctum	do	1
Serpulorbis squamigera, *Cpr.*	do	1
Scalaria clathratus, *Lin.*	Sandwich Islands	1
— indianorum, *Cpr.*	Vancouver	2
Opalia borealis, *Gld.*	do	5
Littorina philippii, var. penicellata, *Cpr.*	Cape St. Lucas	8

NAME.	LOCALITY.	No.
LITTORINA PLANAXIS, *Phil.*	California Survey	3
— PLENA, *Gld.* var.	do	3
— PULLATA, *Cpr.*	Cape St. Lucas	2
— SCUTULATA	Vancouver	3
— SITCHANA, *Phil.*	do	5
— — — var.	do	2
SOLARIUM GRANULATUM	Cape St. Lucas	1
LACUNA EXAQUATA, var.	Vancouver	1
— ? EFFUSA, var.	Neeah Bay	2
— PORRECTA, *Cpr.*	do	4
— SOLIDA, *Lam.*	Vancouver	8
— SOLIDULA, var. COMPACTA	Neeah Bay	1
— PORRECTA, *Cpr.*	do	4
— UNIFASCIATA, *Cpr.*	Sta. Barbara	2
— SOLIDULA, var. COMPACTA	Neeah Bay	1
RISSOA COMPACTA, *Cpr.*	do	1
RISSOINA FORTIS, *C. B. Ad.*	Cape St. Lucas	1
— STRIATA, *Mke.*	do	1
— FIRMATA, *C. B. Ad.*	do	1
TRUNCARIA EURYTOIDES, *Cpr.*	do	1
VALVATA SINCORA, *Say.*	Clear Lake, Cal.	2
NERITINA CHRYSOCOLLA, *Gld.*	Upola	6
TURBO SMARAGDUS, *Lin.* (2 opercula)	New Zealand	2
MARMOROSTOMA CORONATA, *Gmel.* (2 opercula)		1
— PORPHYRITES, *Gmel.*		2
— VERSICOLOR, *Rve.*		1
— UNDULATA, *Chem.*		1
AMYXA NIGER, *Gray.*	Chili	3
SENECTUS ARTICULATUS, *Rve.*		1
— TICARONICUS, *Rve.*		1
— RADIATUS, *Gmel.*		4
— SQUAMIGERUS	Acapulco	1
— SPINOSUS, *Chem.*		1
HOMALOPOMA SANGUINEUM, *Lin.*		5
PHASIANELLA COMPTA, *Gld.*	San Diego	1
— — var. ELATIOR	Sta. Barbara	2
— — var. PULLOIDES	San Diego	1
— — var. PUNCTULATA	Sta. Barbara	2
OCEANA HELIXINA, *Born.*	Cape Good Hope	1
CALLIOSTOMA ANNULATUM, *Martyn*	Vancouver	1
— CANALICULATUM, *Martyn*	do	1
— COSTATUM, *Martyn*	do	4
CHLOROSTOMA AUREOCINCTA, *Sby.*	California Survey	1
— FUNEBRALE, *A. Ad.*	Vancouver	2
— GALLINA, *Fbs.*	California Survey	1
OMPHALIUS BRUNNEUS, *A. Ad.*	Sta. Barbara	1
— CORONULATUS, *C. B. Ad.*	Cape St. Lucas	2

NAME.	*LOCALITY.*	*No.*
OMPHALIUS FUSCASCENS, *Phil.*	California Survey	1
CANTHARIS IRIS, *Gmel.*	New Zealand	1
TROCHUS PRUNUNUS, *Gld.*	Auckland Island	1
— (CANTHARIS) TEXTURATUS, *Gld.*	New Zealand	2
— (OSILINUS) COLUBRINUS, *Gld.*	Madeira	1
TRITONIS ACINOSUS, *Gld.*	New Zealand	1
MARGARITA LIRULATA, *Cpr.*	Neeah Bay	2
— PERSICA		1
— PUPILLA, *Gld.*	Vancouver	8
— TENUISCULPTA, *Cpr.* var.	Neeah Bay	1
GIBBULA SUCCINCTA	do	1
TROCHISCUS NORRISSII, *Sby.*	Ceros Island	2
BIVONIA COMPACTA, *Cpr.*	Neeah Bay	1
TECHIS FENESTRATUS, *Gmel.*	Sooloo	1
PHORCUS (GIBBULA) PULLIGO, *Mart.*	Vancouver	2
PACHYPOMA GIBBEROSUM, *Chem.*	do	1
POMAULAX UNDOSUS	Lower California	1
HALIOTIS ASININUS, *Lin.*		1
— CRACHERODII	California	2
— DECUSSATA, *Phil.*	Gambia	1
— DISCUS, *Rve.*	Japan	1
— KAMTCHATKANA, *Jon.*	Vancouver	1
— SPLENDIDUS		1
— RUFESCENS, *Swn.*		1
FISSURELLA CHILIENSIS, *Sby.*	Chili	1
— CRASSA, *Sby.*	do	1
— CUMINGII, *Rve.*	do	2
— LATA, *Sby.* var.	do	1
— LIMBATA, *Sby.*	do	1
— MAXIMA, *Sby.*	do	1
— MEXICANA, *Sby.*	do	1
— MICROTREMA	Cape St. Lucas	1
— OCCIDENS, *Gld.*	Callao	1
— ORIENS, *Sby.*	Chili	1
— — *Sby.* var.	do	1
— PERUVIANA, *Lam.*	Callao	2
— VERNA, *Gld.*	Cape de Verde	1
— VOLCANO, *Rve.*	California Survey	1
GLYPHIS ASPERA, *Esch.*	Puget Sound	3
PUNCTURELLA CUCULLATA, *Gld.*	Vancouver	1
— GALEATA, *Gld.*	Puget Sound	1
CREPIDULA ALUNEA *Sby.*	Vancouver	8
— LINGULATA, *Gld.* V. DORSATA, *Brod.*	do	3
— NAVICELLOIDES, *Nutt.*	do	3
— RUGOSA, *Nutt.*	California Survey	1
GALERUS FASTIGIATA, *Gld.*		1
CRUCIBULUM UMBRELLA (young)	Cape St. Lucas	1

NAME.	*LOCALITY.*	*No.*
HIPPONYX ANTIQUATUS, *Lin.*	California Survey	1
— BARBATUS	Cape St. Lucas	2
— CRANIOIDES, *Cpr.*	Vancouver	2
— TUMENS, *Cpr.*	California Survey	1
PATELLA ÆNEA, *Mart.*	Orange Harbor	1
— — *Mart.*	do	1
— AMUSSILATA, *Rve.*	Japan	1
— BARBATA, *Lin.*	Cape Good Hope	1
— CLYPEASTER, *Lin.*	Chili	1
— CONSPICUA, *Phil.*	Cape Good Hope	1
— DECORA, *Phil.*	New Zealand	2
— EXARATA, *Nutt.*	Sandwich Islands	2
— GRANULUS, *Lin.*	Cape Good Hope	1
— LUCTUOSA, *Gld.*	New Zealand	1
— LUGUBRIS, *Dkr.*	Cape de Verd	1
— MINIATA, *Lam.*	Cape Good Hope	1
— ORNATA, *Dwil.*	New Zealand	1
— PAMNOTENSIS, *Gld.*	Pacific Island	3
— PIPERATA, *Gld.*	Cape de Verd Island,	1
— SACCHARINA, *Linn.*	Fiji	3
— SAGITTATA, *Gld.*	Fiji	8
— TALOSA, *Gld.*	Hawaii	1
— TRAMOSERICA, *Chem.*	Sydney Harbor	1
— VARIEGATA, *Rve.*	Hakodadi	1
— ZEBRA, *Rve.*	Australia	1
— (HELCION) PECTINATA, *Lin.*	Cape Good Hope	1
— (OLANA) COCHLEA, *Born.*	do	1
— (SCUTELLINA) CINNAMONEA		1
— (TECTURA) CYMBIOLA, *Gld.*	Valparaiso	3
NUCELLA INCESSA, *Hds.*	California Survey	1
— INSTABILIS, *Gld.*	Vancouver	2
— PALLEACEA, *Gld.* (label only)	Sta. Barbara	--
ACMÆA ARAUCANA, var. *D'Orb.*	Chili	5
— CANTHARUS, *Rve.*	Cape Good Hope	1
— CRIBRARIA, *Gld.*	Vancouver	1
— FLACCATA, var. PUNCTATA	Cape St. Lucas	1
— LEUCOPLEURA, *Gmel.*		1
— LIMBATA, *Phil.*	Australia	1
— PATINA, *Esch.*	Vancouver	3
— — var. SCUTUM, *Esch.*	do	5
— PELTA, *Esch.*	do	4
— PERSONA, *Esch.*	do	6
— — var. UMBONATA	California Survey	1
— — var. TEXTILIS, *Gld.*	do	1
— PIETREI, *D'Orb.*	Chili	5
— PSEUD-OREGONA	Orange Harbor	3
— SCABRA, *Nutt.*	Sta. Barbara	1

NAME.	*LOCALITY.*	*No.*
ACMÆA SCABRA, var. LIMATULA	California Survey	1
— SCUTUM, *D'Orb.*	Chili	3
— SPECTRUM, *Nutt.*	California Survey	3
— STRIGATELLA, *Cpr.*	Cape St. Lucas	2
— VARIABILIS, *Gray.*	Chili	1
— VIRIDULA, *Lam.*	do	7
— — var. *Lam.*	do	7
— — var. ZEBRINA, *Less.*	do	4
SCURRIA MITRA, *Esch.*	Vancouver	6
LOTTIA GIGANTEA, *Gray.*	California Survey	2
— ONYCHINA, *Gld.*	Rio Janeiro	1
SIPHONARIA ANTARCTICA, *Gld.*	Orange Harbor	1
— ? ÆQUILATERA, *Cpr.*	Cape St. Lucas	1
— CORNUTA, *Gld.*	Mangsi	3
— INCULTA, *Gld.*	New Zealand	1
— LATERALIS, *Gld.*	Orange Bay	1
— THERSITES, *Cpr.*	Vancouver	1
HELIX ARROSA	California	1
— AREOLATA	do	1
— DUPELITHONARSI	do	1
— TUDICULATA	do	1
— (AGLAIA) FIDELIS, *Gray.*	Oregon	1
— (ARIANTA) TOWNSENDIANA, *Lea.*	do	3
— — CALIFORNIENSIS, *Lea.*	California	1
NANIA (HEMIPLECTA) LURIDA, *Gld.*	Fiji	1
— — RUBRICATA, *Gld.*	Tutuilla	3
MACROCYCLIS NEWBERRYANA, *W. G. Binney*	California	1
— VANCOUVERENSIS, *Lea.*	Oregon District	1
BULIMUS (MESEMBRINUS) PALLIDIOR, *Sby.*	Cape St. Lucas	1
PHYSA VIRGINEA, *Gld.*	Sacramento River	1
— — (broken), *Gld.*	do	1
PLANORBIS (HELISOMA) CORPULENTUS, *Say.*	Columbia River	2
MELAMPUS OLIVACEUS	California Survey	1
HYALÆA GLOBULOSA, *Rang.*	Sandalwood Bay	1
HAMINEA VERSICULA, *Gld.*	Cape St. Lucas	1
TORNATELLA GLABRA, *Rve.*		1
— NITIDULA, *Lam.*		1
TORNATINA CEREALIS	San Diego	1
— EXIMIA, *Bd.*	Puget Sound	1
— INCULTA	San Diego	1
LASEA RUBRA	Cape St. Lucas	1
CYTHNA ALBIDA, *Cpr.*	San Diego	1
AMPHITHALIMUS INCLUSUS, *Cpr.*	California Survey	1
DUNKERIA LAMINATA, *Cpr.*	do	1
BARLECIA SUBTENUIS (broken)	do	
— — var.	Cape St. Lucas	1

OPERCULA.

NAME.	LOCALITY.	No.
OPERCULA OF STROMBUS, sp. ?		1
— PURPURA, sp. ?		2
— SENECTUS ARGYROSTOMA, *Lin.*		2
— — LAJONKAIRII, *Dsh?*		1
— SENECTUS, sp. ?		2
— SENECTUS SETOSUS, *Gmel.*		2
— SENECTUS CHRYSOSTOMA, *Lin.*		1
— TURBO PETHOLATUS, *Lin.*		3

CEPHALOPODA.

SPIRULA AUSTRALIS, *Blain.*	Sandalwood Bay	3

The collection of shells, catalogued above, is composed of the following specimens:

GASTEROPODA and other univalves, 663 species and 22 varieties, or repetitions otherwise represented in the collection = 685; consisting of 1,087 specimens.

BRACHIOPODA, 9 species, consisting of 12 specimens.

CHITONIDÆ, 10 species, represented by 8 entire specimens, and a few valves not enumerated.

LAMELLIBRANCHIATA, 343 species and 21 varieties or repetitions = 364; consisting of 200 specimens with both valves, and 373 separated valves.

SHELLS.	Species and varieties.	Specimens.
GASTEROPODA	685	1087
BRACHIOPODA	9	12
CHITONIDÆ	10	8
LAMELLIBRANCHIATA	364	573
Total	1,068	1,680

Many of the LAMELLIBRANCHIATA are much broken—a few of them nearly destroyed. The GASTEROPODA are in much better condition, although many of these are dead or beached shells, and much weathered; but nevertheless making a valuable addition to the collection, from their authentic labels, and in representing new or obscure genera.

(C.)

SECOND CATALOGUE OF SHELLS PRESENTED TO THE STATE MUSEUM BY THE SMITHSONIAN INSTITUTION.

PULMONIFERA.

NAME.	LOCALITY.	No.
HELIX DISPECTA, *Gray*	Ousima	1
— (THEBA) PISANA, var.	Canaries	2
— — CAPENSIS, *Pfr.* (1 broken)	Cape Good Hope	2
— — SIMILIS, *Fer.*	Hong Kong	2
— (DISCUS) PAUPERA, *Gld.*	Kamschatka	1
— — ARATUS, *Gld.*	Orange Harbor	2
— (CONULUS) MISELLA, *Fer.* (crushed)	Upolu	1
— — CULTRATUS, *Gld.*	Tahiti	1
— — CHAMISSOI, *Pfr.*	Sandwich Islands	1
— — CRYPTOPARTICUS, *Pre.*	do	2
— (HYGROMIA) SAXATILIS	Orange Harbor	1
— (PITYS) ? ZOLINGERA, *Pfr.*	Tahiti	2
— — BURSATELLA, *Gld.* var. εε		6
— (CAMŒNA) VERNICULA, *Pfr.* (broken)	Ecuador	1
— (TROCHOMORPHA) CRESSIDA, *Gld.*	Samoa, Tahiti	1
— — EURYDICI, *Gld.*		1
— — TROCHIFORMIS, *Fer.*	Pacific Island	3
— — TROILUS, *Gld.*	Samoa Island	2
— — POLYMORPHUS, *Swn.* (cr'shd)	Madeira	1
— (IBERNUS) SPIRALIS, *Gld.*	Lima	1
POLYGYRA STENOSTREPTA, *Pfr.*	Ecuador	1
HELICELLA AUREOLENTA, *Buv.*	Sandwich Islands	2
— CELLARIA, *Lin.*	Madeira	1
— — *Lin.*	Sidney	1
— SUBRUTILE, *Mighl.*	Sandwich Islands	2
ZONITES sp. ind. (like H. MINISCULA)	Hong Kong	1
NANINA CARICA, *Gld.*	Fiji	2
— NANINOIDES, *Benson*	Singapoor	1
— (HEMIPLECTA) HUMPHREYSIANA, *Lea.*	Borneo	1
COCHLEA PHLEBOPHORA, *Lowe*	Madeira	2

NAME.	LOCALITY.	No.
HELICOSTYLA KOCHII, *Pfr.*	Philippines	1
— ROISSYANA, *Fer.*	do	1
— sp.?	do	2
— (CORASIA) BRODERIPII, *Pfr.*	do	2
— (CALLICOCHLEA) COCOMELUS, *Sby.*	do	1
— — FRASERI, *Gray.*	Australia	1
— — *Pfr.*	Philippines	2
— — LUZONICA, *Sby.*	do	1
— — MELANO	do	1
— (CHLOROSTOMA) AMANA, *Fer.*	do	1
SUCCINEA CADUCA, *Mighl.*	Sandwich Islands	1
— CANCELLA, *Gld.*	Manai	1
— CROCATA, *Gld.*	Upolu	1
— GOULDIANA, *Pfr.*	Tahiti	1
— HUMEROSA, *Gld.*	do	1
— LIMASIANA, *Pfr.*	Lima (?)	1
— MANUANA, *Gld.*	Manua	1
— MODESTA, *Gld.*	Upolu	1
— PALLIDA, *Pfr.*	Tahiti	1
— PUDORINA, *Gld.*	do	1
— STRIGATA, *Pfr.*	Australia	1
— TAHITENSIS, var. *Pfr.*		1
— VENUSTA, *Gld.*	Sandwich Islands	1
— (OMALONYX) PUTAMERI, *Gld.* (fragment)		1
— (HELISIGA) ROTUNDATA, *Gld.*	Sandwich Islands	1
— — CIPULA, *Gld.*	do	1
OMALONYX EXPLANATA, *Gld.*	Kanai	1
MACROCYCLIS FALLICOSA, *Fer.*	Ecuador	1
— (EURYSTOMA) VITTATA, *Mull.*	Ceylon	2
LUCERNA (ORBA) PLANULATA, *Lam.*	Philippines	2
— — LISTERI, *Gray.*	do	1
VITRIA NITIDA, *Gld.*	Madeira	1
COCHLOSTYLA CONCINNUS, *Sby.*	Philippines	5
— METAMORPHUS, *Fer.*	do	3
— (EUDOXUS) SIMPLEX, *Jones*	do	1
— (AMPHIDROMUS) STABILIS ?	do	1
— — DRYAS, *Brod.*	do	2
— — LUZONICA, *Sby ?*	do	1
— (CHRYSALIS) ORMIS, *Su ?*	do	1
— — ? *Brod.*	do	1
— — SYLVANUS, *Brod.*	do	1
BULIMUS CRENULATUS, *Pfr.* (broken)	Chili	1
— ROSACEUS, *King.*	Valparaiso	2
— PULLUS. *Gray.*	India	3
— (STENOGYRA) JUNCEUS, *Gld.*	Sandwich Islands	2
— (CHARIS) MOROSUS, *Gld.*	Fiji	1
— (ORPHARUS) MAGNIFICUS, *Gray.*	Rio Janerio	1

NAME.	LOCALITY	No.
PLACOCHEILUS STRANGEI	Australia	1
PLACOSTYLUS SHONGII, *Less.*	New Zealand	1
OTASTOMUS AURIS-LEPORIS, *Brug.*	Brazil	1
PARTULA CONICA, *Gld.*	Upolu	1
— DENTIFERA, *Pfr.*	Raiatea	1
— FABA, *Mart.*	do	1
— FILOSA, var. *Pfr.*	Eimea	1
— GIBBA, *Fer.*	Guam	1
— HEBE, *Pfr.*	Raiatea	1
— HYALINA, *Brod.*	Tahiti	1
— LIGNARIA, *Pse.*		1
— MASTERSI, *Pfr.*	Guam	1
— ROSEA, *Brod.*		2
— RUBESCENS, *Rve.*	Upolu	2
— SOLIDULA, *Rve.*	Bolabola	1
— SOPADICEA, *Rve.*	Eimea	1
— TAHITANA, *Brug.*	Tahiti	2
— ZEBRINA, *Gld.*		1
SUBULINA STRIATELLA	Siberia	1
ACHATINELLA PRODUCTA, *Rve.*	Sandwich Islands	1
TORNATELLINA NEWCOMBIANA, *Pfr.*	do	1
— PEPOMENA ? *Gld.* (broken)	do	1
— SERRATA, *Gld.*	do	1
AURICULELLA AURICULA, *Fer.*	do	2
ORTHALICUS (SCUTALUS) MUTABILIS, *Brod.*	Peru	2
— — PROTEUS, *Brod.*	do	1
— (PLECTOSTYLUS) CHILENSIS, *Lin.*	Valparaiso	2
— (MESEMBRIONIS) PAPYRACEUS, *Mart.*	Brazil	1
— (RABDOTUS) ALBICANS, *Brod.* (broken)	S. Lorenzo	3
— — ERYTHROSTOMA, *Sby.*	Chili	1
— — LAURENTII, *Sby.*	S. Lorenzo	5
SIMCOLARIA TURBINATA, *Lea.*	West Africa	1
LEPTACHATINA GUTTULA, *Gld.*	Sandwich Islands	1
— STRIATULA, *Gld.*	do	1
CLAUSILIA CÆRULEA, *Fer.*	Cape Palmas	2
MEGASPIRA ELATIOR	Brazil	1
VERTIGO TANTILLA, ? *Gld.*	Tahiti	1
LIMNÆA AMAGDALINUM, *Grosch.*	Bengal	1
— PARTULA, *Grosch.*	do	1
— VESTOR, *D'Orb.*	Chili	1
— VOLUTATA, *Gld.*	Oahu	5
— sp.?	Bengal	1
— sp.?	do	1
PHYSA NOVA-HOLLANDICA		1
— RETICULATA, *Gld.*	Sandwich Islands	3
— TABULATA, *Gld.*	New Zealand	1
— VENUSTULA, *Gld.* (1 broken)	Lima	3

NAME.	LOCALITY.	No.
PHYSA sp.?		1
PHYSOPSIS AFRICANA, *Kraup.*	Natal	1
CHILINA BULLOIDES, *D'Orb.*	Chili	1
— FASCIATA, *Gld.*	do	1
— FLUVIATILIS, *Gld.*	Quillota	1
— OBOVATA, *Gld.*	do	1
— PUELCHA, *D'Orb.*	Chili	1
ANCYLUS KAFFIR	Natal	1
— sp. (like A. ADAUCTUS)	Madeira	1
ERISMA NEWCOMBI, *Pfr.*	Sandwich Islands	1
PILEX LATERALIS, *Pfr.* (broken)	New Zealand	1
PLANORBIS CRASSUS, *Couth.*	Rio Janeiro	1
— COMMUTATUS, *D. K.*	Brazil	1
— sp.?	Ceylon	2
— KERMATOIDES, *D'Orb.*	Lima	1
— LUGUBRIS, *Wagn.*	Brazil	1
SEGMENTINA LARGILLIERTI, *D.*		1
ANCLUSTOMA (CORILLA) ERRONEA, *Albers.*	Ceylon	1
AURICULA AURIS-JUDÆ, *Lin.*	East Indies	1
— ELONGATA, *Parr.*	Fiji	3
PYTHIA ALBIVARICOSA, *Pfr.*	do	1
— BIVARICOSA, *Pfr.*	do	1
PLECOTREMA CLAUSA, *A. Ad.*	Sandwich Islands	1
— INEQUALIS, *C. B. Ad.*	do	1
LÆMODONTA BROWNII, *A. Ad.*	do	4
— SANDWICHENSIS, *Rve.*	do	1
OPHICARDELIS BALTEATUS, *A. Ad.*	New Zealand	4
CASSIDULA COFFEA, *Chem.*	East Indies	1
— DOLIUM, *Petit.*	Ceylon	1
— FELIX, *Lam.*	Singapoor	1
— SULCULOSA, *Mons.*	East Indies	1
MELAMPUS CASTANEUS, *Muhl.*	Pacific Island	3
— — *Muhl.*	do	3
— — var. FUSCUS	do	1
— — var. FUSCATUS	do	3
— COFFEA, *Lin.*	Cape Palmas	3
— — *Lin.*	Rio Janeiro	1
— FUSCATUS, *Chem.*	Pacific Island	3
— GRAMIFERUS, *Mons.*	Society Island	1
— LIVIDUS, *Lin.*	Pacific Island	3
— LUTEUS	do	3
— MUCRONATUS, *Gld.*	Karuka Island	1
— PARVULUS, *Mull.*	do	1
— SONATUS, *Mull.*	Marquesas	1
CYCLOSTOMA LIGATUM, *Sby.*	Cape Good Hope	1
— (OMPHALOTROPIS) ROSEUM, *Gld.*	Fiji	6
— (OSTODES) PLICATUM, *Gld.*	Upolu	4

NAME.	*LOCALITY.*	*No*
OSTODES OBLIGATA, *Gld.*		1
— STRIGATA, *Gld.*	Upolu	2
CYCLOTUS INCOMPTUS, *Sby.*	Peru	1
CYCLOPHORUS INORNATUS, *Sby.*	Philippines	1
— PHILIPPINARIUM, *Less.*	Loo Choo	1
— ? PUNCTATUS	China	1
LEPTOPOMA HALOPHILUM, *Born.*	India	2
— HELICOIDES, *Gray.*	Philippines	1
— ATRIAPILLUM, *Sby.*	do	2
REALIA ELONGATA, *Rve.* (from type)	Pacific Islands	1
— SCITULA, *Gld.* (broken)	do	1
— TEREBRALIS, *Gld.*	do	1
REGISTANA GRANDE, *Gray.*	Philippines	1
— SIMILE, *Gray.*	do	1
HELICINA BERYLLINA, *Gld.*	Fiji	1
— BRAZILIENSIS, *Gray.*	Rio Janeiro	1
— CITRINA, *Grat.*	Philippines	2
— FULGORATA, *Gld.*	Upolu and Manua	3
— LUCINOSA, *Migh.*	Sandwich Islands	1
— MULTICOLOR, *Gould.*	Tahiti	1
— ONNUSIRA, *Gould.* (broken)	Upolu	1
— PALLIDA, *Gould.*	Fiji	1
— PISUM, *Phil.*	Sandwich Islands	1
— SOLIDULA, *Gray.*	Tahiti	4
— TENIATA, *Quoy.* (broken)	Fiji	3
— TROCHLEA, *Gld.* (broken)	Aurora Islands	1
— UPERA, *Gld.*	Manua	1
— sp.?	Fiji	1
ONCHIDIUM, sp.?	Lima	1
— sp.?	do	1

GASTEROPODA.

STROMBUS DENTATUS, var.	Red Sea	1
PISANIA RUSTICA, *Rve.*	Australia	1
CHRYSODOMUS, sp. ind. (very poor)	Rio Negro	1
CLATHURELLA PLANILABRUM, *Har.*		1
EUGENIA FORTICOSTATA, *Rve.*	Pacific Islands	1
— ? ORATA *Rve.*	do	2
COMINELLA ALVEOLATA, *Quoy.*	South Australia	1
— COSTATA, *Quoy.*	do	1
— sp.?	Cape Good Hope	2
PSEUDOSTROMBUS MALABARICUS, *Hun.*	Cochin	2
NASSA BILOBATA, *Cpr.* var. VENUSTA	Central Pacific	1
— CINCTELLA, *Gld.*		1
— CURTA, *Gld.*	Samoa Island	2
— FASCIATA, *Chem.*		1
— GEMMULIFERA, *A. Ad.*	Australia	1

NAME.	LOCALITY.	No.
NASSA GLABERIANA, *Gmel.* (= N. PFIEFFERI, *Phil.*)	Canaries	1
— GRANDIOSA, *Ad.* var. LILACINUS, *Gld.*		1
— INCRASSATA, *Mont.*	Madeira	1
— ISABELLA, *D'Orb.*	Akaba	1
— LIVESCENS, *Phil.*	Indian Ocean	1
— MADEIRENSIS, *Rve.*	Madeira	1
— MUCRONATA, *A. Ad.*	East Indies	1
— ORNATA, *Lam.*	Bombay	1
— PAUPERA, *Gld.*	Central Pacific	1
— PAUPERATA, *Lam.* var. LUCELLA, *Brug.*		1
— PULCHELLA, *A. Ad.*	Cape Good Hope	1
— THERSITES, *Bing.*		1
— VELATA, *Gld.* (= var. PUNCTATA, *A. Ad.*)		1
RINGICULA AURICULATA, *Mont.*	Madeira	1
PLANAXIS ABBREVIATA, *Pse.*	Central Pacific	1
— LABIOSA, *A. Ad.*		10
— LINEOLATA, *Gld.*	Pacific Islands	2
— LINEOLATA, *Gld.*	Sandwich Islands	1
— MOLLIS, *Sby.*	New South Wales	1
— NUCLEUS, *Lin.*		5
— PLUMBEA, *Pse.*	Central Pacific	1
— SUCCINEATA, *A. Ad.*	Red Sea	2
— SULCATA, *Lin.*		5
COLUMBELLA PACIFICA, *Gask.*		2
— PALLIDA, *Desh.*		2
— PARDULINA, *Lam.*	Brazil	6
— RETICULATA, *Lam.*		2
— TURTURINA, *Lam.*		2
— VERSICOLOR, *Sby.*		8
NITIDELLA MARMORATA, *Gray.*	Philippines	1
PYRENE FLAVIDA, *Lam.* var.	Japan	1
PYRENE SPLENDIDA, *Car.*		3
AMYCLA UNICOLOR, *Sby.*	Rio Janeiro	3
CONELLA PHILIPPINARIUM, *Rve.*		2
ANACHIS ATRATA, *Gld.*	Hong Kong	1
— FULMINEA, *Gld.*	Cape Good Hope	1
— ? PYGMÆA	Ceylon	3
— sp.?	Rio Negro	1
OLIVA ELEGANS, var.	Fiji	2
— EPISCOPALIS, *Lam.*		1
PLEUROTOMA AUSTRALIS, *Chem.*		1
— GEMMATA, *Hds.*	Kagosima	1
— SPECTABILIS, var.	Fiji	1
MITRELLA ALBINA, *Kien.*		1
— LIGNA, *Decl.*		2
ERATO CORRUGATA, *A. Ad.*	China Seas	1
PERSICULA CORNEA, *Lam.*	Gambia	1

NAME.	LOCALITY.	No.
NATICA LABRELLA. *Lam.*	Cambria	1
— ZELANDICA, *Quoy.*	New Zealand	1
POLINICES CONICUS, *Lam.*	South Australia	1
SIGARETUS ZONALIS, *Quoy.*	do	1
STILIFER AURICULA, *Gld.*	Fiji	7
EURYTA PLUMBEA, *Quoy.*	Australia	2
CERITHIUM ALTERNATUM, *Sby.*	Singapoor	1
— ALUCO, *Lam.*		1
— ALVEOLUS, *Horn.*	Pacific Islands	9
— BREVE, *Quoy*	East Indies	4
— CAUDATUM, *Sby.*	Rio Janeiro	1
— CŒRULEUM, *Sby.*	Akaba	1
— COLUMNA, *Sby.*		7
— — (dwarf var.)		1
— CORALLIUM, *Kien.*	Singapoor	1
— ECHINATUM, *Lam.*	Wakes Island	1
— EGENSE, *Gld.*		1
— ERIGENSE, *Val.*	Indian Ocean	1
— GRACILIS, *Pse.*		2
— GRANOSUM, *Kien.*	East Indies	2
— INFLATUM, *Quoy.*	Philippines	1
— LACTEUM, *Sby.*	Sandwich Islands	2
— MACULOSUM, *Mighl.*	do	1
— MONILIFERUM, *Kien.*		3
— MORUS, *Lam.*		4
— OBESUM, *Sby.*	Philippines	1
— PATULUM, *Sby.*	Singapoor	1
— PETROSUM, *Wood.*		4
— PUSILLUM, *Gld.*	Pacific Islands	5
— RUGOSUM, *Wood.*		4
— — var.	Japan	1
— SORDIDULUM, *Gld.* var.	Loo Choo	1
— — *Gld.*	Pacific Islands	1
— SPLENDIDUS, *Sby.*	East Indies	1
— TRAILLER, *Sby.*	Java	1
— TUBERCULATUM, *Lin.*		1
— UNCINATUM, *Gmel.*	West Indies	1
— VARIEGATUM, *Quoy.*	East Indies	2
RHINOCLAVIS ARTICULATA, *A. Ad.*	Ceylon	1
— ASPERA, *Lin.*		1
— CEDONULLA, *Sby.*		1
— LINEATA, *King.*		1
— MARTINIANA, *Pfr.*		1
— OBELISCUS, *King.*		1
— PHAROS, (var.)	Pacific Islands	1
— PULCHRA, (var.)		1
PYRAZUS PICTUS, *Born.*	Ceylon	1

NAME.	LOCALITY.	No.
PYRAZUS SULCATUS, *Born.*	East Indies	1
— (TYMPANOTUS) EURYPTERA, *A. Ad.*	Bombay	1
— — FUSCATUS, *Lea.*	West Africa	1
— — MACROPTERA, *Kien.*		4
— — RADULA	West Africa	3
CERETHIOPSIS GLAUCOSA, *Gld.*	China Sea	1
CERITHIDEA OBTUSA, *Lam.*	East Africa	1
AMYCLA SAGITTA, *Gask.*		1
LAMPANIA AUSTRALIS, *Quoy.*	Australia	1
— UNDULATA, *Sby.*	Loo Choo	1
— ZONALIS, *Lam.*	Hong Kong	1
PIRENELLA BICARINATA, *Quoy.*	New Zealand	1
— CINERASCENS		2
— CONICA, *Blain.*	New Zealand	3
— TURRITELLA, *Quoy.*	Australia	1
BITIUM LACERTINUM, *Gld.*	New South Wales	1
— GRANARIUM, *Kien.*	do	1
— PARCUM, *Gld.*	Loo Choo	1
MELANIA ASPIRANS, *Hds.*	Fiji	1
— CORPOROSA, *Gld.*	do	1
— DOLOROSA, *Gld.*		1
— FASCIOLATA, *Fer.*	Casina	1
— SAMOENSIS, *Rve.*	Upolu	2
— FIGURATA, *Hds.*	Fiji	3
— FULGIDA, *Rve.*	do	2
— GRACILIS, *Gld.*	Tahiti	1
— LIBERTINA, *Gld.*	Simoa	1
— LUTOSA, *Gld.*	Upolu	1
— PERPINGUIS, *Hds.*	Fiji	3
— RUDENS, *Rve.*	do	3
— — var., *Rve.*	do	2
— SCITULA, *Gld.*	Tahiti	1
— sp.? PERPINGUIS, *Hds.*	Fiji	3
— sp.? PERPINGUIS, (var.)	do	3
— sp.? HASTULA	do	1
— sp.? RUDIS, (var.)	do	2
— sp.? TERPSICHORA, *Gld.*	do	1
— sp.? SAMOENSIS	do	3
— sp.? CORPOROSA	do	1
PACHYCHEILUS (AYLACOSTOMA) IMPURUS, *Lea.*	Tutuilla	1
MELANOIDES ASPERATA, *Lam.*	Phillipines	1
— CRENULATA, *Desh.*	Manilla	1
VIBEX CRENIFERA, *Lea.*	Sandwich Islands	1
— HISTRIONEA, *Rve.*	Cape Palmas	1
— MANUENSIS, *Lea.*	Sandwich Islands	1
— PYRAMIS, *V. de Busch*	India	4
— SCABRA *Gld.*	Manilla	1

NAME.	LOCALITY.	No.
TIARA (PLOTIA) SPINULOSA, *Lam.*	India	1
MELANOPSIS CURIOSUS, *Linn.*	Lake of Galilee	9
— LENTIGINOSUS, *Rve.*	Tunis	4
— ZEALANDICA, *Gld.*	New Zealand	4
TURRITELLA CONSPERSA, *Ad. & Rve.*	Cape Good Hope	1
— GRACILLIMA, *Gld.*		2
SIPHONIUM MAXIMUM, *Wood.* (operculum)	Fiji	2
— TONGANUM, *Quoy.*	Wakes Island	1
SERPULORBIS NEBULOSA	Akaba	1
CLADOPODA POLYPHRAGMA, *Mork.*	New Zealand	2
PETALOCRECHAS RENIFORMIS, *Cpr.*	Bombay	1
BIVONIA COMPACTA	Pacific Islands	2
— SPINULÆFORMIS, *De Lev.*	do	1
LITORINA ACUMINATA, *Gld.*	Mangsi	1
— AFRICANA, *Kraus.*	Cape Good Hope	3
— BREVICULA, *Phil.*	Hakodadi	1
— — *Phil.*	do	2
— CALIGINOSA, *Gld.*	Orange Harbor	7
— CINCTA, *Quoy.*	Sandwich Islands	3
— DEBILIS, *Gld.*	New Zealand	2
— FLAVA, *Brod.*	Rio Janeiro	1
— GRANOCOSTATUS, *Rve.*	Cape Palmas	2
— LINEATA, *Lam.*	Pacific Islands	1
— NEBRA (var.)	Chili	6
— — = L. PERUVIANA, *Lam.*		6
— NEBULOSA, *Lam.*		2
— NERITOIDES, *Lin.*	Madeira	3
— NEWCOMBI, *Rve.*	Sandwich Islands	2
— OBESA, *Sow.* (= L. LIMAX, *Mart.*), *Pease.*		5
— PICTA, *Phil.*	Sandwich Islands	1
— PINTADO, *Wood.*	do	4
— SAYI, *Phil.*	Rio Janeiro	2
— STRIATA, *King.*	Cape Verde Island	3
— TESSELLATA, *Phil.*	Cape Palmas	3
— UNDULATA, *Gray.*		5
— — *Gray.*		1
— UNIFASCIATA, *Gray.*	Australia	2
— ZEBRA (young)	Valparaiso	3
— ZELANDICA, *Rve.*		1
— ZICZAC, *Lin.*	Rio Janeiro	3
— (MELARHAPHE) ABENA, *Rve.*	Cape Palmas	1
— — ARBORICOLA (var.)	Fiji	1
— — INTERMEDIA, *Phil.*	Ceylon	1
— — SCABER, *Lin.*		6
— — — var. INTERRUPTA, *Pse.*	Central Pacific	2
RISELLA AURATA, *Quoy.*	Australia	1
— LUTEA, *Gld.*	Hong Kong	1

NAME.	LOCALITY.	No.
RISELLA MELANOSTOMA, *Quoy.*	Australia	1
— MILIARIS, *Quoy.*	do	1
— NANA, *Lam.*	New Zealand	1
— PLANA, *Quoy.*	Australia	1
MODULUS CANDIDUS, *Petit.*	Pacific Islands	2
— CERODUS (young)	Acapulco	1
— DISCULUS, *Phil.* (= M. DORSUOSUS, *Gld.*)	do	5
TECHTARIA GRANOSUS, *Phil.* var.		6
— MILLEGRANUS, *Phil.*	Loo Choo	3
— VILIS, *Mk.*	do	2
CHRYSOSTOMA PARADOXA, *Born.*		1
SOLARIUM FORMOSUM		1
— PERDIX, *Hds.*	Singapoor	1
— PERSPECTIVUM, *Lin.*		
MINOLIA SOLARIFORMIS, *Short.*	Cochin	1
TORINIA VARIÆGATA, *Lam.*	Pacific Islands	1
PHILIPPIA CINGULATA, *Kien.*	Fiji	1
— HYBRIDA, *Lin.*	Pacific Islands	1
HYDROBIA ANTIPODIUM ? *Gld.*	New Zealand	1
— COROLLA, *Gld.*	do	1
— EGENA, *Gld.*	do	2
— PETENINGANA, *Gld.*		4
— sp.? PETENINGANA	Buenos Ayres	4
— PORRECTA	Sandwich Islands	2
— sp.?	New Zealand	2
TRUNCATELLA AURANTIA, *Hds.*	Fiji	3
— — *Gld.*	do	1
TAHITIA VITIANA, *Gld.*	Pacific	1
— — *Gld.*	do	2
PALUDINA ANGULARIS, *Phil.*	Manilla	1
— BURROWSIANA, *Lea.*	Loo Choo	1
— DOLEARIS, *Gld.*	Burmah	1
— ELONGATA, *Swain.*	Whampoa	1
— QUADRATA, *Bens.*	do	2
— HAYNSIANA, *Lea.*	India	1
— HISTRICA, *Gld.*	Whampoa	2
— LECYTHOIDES, *Bens.*	China	1
BYTHINIA STENOTHYROIDES		2
AMPULLARIA ORATA, *Desh.*	Manilla	1
— sp.?	do	1
ASOLENA AUROSTOMA, *Lea.*	New Grenada	1
AMPHIBOLA ARELLANA, *Gmel.*	New Zealand	3
— TENUIS, *Gray.*	South Australia	1
NERITA ALBICELLA, *Lin.*		3
— ANTIQUATA, *Recl.*	East Indies	3
— ARGUS, *Recl.*	do	1
— ATRATA, *Chem.*	Sidney	1

NAME.	LOCALITY.	No.
NERITA COSTATA, *Chem.*	East Indies	1
— EXUVIA, *Lin.*	India	1
— GRISEA, *Rve.* (= N. RUMPHII, var.)	East Indies	3
— HAUSTRUM, *Rve.* (= N. SENEGALENSIS, var.)	Cape de Verde Isles	1
— LINEATA, *Chem.*		2
— MAURA, *Recl.* (= N. ANTIQUATA, var.)	East Indies	2
— MARGINATA, *Pease.*	Tahiti	10
— — (young)	Loo Choo	1
— MUSSIRA, *Gld.* (= N. SIGNATA, *Mart.*)		1
— NERITOIDES, *Rve.*	New Zealand	2
— NOVA GUINÆ, *Less.*	Pacific Islands	2
— PICEA, *Recl.*	Sandwich Islands	10
— PLANISPIRA		1
— PLICATA, *Lin.*		7
— POLITA, *Lin.* (var. MAXIMA, *Chem.*)		4
— RUMPHII, *Recl.*		6
— SENEGALENSIS, *Gmel.*	Cape Palmas	3
— SIGNATA (young, var.)	Mediterranean	2
— SQAMULATA, *Le Guil.*		3
— STELLA, *Chem.*	East Indies	1
— SUBVITREA, *Cpr.*		1
— UNDATA, *Lin.*		2
— YOLDII, *Recl.*	East Indies	1
NERITINA ADAMSI, *Recl.*	Cape Palmas	3
— ADUMBIATA, *Recl.*	Pacific Islands	1
— AMANA, *Gld.*	do	1
— CANALIS, *Sby.*	Tahiti	1
— CARIOSA, *Gray.*	Sandwich Islands	3
— CHOLERICA, *Gld.*	Fiji	4
— CHOLOROSTOMA, *Brod.*	Tahiti	2
— DUBIA var. *Chem.*	East Indies	1
— GAGATES, *Lam.*	Africa	1
— LATISSIMA, *Brod.*	Central America	1
— MICHAUDI, *Recl.*	Simoda	1
— MORTONIANA, *Recl.*		7
— PEROTITIANA	Ceylon	1
— PETITII, *Recl.*	Fiji	1
— PORCATA, *Gld.*	Pacific Islands	2
— PULLIGERA, *Lin.*	Fiji	2
— SIDERA, *Gld.* (= N. PEROTITIANA, *Rec.*)	do	3
— SQUAMIPICTA, *Recl.*	Guam	1
— TAHITENSIS, *Lin.*	Sandwich Islands	6
— TURRITA, *Chem.*	Tahiti	3
— TURTONI, *Recl.* (= N. HELVOLA, *Gld.*	Pacific Islands	1
— VESPERTINA, *Nutt.*	Sandwich Islands	3
— ZEBRA, *Rang.*	Tahiti	1
— ZICZAC, *Lin.*		2

NAME.	LOCALITY.	No.
Neritina (Clithon) corona, *Lin.*		6
— — spinifera, *Recl.*		--
— — spinosa, *Sow.*		6
— — squarrosa, *Recl.*		--
Clithon angulosa, *Recl.*	Pacific Islands	2
— avellana, *Recl.*	do	2
— obscurata, *Recl.*	do	2
— ruginosa, *Recl.*	do	6
Dostia melanostoma, *Troch.*	Hong Kong	1
— crepidularia, *Lam.*	Bombay	1
— reticularis, *Sby.*	Pacific Islands	1
Navicella depressa, *Lin.*		1
— bimaculata, *Rve.*		3
— macrocephala, *Le Guil.*		3
— scarabæus, *Rve.*		3
— — *Recl.*		1
Turbo amussitatus, *Gould* (= Leptonyx sanguineus, *Lin.*	Simoda	1
— nocturnus, *Gould* (= Leptonyx sanguineus, *Lin.*)	do	1
Leptonyx rubricincta, *Mighl.*	Sandwich Islands	5
Modelia punctulata, *Mart.*	New Zealand	2
Phasianella australis, *Gmel.*		2
— kochii, *Phil.*	East Africa	2
— ventricosa, *Quoy.*		1
— venusta, *Rve.*	Australia	2
Infundibulum acinodus, *Gld.*	New Zealand	1
Chlorostoma agryostoma, *Chem.*	China	1
— lactuosa, var.	Chili	3
— tridentata, *Pot. & Mich.*	do	1
— undatella, *Gld.*	Ousima	1
— sp.?	Rio Negro	1
— (Omphalius) euryomphalus, *Jonas*, = var. luctuosum, *D'Orb.*	Chili	2
— — ater, *Less.*		1
— — euryomphalus, *Jonas*, (jun.) var. bicarinatum, *Pot. & Mich.*		2
Monilia callifera, *Lam.*	Tonga	1
— calyculus, *Wood.*	Ceylon	1
— nucleus, *Phil.*	Kagosima	1
Liotia granulata, *Dks.* (= Monilia spurius, *Gld.*)	Cape Good Hope	1
Gibbula capensis, *Gmel.*	Natal	1
— guadiosa, *Gld.*	Cape Good Hope	1
— leucostica, *A. Ad.*	Hakodadi	1
— musira, *Gmel.*	Cape Good Hope	1
— picturata, *Ad. & Gray.*	Port Jackson	1
Photinula expansa, *Sby.*	Cape Horn	2

NAME.	LOCALITY	No.
PHOTINULA ZONATA, *Gray.*	Natal	1
ELENCHUS BADIUS, (var.)	South Australia	1
— BELLULUS, *Dkr.*	do	1
— IRIODON, *Quoy.*	do	1
— SHAYERI, *Troch.*	New Zealand	1
THALOTEA CONICA, *Gray.*	South Australia	1
— KAMBURII, *Cross.*	do	1
— PICTA (var.)	do	1
POLYDONTA MACULATA, *Lin.*	Kingsmills Island	1
— METALLICA, *Rve.*	Sandwich Islands	3
— SPINGLERI, *Chem.*	do	1
DILOMA AMŒNUM, *Gld.*	Fiji	2
— CINGULATA, *Quoy.*		10
— NIGGERRIMA, *Gmel.*	Chili	4
— SULCATA, *Wood.*	New Zealand	1
— (OXYSTYLA) TABULARIS, *Kr.*	Cape Good Hope	1
OXYSTYLA LEPIDA, *Gld.*	New Zealand	1
— MERULA, *Chem.*	Brazil	1
— TIGRINA, *Chem.*	Cape Good Hope	1
PACHYPOMA TUBEROSA (var.)	Pacific Islands	1
BOLMA AMEA, *Jonas*	Australia	1
CALLIOSTOMA EUGLYPTUM, *A. Ad.*	Texas	1
— GRANATUM, *Chem.*	New Zealand	1
— sp. ind., like C. JUCUNDUM, *Gld.*	Rio Janeiro	1
MONODONTA NERITOIDES, *Phil.*	Japan	1
— LABIS, *Lam.* var.	China	1
— sp. ?		
CLANCULUS ATROPURPUREUS, *Gld.*		
— MINOR, *A. Ad.*	Australia	1
— MODESTUS, *Koch.*	Cape Good Hope	1
— PUNICEUS, *Phil.*	St. Helena	1
— RUBEUS, *A. Ad.*	Adelaide	1
OMPHALIUS VIRIDULUS, *Gmel.*	Rio Janeiro	2
OSILINUS FULGINEUS, *A. Ad.*	New Zealand	1
— RETICULATUS, *Wood.*	do	1
— ZEBRA, *Munk.*	do	1
— (TROCHO-COCHLEA) PORCATA, *A. Ad.*	Cape Verde Islands	1
— — NERITOIDES, *Born.*	New Zealand	1
COLLONIA LÆTA, *Mont.*	Island of Lipari	1
ENCHELUS DENIGRATUS, *Chem.*	Fiji	1
— PLANATUS, *Cpr.*	Sandwich Islands	1
ROTELLA COSTATA, *Val.*	Hakodadi	1
— ELEGANS, *Beck.*		7
— VESTIARIA, *Lin.*		5
OCEANA HELLINA, *Born.*	Natal	1
HALIOTIS VIRGINIA, *Chem.*	Fiji	1
JANTHINA DECOLLATA, *Cpr.*	Sandwich Islands	3

NAME.	LOCALITY.	No.
JANTHINA STRIOLATA, *Cpr.*	Sandwich Islands	5
FISSURELLA NUBECULA, *Linn.*	Rio Janeiro	1
— SAGITTATA, *Rve.*	West Africa	1
PARMORPHORUS GRANULATUS, *Blain.*	China Seas	1
CALYPTRÆA CICATRICOSA, *Rve.*	Pacific Islands	1
CRUCIBULUM QUIRIQUINUM, *Lin.*	----	--
— — var. FERRUGINEUM, *Rve.*	Callao	2
— QUIRIQUINUM, *Lin.* var. CORRUGATUM, *Cpr.*	do	1
— QUIRIQUINUM, var. LIGNARIA, *Brod.*	do	2
TROCHITA RUDIANS, *Lam.*	do	3
— COMMUNOTATA, *Sby.*	New Zealand	1
GALERUS CORRUGATUS, *Rve.* (broken)	Rio Negro	1
CREPIDULA ACULEATA, *Gmel.*	Sandwich Islands	1
— — *Gmel.*	Japan	1
— — *Gmel.*	Rio Negro	1
— CONTORTA, *Quoy.*	New Zealand	1
— COSTATA, *Sby.*	do	4
— DILATATA, *Lam.*	Orange Harbor	1
— — *Lam.*	Callao	2
— — *Lam.* var. NAUTILOIDES, *Lin.*	do	5
— HEPATICA, *Desh.*	Cape Good Hope	1
— MOULINSII, *Mich.*	do	1
— PROTEA, *D'Orb.*	Rio Janeiro	1
— — *D'Orb.*	Rio Negro	1
HIPPONYX BARBATUS, *Sby.*	Japan	1
— ANTIQUATUS, *Lin.*	Pacific Islands	2
AMALTHEA CONIDA, *Schum.*	do	1
— SUTURALIS, *Quoy.*	do	1
PATELLA SCUTELLARIS, *Lam.*	Madeira	1
PATELLA SPINULOSA, *Munk.*	Maderia	1
NASELLA CYMBALARIA, *Lam.*	Cape Horn	2
SIPHONARIA AMANA, *Nut.*	Sandwich Islands	7
— ATRA, *Quoy.*	----	2
— CONCINNA, var.	South Australia	1
— — *Sby.*	Cape Good Hope	1
— CREBRICOSTA, *Nutt.*	Sandwich Islands	1
— DENTICULATA, *Quoy.*	Pacific Islands	1
— EXIGUA, *Sby.*	East Indies	1
— KARRACHIENSIS, *Rve.*	----	1
— LINEOLATA, *Sby.*	Orange Harbor	4
— LÆVIUSCULA, *Sby.*	Cape Horn	1
— MOURET, *Desh.*	Cape Palmas	2
— NUTTALLII, *Hanl.*	Sandwich Islands	1
— RADIATA, *Rve.*	Natal	1
— SIPHO, *Sby.*	East Indies	1
— SCABRA, *Rve.*	----	1
— SUBRUGOSA, *Sby.*	New Zealand	1

NAME.	LOCALITY.	No.
SIPHONARIA (var.) TRITENSIS, *Sby.*	Orange Harbor	3
— VENOSA, *Rve.*	Cape Verde Islands	1
SCURRIA SCURRA, *Less.*	Chili	1
DENTALIUM ACICULUM, *Gld.*	Hong Hong	1
— BUCCINULUM, *Gld.* (=D. BELCHERI, *Sby.*)	do	1
— EBURNEUM, *Lin.*	Singapoor	2
— EUTALIS, *Lin.*	Rio Janerio	1
— QUADRIPLICATA, *Hanl.*	Cochin	1
CHITON (LOPHYRUS) CUMINGII, *Flem.*	Chili	6
— — GRANOSUS	do	2
— — MAGNIFICUS, *Desh.*	do	1
— — PELLIS-SERPENTIS, *Quoy.*	New Zealand	3
— — QUOYII, *Desh.*	do	1
ISCHNOCHITON LONGICYMBIA, *Quoy.*	do	1
— PRUINOSUS, *Gld.*	Rio Janeiro	1
— PUNCTULATISSIMUS, *Sby.*	Callao	1
— VIRIDULUS, *Couth.*	Orange Harbor	1
TONICIA CHILENSIS, *Frem.*	Chili	1
— ELEGANS, *Frem.*	do	1
— FASTIGIATA, *Gray.*	Orange Harbor	1
— LINEOLATA, *Frem.* (=T. ELEGANS, var.)	Chili	1
— SWAINSONII, *Sby.*	Callao	1
PLAXIPHORA ACULEATA, *Lin.*	Orange Harbor	1
— STIGES, *King.*	do	1
ACANTHOPLEURA SPINIGER, *Sby.*	Fiji	1
ACANTHOCHITES CARNOTTII, *Blain.*	Cape Good Hope	1
ENOPLOCHITON COQUIMBENSIS, *Frem.*	Chili	1
CHÆTOPLEURA PERUVIANA, *Lam.*	do	1
TOMATINA FUSIFORMIS, *A. Ad.*	Kagosima	1
BULLA AMPULLA, *Lin.* var.	Fiji	2
— AUSTRALIS, *Quoy.*		3
— OCCIDENTALIS, *A. Ad.*	Sandwich Islands	1
— MAGDELUS, *List.*	New Zealand	3
— MEDIA, *Phil.*	Rio Janeiro	1
— OBLONGA, *A. Ad.* (=B. AUSTRALIS)	South Australia	1
— PUNCTATA, *A. Ad.*		1
ATYS CYLINDRACEA, *Chem.*		4
— ELONGATA, *A. Ad.* (=A. CYLINDRACEA, var.)		2
— NAUCUM, *Lin.*		2
— SOLIDA, *Bing.* (=A. CYLINDRACEA, var.)	Fiji	2
HAMINEA GUILDINGII, *Swain*	Rio Janeiro	2
— VIRESCENS, *Sby.*	St. Pedro	1
SMARAGDINELLA VIRIDIS, *Brug.*	Sandwich Islands	1
AKERA VOLUTA, *Chem.*	South Australia	1
APLUSTRUM THALASSIARCHUM, *Chem.*	Sandwich Islands	4
HYDATINA PHYSIS, *Linn.*	Ceylon	1
PLICATULA SIMPLEX, *Gld.*	Kagosima	1

NAME.	LOCALITY.	No.
PECTEN PATAGONICUS, var.	Orange Harbor	2
— DARWINII, *Rve.*	Rio Negro	1
— PICA, *A. Ad.*	Japan	2
MYTILUS BIDENS, *Lea.*	Fiji	4
MODIOLA sp.?	Tongataba	2
— var. VENOSA, *Cpr. Ms.*	East Indies	1
LITHOPHAGUS DUNKERI, *Cpr. Ms.*	Callao	2
BARBATIA, sp. ind.	Port Philip	3
AXINŒA INTERMEDIA, *Brod.*	----	2
TRIGONA HINDSII, *Haml.*	W. America	1
UNIO sp.?	R. Panama	2
CORBICULA ORIENTALIS, *Desh.*	China	1
— ANGARI	South Australia	1
SASEA RUBRA, *Mont.*	Burnt Island	5
USTULARIA PUSILLA, *Gld.*	Orange Harbor	4
MYRTÆA SEMINULA, *Gld.*	Hong Kong	2

(D.)

LIST OF SPECIMENS IN THE ECONOMIC COLLECTION.

MAGNETIC IRON ORES FROM NORTHERN NEW YORK.

1. A block from Moriah Mining Company, Humbug Hill, Moriah, Essex Co.
2. A large block from the Cheever ore bed, Port Henry, Essex county.
3. A large mass of veinstone, with iron ore, from a vein cutting the Cheever ore bed.
4. Two small blocks from the Cheever ore bed.
5. One large block of crystalized Magnetic Ore from the New Bed, Moriah, Essex county.
6. A small block from the same bed.
7. Two large blocks from Wetherbee, Sherman & Co., Old Bed, or No. 21, Moriah, Essex county.
8. One block from ——— ore bed, Moriah, Essex county.
9. Two blocks of Iron Ore from Adirondac region, sources of the Hudson river; name of particular locality not known.
10. Two blocks of Iron Ore, with felspar. French mountain.
11. One block of Red Hematite from Clinton, Oneida county.

SPECIMENS OF BUILDING STONES OF THE STATE OF NEW YORK.

LAURENTIAN SYSTEM.

1. A large block of Granite, or fine-grained Gneiss, with surface not dressed; squarely broken. Greenfield, Saratoga county.
2. A large irregular block of the same, showing in part a weathered surface and regular even fractured sides. Greenfield, Saratoga county.
3. A cube of about six inches, same rock, with the sides dressed, and one face showing the natural fracture. Greenfield, Saratoga county.
4. A large block of fine-grained Gneiss, or Granite. A few miles northeast from the above locality.
5. A block of coarse Gneiss, from Luzerne, Warren county.
6. A large block, two feet by eighteen inches, and twelve inches thick, very even in character and fracture. From the Gneiss at Sacandaga river at the crossing of the Adirondac railroad.

VERDE ANTIQUE, OR SERPENTINE LIMESTONE.

1. One large block, nearly two feet long by one foot wide and high. This is placed outside the building.
2. One slab of eighteen inches by one foot, fractured face, intended for polishing.
3. One column about four feet high, with base and shaft polished. A very fine illustration of the adaptation of this marble to ornamental use.

POTSDAM SANDSTONE.

1. One block of about one foot by eight and ten inches, with cleavage or fractured faces.
2. One small specimen of about four by six and eight inches: cleavage and fractured faces.

CALCIFEROUS SANDSTONE.

1. A block of about one foot by ten and eight inches: cleavage and fractured faces.

QUEBEC GROUP.

1. Two slabs of Roofing Slate, about five feet by ten feet: from Granville, Washington county.

CHAZY LIMESTONE.

1. One large slab, sawed for polishing, about twenty inches by two and a half feet.

BIRDSEYE LIMESTONE.

1. A block fourteen by eight and ten inches: cleavage and fractured faces.

HUDSON RIVER GROUP.

1. A block "Blue stone," with dressed and fractured faces; eighteen by six and eight inches: the same as used in St. Peter's Church. From near Schenectady.
2. A dressed and clean-fractured block of nearly two feet long by six and eight inches: "Blue stone." From near Schenectady.
3. A cube of nine inches, finely dressed on four faces; with the upper side a fractured surface. Locality?
4. A gray Sandstone, one foot long by five and six inches; dressed on three faces: one face and ends fractured. From near Newburgh.

MEDINA SANDSTONE.

1. A block two feet long by eight inches wide and thick: dressed and cleavage faces. From near Lockport.
2. A block one foot long by ten inches wide and thick; dressed surface and one fractured face: red. From Medina.
3. A block of about one cubic foot; dressed and fractured faces: variegated. From Medina.
4. A block of about one cubic foot; dressed and fractured faces: gray. From Medina.

CLINTON GROUP.

1. Brown Sandstone: A block eight inches square and five inches thick; dressed faces, with rosette cut on one side. Frankfort, Herkimer county.
2. A block of the same stone, thirteen by seven inches, and four inches thick; dressed faces. Frankfort, Herkimer county.

NIAGARA GROUP.

1. A block of one cubic foot: one face showing rock fracture, one polished face showing the regular crinoidal columns, the other faces dressed in several ways. From Lockport.
2. A block of one cubic foot: one face showing rock fracture; one face polished, a fine gray marble; the other faces variously dressed. Lockport.
3. One block of a cubic foot; one face showing rock fracture; the other faces variously dressed to show adaptation of the material. A fine gray block. Lockport.
4. A block twelve by sixteen, and six inches thick; all the sides dressed. A gray stone. Lockport, N. Y.

LOWER HELDERBERG GROUP.

1. A block of Encrinal Limestone, of triangular form, with faces polished, showing variegations from crinoidea and other fossils. Near Hudson.
2. A block of polished Black Marble from the Tentaculite Limestone, two feet four inches long, thirteen inches wide, and seven inches thick, resting on a large block of the same stone, one face showing rock fracture and the other faces dressed as a building stone; showing the adaptation of the rock to building and ornamental uses. From Schoharie.

UPPER HELDERBERG OR ONONDAGA LIMESTONE.

1. A block of one cubic foot; light gray color: one face rock fracture, one face polished, the others variously dressed. From near Syracuse.
2. A block of a cubic foot; bluish gray color: one face showing rock fracture, the others variously dressed. Near Syracuse.
3. A block ten by seven and nine inches; gray stone, with dressed and fractured faces.
4. One block ten by seven and nine inches; gray stone, dressed faces.
5. One block of a foot by eight and ten inches; dressed faces, with one showing rock fracture. (The particular quarries of 3, 4 and 5 are not known.)
6. A slab twelve by eighteen inches; light gray stone, polished face, showing organic remains.
7. A slab twelve by eighteen inches; color gray or bluish gray, and with one face polished.

(E.)

CATALOGUE OF BOOKS IN THE STATE CABINET OF NATURAL HISTORY, JANUARY, 1866.

A complete set of the Natural History of New York (wanting the volume on Insects, by EMMONS).

Duplicate: Vol. I. Palæontology of New York.

Annual Reports of the Geological Survey of the State of New York. Vol. 1. 1837, 1838, and 1839. Vol. 2. 1840, 1841.

Catalogue of the New York State Cabinet.

Reports on the State Cabinet, and bound sets (4 vols.) from No. 1 to No. 6 inclusive.

Separate Reports in Pamphlet: 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17. 14th Report, a bound copy.

The Taconic System, by E. EMMONS.

Transactions of the American Institute, 1856 and 1857. 2 vols.

Transactions of the New York Agricultural Society, 1857.

Gazetteer of New York, 1860.

Catalogue of the State Library, 1855.

Annals of Albany. Vols. 1–10 inclusive.

American Journal of Science: Vol. 19, 20, 21, 22, complete; Vol. 23, wanting Nos. 67 and 68; Vol. 24, wanting No. 70; Vol. 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, complete; Vol. 40, wanting No. 119.

P. W. CARPENTER: Catalogue of the Reigen Collection.

— Report on the present state of our knowledge of the Mollusca.

GRAY'S Manual of Botany.

Journal of the Academy of Natural Sciences, Phila. Vol. 1, parts 2 and 3.

SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE—

J. W. BAILEY: 1. Microscopical Observations made in South Carolina, Georgia and Florida.

— 2. Microscopical examinations of the soundings on the Atlantic Coast of the United States.

— 3. Notes on new species and localities of microscopic organisms.

SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE—

J. LEIDY: Fauna and Flora in Living Animals.

W. STIMPSON: Marine Invertebrata of the Grand Manon.

J. L. LE CONTE: Coleoptera of Kansas and Eastern New Mexico.

JOSEPH JONES: Investigations, chemical and physiological, relative to certain American Vertebrata.

MEEK & HAYDON: Palæontology of the Upper Missouri. Part 1.

JOHN TORREY: 1. Plantæ Fremontianæ.
2. Observations on the Batis maritima of LINNEUS.
3. Observations on the Darlingtonia californica, a new Pitcher Plant.

CHARLES GIRARD: Contributions to the Natural History of the Fresh-water fishes of North America. 1. Monograph of the Cottoids.

WOLCOTT GIBBS and F. A. GENTH: Researches on the Ammonia-cobalt Bases.

I. A. LAPHAM: Antiquities of Wisconsin.

E. G. SQUIER: Aboriginal Monuments of the State of New York.

S. F. BAIRD: Catalogue of N. A. Birds in the Smithsonian Institution. Quarto.

SMITHSONIAN INSTITUTION; MISCELLANEOUS COLLECTIONS—

S. F. BAIRD: Catalogue of North American Birds, chiefly in the Smithsonian Institution. 1st octavo edition, four copies.

— Report on the Fishes of the New Jersey Coast.

BAIRD & GIRARD: Catalogue of North American Reptiles. Part 1: Serpents.

JOHN L. LE CONTE: Classification of the Coleoptera of North America. Part 1.

F. E. MELSHEIMER: Catalogue of the Coleoptera of the United States.

R. OSTEN-SACKEN: Catalogue of the Diptera of North America.

H. LOEW: Monograph of the Diptera of North America. Part 1.

HERMANN HAGEN: Synopsis of the Neuroptera of North America.

JOHN G. MORRIS: Synopsis of the Lepidoptera of North America.

T. EGLESTON: Catalogue of Minerals in the Smithsonian Institution.

Catalogue of Publications of the Smithsonian Institution.

Directions for Collecting, Preserving, and Transporting Specimens of Natural History.

F. B. MEEK: Check Lists of Invertebrate Fossils of North America.
1. Cretaceous and Jurassic.
2. Miocene.

Smithsonian Reports: 4th, 5th, 6th, and 7th Annual Reports, not bound; 8th, 9th, and 10th Annual Reports, bound copies.

D. OWEN: Geology of Wisconsin, Iowa and Minnesota.

PARRY: Expedition to Japan. Vols. 1 and 3.

United States Naval and Astronomical Expedition. Vols. 1 and 2.

Agassiz : Contributions to Natural History. Vols. 1, 2, 3, and 4.

Warren on the American Mastodon.

Foster & Whitney : Geological Report on the Copper Lands of Lake Superior. Vol. 1, 1850; vol. 2, 1851.

Sitgreaves : The Zuni and Colorado. 1 vol.

Marcy : The Red River of Louisiana. 1 vol. and plates.

— Reconnoissances of New Mexico and Texas. 1 vol.

Gibbon : Exploration of the Valley of the Amazon. Part 2.

John Delafield : An Inquiry into the Antiquity of North America.

Seventeenth Annual Report of the Regents of the University of New York. Bound vol.

Miscellaneous —

W. Newcomb : Synopsis of the Genus Achatinella.

J. G. Anthony : New Species of American Fluviatile Gasteropods.

G. W. Clinton : Preliminary List of Plants of Buffalo and vicinity.

Spencer F. Baird : Serpents of New York.

Report of the North Clear Creek Mining Company.

National Institue for the Promotion of Science : Third Bulletin.

(F.)

LOCAL CLIMATOLOGY.

By W. D. WILSON, D.D.,

PROFESSOR IN HOBART COLLEGE.

The climate of every locality has certain peculiarities of its own, which, while they are interesting on their own account, are valuable, also, as material towards a general knowledge of the causes which affect and control the diversities of climate in all the different and varied regions of the globe. These facts are of such a nature that no one observer can possibly observe them all, or even any considerable portion of them, by himself alone, unaided by other co-laborers in the same field of science. They must be obtained by a long-continued series of observations; observations that must be carefully made, intelligibly recorded, computed and averaged, day by day to some extent, and which especially should not be interrupted or omitted for a single day, or even a single period in that day at which observations are to be made. They must also be obtained in many different places at the same time; and hence the necessity for co-laborers, and many of them too, in all parts of the world.

It is to aid in this work that I make the following contribution.

The temperature, or amount of solar heat, in any place depends upon the following variables:

I. Latitude, or distance from the equator;

II. Elevation above the sea level;

III. Distance from the sea coast;

IV. Situation in reference to mountain ranges, etc.;

V. Situation in reference to inland lakes, etc.

Under the third head, inland distance, I shall also speak of the influence of sea currents upon those places that are situated near the sea coast.

I. Latitude, or Distance from the Equator.

Every body knows that the weather is warmer in summer than in winter; and everybody is also probably aware that this depends upon the fact that the days are longer than in the winter, no less than upon the fact that the sun *"runs higher,"* as the expression is. But it may not have occurred to all persons that it is perfectly practicable to compute the amount of heat, and to the average temperature for each part of the earth's surface, as it would be if there were no variations caused by the other influences just named.

I have alluded to the fact that the heat of the sun, or rather its heating power, depends upon its altitude. It varies exactly with what is known to mathematicians as the sine of the sun's altitude. The length of the day is also an element; for the longer the sun continues to shine on any object the hotter it will become, other things being equal. Rays of heat, also, like rays of light, suffer some refraction as they pass through the air; but on the other hand, it has been proved by the experiments of Herschell and Pouillet, that a part of the sun's rays are absorbed by the atmosphere, or rather by the moisture that is contained in it, so that only about seventy-five per cent, or three-fourths of all the heat that the sun emits reaches the earth. This absorption of the sun's heat will of course be greater the less the sun's altitude, and consequently will vary with the average of its altitude; not only for places in different latitudes, but also for the same place at different seasons of the year, and for different hours in the day.*

But in order to express the results thus obtained, in degrees of temperature, as indicated by any known standard, it becomes necessary to

* Of the reality of the fact referred to, there can, of course, be no doubt; but I shall take the liberty to doubt the theory or explanation given of it. When heat is absorbed, unless it becomes latent by the mass absorbing it passing from a solid to a fluid, or from a fluid to a gaseous state, the absorbing mass shows the effect of the heat by an increase in its own temperature. If, therefore, any portion of the sun's heat were really absorbed by the air, or rather the moisture in it, the temperature of the atmosphere would be raised thereby, and of course the influence of that heat would be felt no less than if it had passed through the air and been returned to it by reflection or conduction from the earth. But if there is anything in the air whereby it can absorb heat, it can, by the same means reflect it; so that it shall not reach the earth at all, but be thrown off into space, and thus be totally and entirely lost in its influence upon the temperature of anything within the reach of our observation. And on this theory the amount of heat lost by reflection will depend upon the angle at which it strikes the atmosphere, so that the correction above suggested will answer as well on one theory as the other.

institute a proportion in which these results may be compared with those obtained by actual experiment with such a standard. Starting with the commonly received 80° Fahrenheit as the average for the equator, although HUMBOLDT gives it as 81°.5, we have all the elements of such a calculation at our command, and the proportion is:

As .958, the sine of the average altitude of the sun at the equator, multiplied by 12, the length of the day at the equator, and this product multiplied by .6, the average of the sines of the altitude for the day (being the correction for the absorption of heat by the atmosphere);
is to 80° Fahrenheit (the average for the year at the equator):
so is the sine of the sun's altitude at noon for any day or latitude multiplied into the length of the day, and this product multiplied by the average altitude of the sun for the day;
to the temperature for the day in degrees of Fahrenheit.

Or, to put the formula into a briefer form:

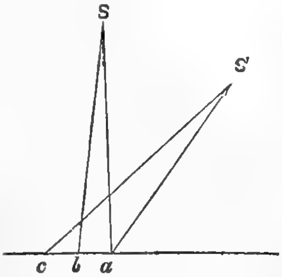
Let sin. A stand for the sine of the altitude at noon, D for the length of the day, and C for the correction of the average of the altitude at the equator; then sin. A′ and D′ and C′ will stand for corresponding values for any day in any other latitude; and we have, with T for temperature:

$$\text{As sin. } A \times D \times C : 80^\circ :: \text{sin. } A' \times D' \times C' : T.$$

If now we call D, in the first term of the first ratio, unity, and make D′ a fraction obtained by dividing the length of the day between sunrise and sunset by 12, we shall simplify the operation of computing for the values of T.

By the use of this formula, I have computed the average temperature, with that for the hottest and for the coldest season, for each latitude in the northern hemisphere.*

* The results given in this Table differ somewhat from those that have been previously given, especially in giving a lower temperature for the higher latitudes; and as the importance that should be attached to the results of any computation depend alike on its method and on its data, I give, for the satisfaction of those who may desire it, the brief outline of both.



Let S and S′ denote the sun at different altitudes, S being perpendicular. Then S′ will denote the sun at a declination from the zenith equal to the angle *SaS′*, which angle we will call the zenith distance of the sun, or simply Z. Now it is manifest that a ray of heat coming from the sun at S, and dispersed over one square foot, *ab*, will become dispersed over a rectangle elongated to *ac*, when the sun has declined to S′; and this elongation is equal to the secant of Z. Hence the intensity of the light in the rectangle *ac* will be $\frac{1}{\text{sec. } Z}$; that on the square *ab* being unity. But $\frac{1}{\text{sec.}}$ = cos., and the cosine of any angle is equal to the sine of the complement; but the complement of Z is the sun's altitude, or angular distance from the horizon.

Hence there can be no doubt that the sine of the sun's altitude = sin. A, is an expression for the intensity of the sun's rays at any place or time, after deducting what is absorbed, or perhaps

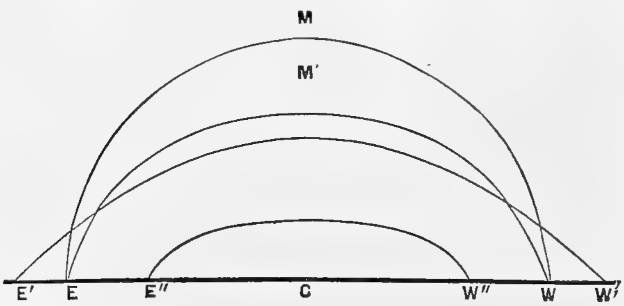
TEMPERATURE OF DIFFERENT LATITUDES IN THE NORTHERN HEMISPHERE.

LATITUDE.	Per cent of solar heat during the year.	Average temperature in deg. of Fahrenheit.	Hottest day.	Pr. cent of equatorial heat.	Length of longest day.	Temperature.	Pr. cent of equatorial heat in the coldest day, Dec. 21.	Length of day.	Temperature in deg. of Fahrenheit.
					H. M.			H. M.	
Equator . 0....	.958	80.0	Mar. 20	1.000	12· 0	83.5	.917	12· 0	64.80
Latitude. 5....	.955	79.6	April 2	1.000	12· 3½	83.8	.879	11·56½	56.30
do .. 10....	.944	78.7	April 15	1.000	12·10	84.6	.834	11·50	51.00
do .. 15....	.925	77.2	April 30	1.000	12·32	87.2	.782	11·28	43.40
do .. 20....	.900	75.1	May 19	1.000	12·45	88.6	.725	11·15	35.90
Tropic .. 23° 28′	.879	73.3	June 21	1.000	13·26	93.4	.681	10·34	29.50
Latitude. 25....	.831	72.5	do	.999	13·34	94.2	.663	10·26	27.60
do .. 30....	.794	69.3	do	.993	13·52	93.6	.595	10· 8	21.70
do .. 35....	.750	65.9	do	.979	14·22	92.1	.522	9·38	17.20
do .. 40....	.702	61.2	do	.958	14·42	89.5	.446	9·18	11.10
do .. 45....	.648	56.5	do	.930	15·26	86.2	.367	8·34	6.70
do .. 50....	.589	51.4	do	.894	16· 8	82.1	.284	7·52	3.50
do .. 55....	.525	45.8	do	.852	17· 6	79.6	.199	6·54	1.50
do .. 60....	.458	39.9	do	.803	18·30	78.4	.113	6·30	— 0.04
Polar cir. 66° 32′	.365	31.8	do	.730	24· 0	77.8	.000	0· 0	— 0.50
Latitude. 70....	.313	27.3	do	.687	24· 0	70.7	—.060	0· 0	— 3.20
do .. 75....	.242	21.1	do	.622	24· 0	67.8	—.147	0· 0	— 8.10
do .. 80....	.158	14.8	do	.651	24· 0	60.5	—.232	0· 0	—12.80
do .. 85....	.080	6.9	do	.476	24· 0	56.0	—.316	0· 0	—16.50
Pole .... 00....	.000	0.0	do	.398	24· 0	44.1	—.398	0· 0	—21.40

It is not at all improbable, however, that after we pass the polar circle, a new law comes into operation that will greatly change the results above given. In summer, it will be remembered, there are no days followed

the difference between what is observed when the sun is at S, and what is absorbed when it is at any zenith distance from S, as S′.

The length of the day is also an element in the calculation. This may be represented to the eye by the annexed diagram, in which EW is a straight line denoting and varying with the



length of the day. On the 21st of March or September, the sun on the equator rises at E, and passes in the arc of the circle through M to W at evening; but at some distance from the equator, say latitude 45°, it reaches only about seven-tenths the distance CM, and its path is denoted by the curve line EM′. But on any day and in a high latitude, when the day is more than twelve hours, the curve denoting the sun's path should start at some point outside of E, as at E′; and on a day when the time between sunrise and sunset is less than twelve hours, the line should start at some point inside of E′, as E″.

Now it is manifest that the amount of heat in any solar day is equal to the space contained between the base line ECW and the curve line above it, whether it be EMW or E′M′W′, &c. This curve line is very nearly if not quite an ellipse. I am inclined to think that the ordinates by nights of radiation and cooling, just as in winter there are no intervals of sunshine to interrupt the process of cooling; and it is probable that the prolonged and uninterrupted radiation may produce an intensity of

in all cases, except when CM = EC and the curve is a circle, will be found, for the first part of the distance E′C, too long for an ellipse, and in the latter part a little too short, until, of course, we come to CM′, which will be the half minor axis of an ellipse, EC being the half of the major axis. Still, however, the figure is nearly enough to an ellipse for all the purposes now before us.

Changing somewhat the ordinary notation for an ellipse, let us, for the convenience of the notation, denote the half of the minor axis, which is, of course, sin. A, by A, and the half of the major axis, which is half the time between sunrise and sunset, by D, and we have the heat of the day denoted by $\frac{AD\pi}{2}$.

But A, in this formula, denotes the greatest altitude of the sun, or the half of the minor axis of the ellipse. If we recur to the process of obtaining the formula $AD\pi$ for the area of an ellipse, we have

$$ds = \frac{A}{D}(D^2 - x^2)^{\frac{1}{2}}\,dx;$$

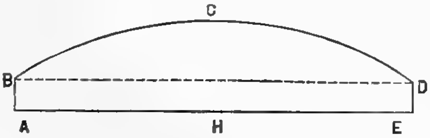
and by consequence,

$$s = \int \frac{A}{D}\,(D^2 - x^2)^{\frac{1}{2}}\,dx.$$

Whence it appears that if we divide $\frac{AD\pi}{2}$ by D, we get the average value of A; that is, $\frac{AD\pi}{2}$ represents a parallelogram whose base is D, and whose altitude is equal to the quotient of this fraction, $\frac{AD\pi}{2}$ divided by D, or $\frac{A\pi}{2}$, which is half the sine of the sun's altitude, into 3.141, &c.

Hence I use the average thus obtained as a correction for the absorption spoken of in the text: this correction, for the perpendicular rays of the sun, is .6. Hence, by multiplying the sine of the sun's average altitude for midday by .6, and by the length of the day, 12h., for the first term in the proportion, and then multiplying the sine of the sun's altitude for any other day and latitude by the correction for the day and altitude obtained as above, for a third term, or the antecedent of the second ratio, we have, with 80° Fahrenheit, the average temperature at the equator, a formula for obtaining the temperature in degrees of Fahrenheit for the day and latitude for which the third term was made.

When we reach the polar circle, however, a modification of the formula becomes necessary. Within that circle the sun does not set or reach a zero of altitude at all; and it becomes necessary, in order to get our average for the correction for absorption, to integrate the values of A between the limits of the maximum altitude for the day, that is, the altitude for noon, and the minimum of the altitude for midnight; and to the average thus obtained, we must add the value of the midnight altitude. The figure that denotes the sun's heat for the day under these circumstances, becomes a semi-ellipse resting on a parallelogram, as in the annexed figure, in which AB represents the sun's altitude at its minimum, and the distance HC its altitude at midday; the base AE or BD having now become constant, and equal to double its length at the equator, where the days are only and constantly twelve hours long.



But in winter, December 21st, the sun never rises within the Polar circle. Hence a new expedient must be resorted to. I have taken the angular depression of the sun at midday as the minimum, and its depression at midnight as the maximum or superior limit within which to integrate for the average to be used as a correction. This implies that radiation of heat from the earth, or the cooling process, goes on at the same rate as the reception of heat from the sun, or the warming process, other things being equal. This is proved to be the case by two considerations:

1. Otherwise, that is, in case either heating or cooling were in excess, the earth would be growing cooler or warmer, not from season to season as it now does from summer to winter, but

cold far beyond what is indicated by the figures in the table; and in the continued sunshine of summer there is likely to be an intensity of heat, arising from the very continuance of the sun's direct rays, far beyond what is indicated. Even in the coldest days of our winter, the sun's rays continue to warm whatever they fall upon, as long as they fall upon it; and every object known to science would not only be heated, but reduced to a fluid, or even a gas, by the prolonged continuance of those rays, provided only the substance could be so isolated as not to part with any of its heat by radiation to other objects. The above results, however, correspond, especially in the column denoting the average for the year, with very great accuracy with the results of observation, denoted by the isothermal lines, so far as those results have been ascertained; and I presume that the results given in columns seven and ten, would be very nearly the temperature of the warmest and the coldest seasons in the northern hemisphere, if the earth were a globe uniform in its surface and none of the causes which I have enumerated above and proceed to consider below, were at work in causing variations.

from year to year; a process which, if it exists at all, must be very slow, as no observed facts prove it to be taking place.

2. A comparison of temperatures as observed at evening and at morning during the year, averaged for several years, shows, of course, that the air is cooler in the morning than at evening; but there is no difference in this respect between summer and winter that indicates the operation of a different law. Hence I infer that although the nights are much shorter in the summer than the days, and longer than the days in the winter, yet the radiation must take place so much faster in the summer when the earth is warmest, that the intensity of radiation multiplied into the term must produce a number whose ratio to the amount of heat received is constant, or very nearly so.

The length of the day I have obtained by Robinson's formula, namely:

$$\frac{\text{tan. of lat.} \times \text{tan. sun's decl.}}{\text{radius}} = \text{sine of the distance at which the sun reaches the horizon from } 90^\circ \text{ longitude from the place of observation.}$$

Converting this sine into time on the usual formulæ, namely, 1° long. $= 4'$ of time, &c., and adding or subtracting, as the case may require, twice the amount of time thus obtained, to 12h., we have the length of the day without correction for refraction; and this correction, as also that for the difference in the apparent semi-diameter of the sun's disk, I have omitted in the foregoing computations as being too small to be of importance for our present purpose.

A much shorter method of obtaining the correction for absorption, and one that is near enough for most purposes, is as follows: divide the midday altitude into a given number of parts, say ten; then the sum of the first part will be one ordinate; double that sum will be another; treble it a third, and so on; take the sine of the successive ordinates, and to this sum add the sine of the midday altitude, and divide the sum of the whole by their number increased by one, and the quotient will be the correction required proximately. Thus, if the altitude be 40°, we have ten parts; the successive ordinates will be 0, 4, 8, 12, 16, &c.

The results obtained by the above method, and given in the Table, differ from those previously given by others (and by myself in fact), in that I have now for the first time, so far as I know, made the correction for absorption. The temperature indicated, especially for the high latitudes, is in consequence lower than that obtained by previous computations, and, I think, more nearly corresponding with observed facts. Moreover, if the effort has before been made to compute the cold of the polar regions, it has not fallen under my notice.

It will be observed, also, in the above Table, column fourth, that the hottest day at the equator is March 20th (the same is true also of September 22d), and at latitude 5 the hottest day is April 2d; and the farther north the later, until we reach the Tropic of Cancer and June 21st. But in fact the greatest heat is not reached until some days after that which is thus indicated as the hottest. Within the tropics this difference is slight, perhaps nothing; but as we pass towards the pole it becomes perceptible. In our latitude the heat does not reach its maximum, as appears on an average of fifteen years, until the first day of August, or about six weeks after the summer solstice. This is owing to the fact that while the sun is decreasing in altitude and the days are decreasing in length, the earth is receiving more heat during the day than it radiates during the night, and it is thus accumulating and hoarding up heat, if we may use such an expression.

Hence, for this and other reasons, to be discussed below, we have in all high latitudes days that are colder, and days that are much warmer than the extremes above indicated. Within the tropics, however, and near them, it is not likely that a degree of cold so great as is indicated in the Table is ever anywhere experienced at the level of the sea coast.

II. *Elevation above the Sea Level.*

The next cause influencing climate, in the order of our enumeration, is elevation above the sea level.

It is commonly held, that as we ascend from the sea level, the air grows colder at the rate of about one degree for every three hundred feet of ascent. This is owing to the fact that the air receives but very little warmth from the direct rays of the sun as they pass through it; consequently, the air depends for its temperature chiefly upon the heat that it receives both by radiation and conduction from the earth. That the temperature grows colder as we ascend, all persons know; and even under the equator, snow becomes perpetual at an elevation of about sixteen thousand feet.

By referring to the preceding Table, it will be seen that between latitudes 35 and 60, an elevation of about three hundred feet, diminishing the average temperature one degree according to the above rule, is equal to one degree of latitude in its effects on the climate of any place. Thus, to elevate it three hundred feet, would produce the same effect on its climate as the placing it sixty miles farther north.

But to this rule there are certain exceptions. It makes a great difference whether the ascent be steep or gradual. The position of the surface from which the ascent is made, is also important in its influence. The average temperature in the Great Salt Lake valley in our own continent, though it is four to five thousand (4,351) feet above the level of the sea, is as warm as the places on the California coast in the same latitude and at the sea level, as Fort Humboldt, for example; Fort Madison, Iowa; and Ottawa, Illinois: the average for the year in Great Salt Lake City being about 52; that at Fort Humboldt is given at 52.1; Fort Armstrong, 50.3; and Ottawa the same.

Again: the cereals, as barley, etc., will grow on the north side of the Himalayas at an elevation of some two or three thousand feet higher than on the south side, notwithstanding a difference of some two degrees in latitude. But on the south side, the reflected rays of the sun are sent up from a plain which is nearly on a level with the sea; while on the north side, the reflecting surface is the elevated plateau and table land of Thibet.

In apparent contradiction to this law, we often find the weather much colder in low narrow valleys, especially in autumn and winter. I have known the thermometer to fall eight degrees in a descent of some two hundred feet, and at a distance of not more than half a mile; and all persons have doubtless observed the fact that frosts frequently cut off the tender crops much earlier in the low lands than on the hill-sides and hill-tops even adjoining them. The reason is, doubtless, to be found in the fact that the cold air being heavier than warm, descends into the valleys by the force of its own weight. This phenomenon, therefore, can occur only when the stratum of air is colder than the earth below it.

III. Distance from the Sea Coast.

Inland distance, or distance from the sea coast, is an important element in determining temperature.

Perhaps this fact will make no great difference in the general average for the year. Its influence is chiefly felt in the contrasts between summer and winter, and the heat of the day when compared with the coolness of the night.

The following examples will illustrate this principle:

Latitude.	Locality.	Winter.	Summer.	Difference.
Latitude 60°	Shetland Isles	38°.5	54°.0	15°.5
do	St. Petersburgh	16 .3	60 .8	44 .5
do	Yakutsk	−38 .0	63 .0	101 .0
Latitude 50°	Penzance	44 .6	60 .4	15 .8
do	Barnoul	6 .6	61 .9	55 .3
Latitude 30°	Madeira	61 .3	70 .0	8 .6
do	Cairo	55 .5	84 .6	29 .1

And for examples on our own continent and one island from each coast:

Latitude.	Locality.	Winter.	Summer.	Difference.
FROM THE PACIFIC.				
Latitude 40°	Fort Humboldt	45°.2	57°.4	12°.2
do	Salt Lake	32 .1	75 .9	43 .8
do	Fort Madison	26 .1	78 .1	52 .0
FROM THE ATLANTIC.				
Latitude 30°	Bermudas	59 .2	75 .2	16 .0
do	Natches	49 .8	79 .9	30 .1

From these comparisons, it appears not only that the contrast between summer and winter increases as we go inland, but also that it is greater in the high latitudes than nearer the equator.

This fact is important to the vegetable productions. Many of our most valuable crops—being annuals—care nothing for the cold of the winter if they can but have the requisite heat in the summer; and others, which are indeed perennial, as grapes, peaches, etc., can be protected against frost in the inland winter, so as to produce most abundant and delicious fruits in the summer; which, however, will not arrive at maturity at all at the sea coast on the same isothermal line, for want of the greater heat of summer which they find in their inland position. England, for example, does not produce grapes, with an average for the year of 50°, two at least more than our own, and winters no more than 40° against our 25°.5; while in the neighborhood of Astracan and coastwise, with the same general average for the year as England, and winters averaging at least 8° or 10° colder than ours, and 25° colder than those of England, "grapes and fruits of every kind are as beautiful and as luscious as in the Canaries," although the vines must be buried several feet deep in the winter to preserve them from frost.

The temperature of places that have no great inland distance, is modified by the sea currents that may happen to flow near their coast. The effects of these currents are scarcely felt in latitudes near the tropics. The Gulf Stream, for example, which flows from the Gulf of Mexico, deflects the isothermal line of 32° for the year, from latitude 55° where it leaves the American continent, to 75° north in the North Atlantic, near the island of Spitzbergen, and produces winters at the North Cape of Norway, latitude 70°, no colder than our own; so that the winters of Iceland are scarcely colder than Lombardy.

But inside of this Gulf Stream, along the Canada and New England coast, there is a cold stream passing from the Polar sea towards the equator. The seasons are perceptibly retarded, especially in the spring, by this cold sea current along their coast. It gives rise also to those cold northeast storms and winds which are so disagreeable through the spring and early summer. These winds and storms are felt as far inland as Central New York, and in some instances still farther.

IV. Situation in Reference to Mountain Ranges, etc.

The fourth cause named as affecting temperature, is situation in reference to the great mountain ranges.

The atmosphere presses upon the earth with a pressure of fifteen pounds per square inch, or a weight equal to a stratum of water about thirty feet deep.

In consequence of the unequal distribution of heat and the rotation of the earth on its axis, there is always a current called "*the polar current*," moving towards the equator, and another called "*the return current*," moving in the opposite direction, or from the equator to the poles. Sometimes the polar current is "*the surface current*," as it is called; that is, it blows next to the surface of the earth, and the return current blows above it in the other direction; and at other times the order is reversed, and we can always distinguish them by two signs: (1) The return current blows in the northern hemisphere from a southerly direction; and (2) is warmer than the polar current, which blows from a northerly direction.

Now, when either of these winds, as surface current, meets with a mountain range or other obstruction of the kind, it does as a stream of water would, turn around it, if it be higher than the upper surface of the wind. Take, for example, the Alps, and in fact the great Eastern range extending from the Atlantic coast as Pyrennees and reaching the Pacific coast as Altai. Starting from the Atlantic coast at latitude about 40°, it stretches across the continent with but few gaps, and reaches the Pacific coast at latitude nearly 60°; and thus it is in just the latitude where the polar and the return currents usually change position. The consequence is that the polar current is seldom if ever felt south of this mountain range, while an undue share of the return current is retained to raise the temperature of all the places that are thus sheltered from the polar current.

On our own continent we have, in like manner, the Rocky mountains stretching across the continent from southeast to northwest. If now we select for comparison some places in the same latitude, one on the Pacific coast, another on the plain east of the mountains, and another still farther east and east of the Mississippi, we shall see the effects of this mountain range. Thus:

LATITUDE.	LOCALITY.	Summer.	Winter.	Year.
Latitude 40°	Fort Humboldt, Cal.......	57°.4	45°.2	52°.1
do	Fort Kearney, Neb.	71 .5	23 .0	47 .7
do	Milton, Ind..............	78 .4	29 .7	52 .2
Latitude 47°	Fort Steilacoom, W.T.....	62 .9	39 .5	50 .8
do	Sandy Lake, Min.........	64 .8	14 .0	39 .9

Farther south, the difference is of course much less. But in latitude 40°, with the summer 14°.1 warmer than on the Pacific coast, the winters are 22°.2 colder, and the average for the year is in consequence 4°.4 colder on the western side of the Rocky mountains; while in Indiana, beyond the more immediate effects of this obstruction to the polar and return current, the summers are 6°.9 and the winters 6°.7 warmer, with a difference in the general average 4°.5 for the year. Farther north, as latitude 47°, the contrast becomes still more remarkable; with summers 2°.1 warmer than on the Pacific coast, the winters 25°.5 colder, and a difference in the general average for the year of 10°.9.

Or, to compare the effects in another way: The isothermal for winter that passes through the places of western New York that lie along the borders of Lake Ontario, and from ten to twenty miles south, starts on the Pacific coast far north of Sitka, 57° north latitude, and reaches in New Mexico, just east of the mountains, the low latitude of 36°, then reaches ours, about 43°, in Michigan; while the isothermal for our summer, 67°, starts from latitude 30° on the Pacific coast, and passes the plains just east of the Rocky mountains in latitude 35°. Thus the cool winds from the pole which pass along down by the side of the mountains, make even the summers as cold at 35° of latitude as ours are at 42° or 43°; or, in other words, these winds make a difference in temperature equal to 8° of latitude.

V. Situation in Reference to Inland Lakes, etc.

These bodies of water cool the air in summer, and warm it in winter.

Let us suppose, first, that the air is below 32°. While the lake is open, the air will be warmed by contact with the water and by radiation from it. It has been ascertained by experiment that one cubic foot of water, in cooling 1° Fahrenheit, gives out heat enough to raise 3,080 feet of air 1°, or 300 feet about 10°.

But again: When the water becomes cold enough to freeze, and freezing commences, the solidification gives out what is called the "*heat of liquefaction;*" and this, in the formation of one cubic foot of ice, is sufficient to raise 691.922 feet of air 1°, or 34.596 feet of air 20°, or 13.854 feet 50°.

Doubtless the tendency of the air, thus heated, is to rise directly upward. But rather than ascend directly through the mass of colder air immediately over it, it is driven by the winds; and even when there are no winds of any considerable force, it will creep along up the banks of the river or lake, and the sides of the adjoining eminences, softening and modifying their climate by its approach to them.

On this point I have no statistics within my reach, except such as have been derived from my own observation. January 8th, 1855, the thermometer indicated 7° above at 7 A. M. in my Observatory. At a private residence only a few miles west, back of the lake, it stood at zero; and at Phelps, eight miles northwest, it was reported at 7° below; and I have observed similar discrepancies in other cases. Even to the east of us, and between the two lakes, Seneca and Cayuga, the temperature is always found to be several degrees colder when the thermometer reaches a figure below zero.

Of course, when a lake becomes entirely frozen over, or frozen out a long distance from the shore, it ceases to influence the temperature in the way I have described: in the one case, because there is no longer any open surface of water; and in the other, because it is so far off, and is separated from the land by a level surface along which the warm air will not pass as it would if it were ascending.

The heat thus given out by the cooling of the water and the formation of ice in the autumn and early winter, would of course be returned in the spring when the ice thaws and the water is gathering its warmth for summer. Hence, while this cause will produce a manifest difference in temperature at particular seasons and on the coldest days, it is not likely that it will exert any very great influence on the general average of temperature for the year; but it will accomplish two important practical results: (1) It will retard the spring so as to prevent the more delicate fruits from putting forth so soon as to be in the way of the later frosts; and (2) it will put off the frosts in the autumn, so as to allow grapes and other fruits that need a long season, to ripen better than they otherwise would.

If, now, inland towns like all those in the western and northwestern part of our State, and those in States farther west and in Canada even, are situated not on a lake merely, but in the neighborhood of a chain or system of them, we shall have these inland bodies of fresh water exerting an influence upon them all, and extending over a large tract similar to what I have described, and similar, likewise, to some extent, to that which I have ascribed to the greater bodies of salt water, in speaking of inland distance. There can be no doubt, I think, that we are indebted to this influence, largely, for the climate which renders our inland towns and counties in central New York so productive. Like the Atlantic ocean on the east of us, which, as already said, is exposed to more than its normal share of the polar current by the position and course of the great mountain ranges of the old continent, so our land is exposed to, and receives far more than its due share of the same cold winds by reason of the situation of the Rocky mountains. The polar current that should pass over where they stand, is turned out of its course by them, and deflected across the continent towards the Atlantic ocean; so that our polar currents, which should come from a northeasterly direction, come from the northwest, and are sometimes deflected so far that they come to us from a point of the compass that is some degrees to the south of west. Hence it is, as I think, that the isothermal line of 50° for the year, which should pass some 10° northward of us—latitude 43°—passes across the continent from the moment it reaches the plains east of the Rocky mountains in the northern part of Colorado, along in a direction somewhat south of easterly until it reaches and passes by the longitude of the great lakes, and then turns to a direction north of east until it reaches its normal parallel of latitude, 50°, about the middle of the Atlantic ocean, and after it has crossed and been warmed by the Gulf stream.

Were it not for the softening influence of these lakes, it can hardly be doubted that our winters would be on the average at least 10° colder than they now are, or as cold as they are in Asia just east of the Caspian sea, where there is a gap in the great mountain chain between the Caucasus and Hindoo Cush, in what are known as the plains or steppes of Mayntsch, where the average temperature for the three winter months, December, January and February, is only 15° above zero, and periods are not unfrequent with the thermometer 25° and 30° below zero for several days in succession. But owing to the influence of these inland lakes, we have along their border and around them, spring as early, autumn frosts as late, and winter as mild, as in central Pennsylvania; while in the region along the south boundaries of New York and in the northern tier of Pennsylvania counties, the summers are some two or three weeks shorter, and the winters five or six degrees colder.

Besides the foregoing general principles, there are many details of local climatology that can be obtained only by long continued and careful observations in each place; and such observations, when published in large numbers and from a large number of places, will undoubtedly furnish facts from which further generalizations and laws can be deduced. But the observations should be published *in full:* no abridgment or summary will answer.

As illustrating what I mean, I will refer to a generalization partially made by myself, and arrested in its progress towards completion for want of the very material I have referred to. In summer we often have days of great intensity of heat; and in winter, in like manner, days of greater cold than mere astronomical forces can account for. Now, whenever we had, at Geneva, a day in which the thermometer has fallen to 6° or 7° below zero, or more, I have found the following phenomena, *observed here. First.* The wind has always passed from a southwesterly direction to west, northwest, north, northeast, and in nearly if not quite all cases it passed by way of east round to southwest again; and if it were blowing very strong, as happens in about half the instances, when it started from the southwest, it gradually lulled down and became very slight as it reached north. *Secondly.* The barometer commenced rising as the wind began to change and the cold to increase, and continued to rise until it reached a very high point. Last winter it reached the unprecedented height of 30.504 inches. *Thirdly.* At night the sky has been generally clear, so as to allow unobstructed radiation by cooling; and in the daytime the sky has been overcast, so as to obstruct the sun's heat from reaching the earth. As *observed elsewhere*, and reported in the newspapers and by personal correspondence, I find, *first*, that in almost all cases, perhaps all, the wave of cold, so to call it, passes from west to east, and the cold reaches its maximum of intensity in the Mississippi valley some fifty or sixty hours before it reaches this place. In case of the unusual cold term last January (Jan. 8th at Geneva), the cold wave appeared on the Pacific coast seven or eight days before it reached us, and I have heard of it in England some ten or twelve days after it had passed our meridian. There were in this case, however, some unusual breaks in the wave; as the cold at Buffalo and Rochester, for example, was not unusual, being only 3° or 4° below, while it was 12° below at Geneva, and increased as it progressed eastward to 31° below at Utica. In fact it would appear as though one wave, that of which we first hear as on the Pacific coast, had expended itself, reaching Geneva on the night of the 4–5th, the thermometer falling to 1° above on the morning of the 5th, it being on that morning 3° below at Rochester; and another commenced immediately, forcing the thermometer to 5° below on the morning of the 7th, and to 12° below on the morning of the 8th, increasing in intensity eastward. The *second* phenomenon that I have observed is, that the crest of the wave, or line of maximum cold, always passes in a curvilinear direction from north to the south, inclining evermore to the west, until it is lost in the tropics. One such line passed through Montreal, Rouse's Point (N. Y.), Utica, Pittsburg (Pa.), Nashville (Tenn.), New Orleans, Galveston, &c.; so that the moment of greatest cold was simultaneous in all the places on this line, while both to the west and to the east of them the weather at that moment was warmer, being 32° at Chicago and 25° or 26° at Portland (Maine); the cold always reaching its maximum at the time when the wind had reached a point of compass somewhat north of east, blowing in fact about in the line that I have indicated as that of the greatest cold.

Now I think that I can generally predict the approach of such a cold term some days — two at least — before its arrival, by observations that are to be made in my own observatory. And the phenomena just described suggest that the balance of the winds, the polar and return currents, are for some reason disturbed; the polar current stiffening and driving back the return current until the former—the polar current—prevails, and becomes so strong as to blow, finally, at the moment of the greatest cold, in its normal course, and as it would always blow if there were no mountain ranges or other disturbing causes to divert it from its proper path.

So with "*heated terms*," as they have been called. So far as I have been able to observe and collect statistics, they occur as follows: *First.* We have a balancing of winds, or air currents, so that over a large tract, a hundred miles or more in diameter, there are no winds, except slight local currents not passing out of this region, and none from without it passing in. *Second.* We have a clear sky, with very little vapor or other substance in the air "to absorb," or rather, as I would say "*to reflect back*" the sun's rays. These conditions, continuing for a day or two, will produce great heat. If the air continues clear and dry, the heat becomes great, and the *direct* rays of the sun seem to be intensely scorching. But for the most part, as a *third* condition, there will arise, by evaporation, within this enclosure of the winds, moisture enough to overspread it like a dome (not perhaps with visible clouds); and thus, while it does not obstruct the sun's rays from passing through to the earth, it absorbs and reflects back all of those that are radiated from the earth, and constitutes an oven-like enclosure, with the walls of wind for its sides and this mass of vapor for a dome; and the weather is not only hot, but *sultry*.

I have said there is in such cases much moisture in the air. This usually shows itself, in time, in clouds and a low dew point. But it is a mistake to suppose that when there are no clouds there is but little moisture, or rather water, in the air. Clouds are merely vapor made visible or manifest by contrast of temperature. When the ascending vapor, which is in fact always ascending in some quantity, even in the coldest of weather, reaches a current or stratum of air enough colder than that in which it first became vapor, it is converted into a cloud. This *may* occur simply by the vapor's ascending to an elevation approaching what is called the snow line; but clouds are formed for the most part at the place where the two currents meet, blowing of course in opposite directions, the upper one being generally the coldest.

Nor can we doubt for a moment that the meteorological records of any place, if accurately kept and published in detail, would furnish data from which other and most important inferences could be drawn; and as illustrating several such points, and as a slight contribution to our knowledge on local climatology, I give in a tabular form the average temperature for every day in the year, with the maximum of heat and of cold for the day as observed in the observatory in this place for a period extending over twelve years, from 1854 to 1865 inclusive. During the first year the records are incomplete; still, however, if any one should wish hereafter to continue the average here given, he has only to multiply that which is given by twelve, and add that for any other year and divide the amount by thirteen.

I. DAILY THERMOMETRICAL RESULTS FOR THE YEARS 1854–1865.

Compiled from observations made at Geneva (New York), lat. 42°.52, long. 77°.2; height 567 feet above sea level.

JANUARY.				FEBRUARY.				MARCH.			
Day.	Average temperature.	Greatest heat.	Greatest cold.	Day.	Average temperature.	Greatest heat.	Greatest cold.	Day.	Average temperature.	Greatest heat.	Greatest cold.
1	24.73	51.0	5.0	1	27.81	50.0	− 2.0	1	29.29	53.0	13.0
2	23.31	40.5	− 2.0	2	21.45	41.0	3.0	2	28.72	53.2	7.0
3	26.19	40.5	6.0	3	19.09	35.0	− 5.0	3	31.81	56.5	5.0
4	27.22	52.0	7.3	4	19.41	35.5	− 6.3	4	30.84	57.0	6.0
5	24.82	53.0	6.5	5	23.10	42.0	− 1.0	5	29.26	57.0	− 1.0
6	25.34	42.0	7.0	6	23.34	52.5	−18.5*	6	28.26	40.5	10.0
7	24.74	46.0	5.0	7	26.11	55.0	−12.0	7	27.82	58.0	4.0
8	19.09	42.0	− 1.0	8	24.19	39.0	− 9.0	8	29.78	50.5	5.0
9	22.54	41.0	− 8.0	9	24.43	46.0	11.0	9	29.66	47.5	− 4.0
10	25.00	46.0	−16.0	10	19.93	44.0	4.0	10	26.30	48.5	− 5.0
11	23.57	52.5	5.0	11	21.28	50.5	3.0	11	30.62	54.0	13.0
12	28.11	65.0	2.0	12	23.68	51.0	− 1.5	12	29.53	52.5	10.0
13	27.32	42.5	6.0	13	25.05	42.0	− 6.0	13	29.50	63.5	8.0
14	27.52	42.0	5.0	14	25.00	42.0	− 1.0	14	35.16	53.7	15.0
15	28.29	44.0	6.0	15	27.54	56.0	5.0	15	35.31	56.0	4.5
16	26.10	46.0	0.0	16	27.15	46.0	8.0	16	36.71	60.0	16.0
17	24.21	40.0	1.0	17	25.16	56.0	− 1.0	17	35.67	59.0	8.0
18	22.42	39.0	−15.0	18	29.12	47.0	2.0	18	33.06	60.3	8.0
19	25.57	42.0	2.0	19	22.78	45.5	− 1.0	19	30.24	54.3	6.0
20	27.10	54.0	0.0	20	26.59	44.0	12.0	20	30.76	62.5	11.0
21	25.89	51.0	10.0	21	26.93	48.0	9.0	21	32.52	72.0	10.3
22	24.19	43.0	− 8.0	22	30.51	49.0	4.0	22	32.82	49.5	15.0
23	26.49	50.5	− 1.0	23	29.71	51.5	7.0	23	35.65	51.5	15.0
24	26.28	48.0	6.0	24	27.86	59.0	8.0	24	32.96	49.0	12.0
25	27.62	50.0	1.0	25	27.04	45.0	7.0	25	33.62	55.7	16.0
26	25.55	52.0	5.3	26	27.72	49.0	10.0	26	33.00	51.0	19.0
27	24.34	54.0	3.0	27	31.02	59.5	10.0	27	33.10	52.0	19.0
28	27.32	39.5	6.0	28	29.92	51.0	11.0	28	32.70	61.0	13.0
29	26.08	39.0	17.0	29	33.37	50.0	15.0	29	37.22	59.0	17.0
30	25.22	41.3	7.0	...	...	...		30	37.82	68.0	18.0
31	22.18	38.0	− 8.0	...	...	...	* 1855.	31	40.00	70.0	16.0

DAILY THERMOMETRICAL RESULTS—CONTINUED.

APRIL.				MAY.				JUNE.			
Day.	Average temperature.	Greatest heat.	Greatest cold.	Day.	Average temperature.	Greatest heat.	Greatest cold.	Day.	Average temperature.	Greatest heat.	Greatest cold.
1	33.32	61.0	11.0	1	49.19	69.0	39.0	1	62.00	75.0	46.0
2	38.45	65.0	21.0	2	48.98	69.0	31.0	2	62.92	84.0	50.0
3	41.44	65.0	25.0	3	48.14	68.0	36.0	3	62.40	80.0	50.0
4	41.42	61.0	28.0	4	50.38	67.0	34.0	4	60.15	87.0	38.0
5	41.29	68.0	23.0	5	53.12	78.3	40.0	5	60.49	84.0	44.0
6	37.80	54.0	22.0	6	52.17	80.0	33.0	6	60.89	85.5	48.0
7	41.98	61.3	27.0	7	51.63	84.0	31.5	7	61.55	86.0	47.5
8	34.92	63.0	25.0	8	55.31	81.0	35.0	8	60.34	78.0	49.0
9	41.81	67.5	26.0	9	55.18	73.0	40.0	9	61.68	82.0	46.0
10	40.23	55.0	31.0	10	53.66	77.0	41.0	10	61.10	85.0	47.0
11	42.63	71.5	29.0	11	51.63	69.0	30.0	11	60.81	85.5	41.0
12	44.63	66.0	32.0	12	54.31	78.0	36.5	12	63.13	83.0	46.0
13	42.17	63.0	22.0	13	51.71	75.0	39.0	13	61.94	79.0	50.0
14	42.79	62.0	27.0	14	56.27	74.0	39.0	14	63.72	79.0	54.0
15	41.92	62.0	26.0	15	58.22	82.0	46.0	15	66.04	86.5	54.0
16	43.64	67.0	32.0	16	58.17	84.0	39.0	16	61.53	80.0	46.0
17	43.72	75.0	30.0	17	55.92	83.5	36.0	17	64.49	81.0	50.0
18	46.54	73.5	31.0	18	56.23	82.0	37.0	18	67.75	88.5	48.5
19	45.46	64.0	35.0	19	55.76	68.0	44.0	19	66.45	87.0	53.0
20	44.02	66.5	32.5	20	55.82	75.0	41.5	20	66.00	87.5	54.0
21	47.07	64.0	34.5	21	58.29	81.5	43.0	21	67.12	87.0	55.0
22	49.16	79.0	34.0	22	56.71	84.0	44.0	22	69.89	87.5	55.0
23	45.88	66.0	32.0	23	59.91	85.0	45.5	23	65.48	85.5	54.0
24	45.25	77.0	32.0	24	63.29	84.5	42.0	24	66.61	85.0	57.0
25	45.94	70.0	31.0	25	60.84	85.0	43.0	25	70.17	90.5	55.0
26	47.70	72.0	32.0	26	60.65	84.0	44.0	26	72.25	88.0	62.0
27	47.68	76.0	30.0	27	60.25	80.0	48.0	27	69.88	86.0	60.0
28	46.76	78.0	30.0	28	57.32	82.0	44.0	28	72.35	89.0	54.0
29	49.30	69.0	33.0	29	57.57	83.0	40.0	29	72.88	94.0	56.0
30	49.70	68.0	37.0	30	57.65	80.0	39.0	30	69.48	89.5	52.5
....	.....	....	....	31	63.31	82.0	40.0	....	.....	....	....

DAILY THERMOMETRICAL RESULTS—CONTINUED.

JULY.				AUGUST.				SEPTEMBER.			
Day.	Average temperature.	Greatest heat.	Greatest cold.	Day.	Average temperature.	Greatest heat.	Greatest cold.	Day.	Average temperature.	Greatest heat.	Greatest cold.
1	68.19	86.0	55.0	1	73.29	90.0	56.0	1	63.93	83.0	50.0
2	68.21	84.0	49.0	2	73.12	89.0	59.3	2	62.72	81.0	46.0
3	69.68	88.0	49.0	3	71.64	86.0	57.0	3	63.76	82.0	46.5
4	64.54	84.0	32.0	4	70.93	92.0	62.0	4	63.65	82.0	47.0
5	68.67	87.0	52.0	5	71.34	84.0	61.0	5	65.38	87.0	50.3
6	70.62	87.5	54.5	6	71.15	84.0	62.0	6	65.17	81.0	49.0
7	71.98	88.0	55.0	7	70.78	90.0	57.0	7	65.01	88.0	56.0
8	71.47	87.0	57.0	8	71.44	88.0	58.0	8	65.12	89.0	52.0
9	71.36	89.0	58.5	9	71.94	88.5	58.0	9	64.45	88.0	47.5
10	71.43	89.5	62.0	10	72.40	90.0	59.0	10	66.94	87.0	47.0
11	70.09	90.0	57.0	11	71.53	90.0	58.0	11	66.56	86.0	53.0
12	69.35	91.0	56.0	12	70.03	86.0	60.0	12	63.03	86.5	44.0
13	69.02	90.0	55.5	13	70.59	92.0	58.0	13	59.39	84.0	50.0
14	70.52	89.0	59.0	14	69.35	90.0	55.0	14	61.38	77.0	46.0
15	72.35	87.5	60.0	15	67.88	82.0	56.0	15	62.71	85.5	37.5
16	71.57	90.2	58.0	16	67.99	84.0	55 0	16	60.37	81.5	52.0
17	72.24	96.5*	56.0	17	67.87	84.0	54.0	17	63.69	85.0	48.0
18	72.41	91.0	58.5	18	68.23	86.0	52.0	18	61.03	89.5	48.0
19	74.32	91.0	63.0	19	66.90	85.0	50.0	19	58.21	77.5	41.0
20	71.38	92.0	61.0	20	68.45	88.0	54.0	20	58.89	86.0	37.3
21	67.79	89.0	56.0	21	69.29	85.0	57.0	21	59.20	76.0	48.0
22	68.26	82.0	56.5	22	68.53	86.0	53.0	22	55.54	77.5	41.0
23	68.32	84.0	58.0	23	65.88	79.0	50.0	23	56.94	78.0	40.0
24	70.12	85.0	54.5	24	68.00	95.5	52.0	24	57.90	75.0	45.0
25	71.79	90.0	60.0	25	66.86	82.0	53.0	25	55.84	73.5	42.0
26	72.53	90.5	62.0	26	67.55	86.0	52.0	26	57.18	74.0	41.0
27	71.66	87.0	57.0	27	65.39	75.0	51.5	27	57.64	79.0	41.0
28	72.12	88.0	61.0	28	65.38	80.0	53.0	28	56.53	76.0	45.5
29	71.37	87.0	62.0	29	63.77	78.0	55.5	29	55.37	71.0	34.0
30	70.96	85.5	56.0	30	61.55	80.0	48.0	30	52.88	74.0	34.0
31	71.46	91.0	53.0	31	62.41	76.0	48.0	....	.....	....	....

* 1856.

DAILY THERMOMETRICAL RESULTS—CONTINUED.

OCTOBER.				NOVEMBER.				DECEMBER.			
Day.	Average temperature.	Greatest heat.	Greatest cold.	Day.	Average temperature.	Greatest heat.	Greatest cold.	Day.	Average temperature.	Greatest heat.	Greatest cold.
1..........	54.13	69.0	40.0	1.........	48.25	73.0	34.0	1.........	34.98	59.0	12.0
2..........	55.45	68.0	39.0	2.........	47.92	68.0	31.0	2.........	32.01	54.0	14.0
3..........	58.94	80.0	44.0	3.........	44.75	62.0	34.0	3.........	30.26	59.0	12.0
4..........	58.54	79.0	42.5	4.........	44.23	69.0	23.0	4.........	29.84	53.5	11.0
5..........	56.87	82.0	40.5	5.........	43.42	72.0	20.0	5.........	31.30	47.5	8.0
6..........	54.51	74.0	36.0	6.........	41.32	62.0	24.0	6.........	32.17	53.0	12.0
7..........	54.60	79.0	36.5	7.........	43.38	58.0	22.0	7.........	32.03	53.0	8.0
8..........	52.82	85.0	35.0	8.........	43.13	58.0	22.0	8.........	28.35	61.0	4.0
9..........	50.12	75.0	34.0	9.........	41.69	64.5	29.5	9.........	30.43	51.0	14.0
10..........	50.59	73.5	38.0	10.........	40.58	58.0	28.0	10.........	30.70	63.5	11.0
11..........	52.41	76.0	41.0	11.........	40.85	58.5	27.0	11.........	29.84	54.0	13.0
12..........	50.65	68.0	37.0	12.........	42.37	57.5	26.0	12.........	28.25	47.0	9.0
14..........	49.48	63.0	33.0	13.........	39.98	55.0	22.0	13.........	33.63	47.0	12.5
13..........	48.48	65.0	34.0	14.........	36.82	57.0	20.0	14.........	35.69	58.0	7.0
15..........	45.73	70.0	29.5	15.........	34.87	49.5	22.0	15.........	31.06	54.0	5.0
16..........	48.62	66.0	30.0	16.........	38.84	47.5	27.0	16.........	33.08	57.5	15.0
17..........	48.74	76.5	35.0	17.........	38.61	58.0	26.0	17.........	27.96	45.3	8.0
18..........	51.74	73.0	37.0	18.........	39.70	56.0	29.5	18.........	25.01	49.0	− 5.0
19..........	49.06	74.0	31.0	19.........	38.87	63.0	28.0	19.........	27.31	46.0	6.0
20..........	46.37	70.0	30.2	20.........	35.03	45.0	20.0	20.........	26.22	45.0	5.0
21..........	47.30	69.5	29.0	21.........	35.30	48.0	23.0	21.........	25.96	40.0	14.0
22..........	47.62	63.0	33.0	22.........	35.51	51.5	24.0	22.........	23.48	37.0	1.5
23..........	45.14	57.0	36.0	23.........	36.32	50.0	23.0	23.........	24.25	43.5	6.7
24..........	45.07	64.5	32.0	24.........	31.40	57.0	19.0	24.........	21.87	40.3	9.0
25..........	43.09	64.5	32.0	25.........	34.05	47.0	10.0	25.........	24.26	52.0	12.0
26..........	41.29	63.0	28.0	26.........	34.27	44.0	20.0	26.........	30.61	49.5	10.0
27..........	41.54	69.0	28.0	27.........	36.13	47.0	20.0	27.........	28.73	44.0	0.0
28..........	45.17	66.0	30.0	28.........	35.75	46.0	23.0	28.........	27.38	44.0	− 2.0
29..........	47.85	71.0	34.0	29.........	34.62	59.0	18.0	29.........	25.22	46.0	− 5.0
30..........	49.68	72.0	33.0	30.........	36.22	60.0	20.0	30.........	27.82	38.0	10.0
31..........	48.66	72.0	32.0	....	.....	....	....	31.........	22.85	39.0	3.0

II. WEEKLY THERMOMETRICAL RESULTS FOR YEARS 1854 1865.

WEEK ENDING	Average temperature for each week.	Temperature computed for 47°.20.	Temperature computed for 60°.
January 7	25.19	21.04	26.80
do 14	24.73	20.28	25.84
do 21	25.65	19.51	24.88
do 28	25.15	19.08	24.32
February 4	23.17	19.24	24.52
do 11	23.19	19.83	25.26
do 18	26.10	20.87	26.58
do 25	25.96	22.30	28.49
March 4	29.90	24.08	30.73
do 11	28.81	26.13	33.28
do 18	33.56	28.35	36.40
do 25	32.65	31.50	40.18
April 1	35.54	34.64	44.08
do 8	40.08	37.59	47.84
do 15	42.31	40.55	52.04
do 22	45.66	43.76	56.08
do 29	46.93	47.92	61.04
May 6	50.24	51.46	65.48
do 13	53.20	53.90	68.68
do 20	56.63	57.90	72.80
do 27	59.99	60.95	76.75
June 3	60.31	62.76	80.15
do 10	60.89	65.55	83.56
do 17	63.09	68.16	86.88
do 24	66.54	70.27	89.56
July 1	70.87	71.97	91.72
do 8	69.29	73.40	93.56
do 15	70.59	74.46	95.00
do 22	71.15	75.09	95.30
do 29	71.13	75.28	96.04
August 5	71.82	75.00	95.68
do 12	71.34	74.50	94.86
do 19	68.40	73.49	93.80
do 26	67.49	72.09	91.96
September 2	63.45	70.20	89.68
do 9	64.65	68.29	87.04
do 16	62.91	65.90	84.00
do 23	59.03	63.32	80.72
do 30	56.19	61.15	77.84
October 7	56.53	58.64	74.04
do 14	50.53	54.59	69.58
do 21	48.22	50.89	63.96
do 28	44.13	47.50	59.36
November 4	47.33	44.06	56.07
do 11	42.07	41.10	52.50
do 18	38.67	38.00	48.44
do 25	35.23	34.40	44.08
December 2	34.75	31.58	40.40
do 9	30.62	29.67	38.30
do 16	31.75	27.17	35.14
do 23	25.74	24.57	31.90
do 30	26.55	22.49	29.18

From the average thus obtained for each day in the year, I obtain averages for each month, for each season, and for the year, as follows:

Month.	Average.	Month.	Average.	Month.	Average.
January	25.29	May	55.66	September	60.47
February	25.39	June	64.93	October	49.66
March..........	32.26	July	70.28	November.....	39.12
April...........	43.21	August	68.08	December	25.56

From which it appears, as we should expect, that July is the hottest month in the average, and January the coldest.

The average for the season is as follows: Spring, 44.21; Summer, 67.68; Autumn, 49.52; Winter, 25.41.

The average for the year is found to be 47°.20. This is obtained, however, not in the usual way of adding together the averages of the months and dividing by 12, or the average of the half months and dividing by 24, but by taking the average for the days and dividing by 365, neglecting the one-fourth day due to February, on account of the bissextile addition. I then made an average for each week in the year, which, together with some other computations, I have also thrown into the accompanying tabular form. In the *first* column is the day of the month on which the week ends; in the *second* is the average for the week, obtained from the observations and the above averages for the days in the year. For the *third* column I have computed what the temperature for the day for each seventh day (beginning with January 4th) should be, provided the 47°.20 were distributed according to astronomical influences alone, namely, the sun's altitude and the length of the day. For a *fourth* column I have, in like manner, computed what the temperature for the day for each seventh day, beginning, likewise, with the 4th of January, would be, if we had the 60° due to our latitude as by the table given in the first part of this essay.

But as our coldest day does not occur until about five weeks after the winter solstice, and as the warmest day comes in like manner about five weeks after the summer solstice, I have placed the third and fourth columns five weeks forward in the year, for the greater convenience of comparison.

These results I have constructed into a diagram, in order to present them more obviously to the eye. The straight lines running across the diagram, from the right hand to the left, denote the degrees of temperature; the continuous irregular line denotes the temperature as obtained from observation, and indicated in the second column in the table; the dotted line, most nearly corresponding with this irregular line, is that obtained by computing the temperature by multiplying the sine of the sun's altitude into the length of the day (between sunrise and sunset), divided by the constant divisor 12; and the other curve line—that which departs most widely from the line of actual temperature—is that which I obtained by computing in the same way the temperature, on the supposition that we receive an average of 60° Fahrenheit for the year.

In this computation I have made no correction for the diversity in the amount of heat which is "*absorbed*," or, as I prefer to consider it, "*reflected back*" by the atmosphere, so that it never reaches the earth, or exerts any influence upon the temperature of the atmosphere within the reach of our observations. This correction I have not deemed of sufficient importance in this connection to be worth the extra labor of making it. If, however, it had been made, it would have made the difference between the observed temperature and the computed temperature greater, both in summer and in winter, than it now is by several degrees—possibly ten—so that the modifying influences which I ascribe to the lakes, etc., would have appeared to be greater than by the present showing.

In the phenomena thus exhibited, I find six facts which I select for comment:

I. The maximum of heat and of cold is behind the time of the longest and the shortest days respectively.

II. Our average for the year is not equal to what is due our latitude.

III. The extremes of heat in summer and cold in winter, are not so great as we should expect to find them.

IV. The summer, that is, the period between the average temperature in the spring and the recurrence of the same temperature in the autumn, is larger than the winter, or the period between the average period in the autumn and its return in the spring.

V. The waviness or the irregularity of the line denoting the actual temperature.

VI. And, finally, the fact that about the last day of May there is an arrest of the increase of average temperature, and a like arrest of the decrease of it in the autumn, coming in the last of October.

1. The greatest amount of solar heat received at any place in any one day, is on the day when the sun, at noon, approaches nearest to the zenith. This, as we have seen, is for the equator the time of the equinoxes. For all places north of the Tropic of Cancer it is the 21st or 22d day of June. The greatest height of the thermometer observed in this place was July 17th, 1856, and the hottest average for the day, 84.7,

July 20th, 1854. But the above averages show that the maximum of heat is not reached on the average until about the 1st of August, when it is 73.29. The maximum of cold is reached on the 3d of February; and the coldest day I have on record was February 6th, 1855, when the average for the day was 14°.2 below zero.

It may be worth observing that the greatest heat and the greatest cold in the day are reached only after noon and after midnight; and the distance of time after noon, for example, when the day is the hottest, is about the same in proportion to the length of the day as the time of greatest heat in the summer, after the solstice, is to the length of the year. The hottest time in the day is generally about three o'clock P. M.; a little before in winter, and a little after in summer; and both phenomena are doubtless to be ascribed to the same cause—the equilibrium of heating and radiation. From the 21st of December the amount of heat received from the sun begins to increase, both because the days are longer, and because the sun runs higher. But, as appears from the table, it is not until the 3d of February that the balance comes to be in favor of the heat; and from this time on until August 1st, the earth receives and absorbs more heat than it gives off by radiation and conduction, and consequently is growing warmer.

However, both processes are going on together. During the day, alike in summer and in winter, the earth receives more heat than it radiates, and in the night it radiates or sends off more than it receives, as is shown by the fact that it is warmer in the evening than in the morning.

As showing the ratio of heating and cooling, I have made a comparison and average for the twelve years during which my records are complete. I subtracted the average for the morning for each month from its average for the evening, and then made an average for all the twelve years, with the following result:

Month.	Difference.	Month.	Difference.	Month.	Difference.
January	1.56	May	2.32	September	2.22
February	1.72	June	2.50	October	1.55
March	2.05	July	3.04	November	1.56
April	3.42	August	2.23	December	1.01

The morning observation is taken at seven o'clock, and therefore in winter before the air has begun to get warmer, though in summer some change has doubtless taken place in that direction. If, therefore, we were to take the observation earlier, it would diminish the subtrahend for the summer; but the observation for the evening is taken at nine P. M., after cooling has been going on much longer in the winter than in the summer. If, therefore, we were to take the observation earlier in the evening for the winter, it would add something to the minuend for that season; and thus probably the result would be about as it now stands, if the observation were taken in summer before the heating of the day, and in winter before the cooling for the night had made any considerable progress. We see that the average difference between the night and the morning temperature for the summer, 2°.89, is nearly double that for the winter, 1°.64.

The most remarkable phenomenon presented by the above comparison, however, is the great difference between the morning and evening temperatures in the month of April, being then 3°.42 greater than at any other time in the year. I am not of course able to say whether that be a peculiarity of this special locality, or not. During the month of March there are usually more cloudy days than in April, and also much snow and ice to thaw away; both of which causes would prevent the atmosphere from becoming so warm at evening as it would otherwise be. These obstacles being removed, the topmost stratum of the earth's crust would warm fast in April. As, however, the ground is not warm far below the surface, but on the contrary is very cold only a few inches down, it cools very rapidly during the night. In May the earth becomes warmed to a greater depth. In July the difference between morning and evening temperature is again about as great as in April. This is perhaps to be explained on the ground that the hotter any body, the more rapidly it radiates heat and cools by radiation.

2. The second phenomenon worthy of comment is the fact that our average for the year is but 47°.20, whereas it ought to be, considering our latitude, about 10° more. I have already hinted at the explanation of this deficiency. It is scarcely 40° of longitude from the northeastern termination of the great old-world mountain range in the promontory of Navarin to the point at which the great North American chain commences. From the direction in which these mountain ranges run, it is not probable that they exert much influence upon the winds or the temperature in the Pacific ocean. But they approach within about 90° of longitude as between Cape Finisterre, on the Spanish coast, and the highlands of Texas; and thus three-fourths of all the polar current is forced to pass through this wind gap of about one-fourth of the earth's circum-

ference, and by consequence each place within this region has about three times as much of the cold polar winds as it ought, and is, moreover, deprived by the same cause of a portion of the amount of the warm return current to which it is entitled.

Nor is this all. From the direction of the polar current from northeast to southwest, in a rhomb or loxodromic curve, the influence of this conformation of the surface is felt much more severely on the westerly side of this gap than on the easterly side; that is, in the United States, than on the Atlantic ocean. This we see in the direction of the isothermals. The isothermal of 50° for the year, for example, leaves Santa Fe, in New Mexico, latitude 35°.41, and passes so much to the north of east on its way across the American continent and the Atlantic ocean, that it meets Great Britain in latitude 52° or 53°. So also of the other isothermals.

This difference, however, between our average for the year and that which is due to our latitude, is felt rather in the winter than in the summer, as will be seen from the following comparison of places in nearly the same latitude, selected on both continents:

Locality.	Latitude.	Coldest month.	Hottest month.
Fort Humboldt, Cal.	40.46	43.10	58.60
Geneva, N. Y.	42.54	25.29	70.25
Marseilles, France	43.17	44.42	74.66
Montpelier, do	43.36	42.08	78.08
Rome, Italy	41.53	42.26	77.00

The cause of this difference, I think, is easily found in the fact that the return current is in part, at least, the surface current, bringing with it the heat of the tropics much farther north than latitude 45° in the summer, and therefore the position and direction of these great mountain ranges do not exert so perceptible an influence upon the temperature of places in this latitude in the summer as in the winter; but in the winter the return current is not much felt north of latitude 40°, and that portion to which we are entitled is shut off by the mountains and replaced by the polar current, which must find its way through this gap to the tropics.

I will notice but one other effect of this peculiar conformation of the mountain ranges. In consequence of the situation of the Asiatic mountains, shutting off the polar current from the Indian ocean, there are no trade winds perceptible there; but on the contrary, we find the monsoons, winds which blow from the southwest to the northeast in our summer, when South Africa is cold and Southern Asia is hot; and on the other hand, they blow from the northeast to the southwest in our winter, when Southern Asia, being in the northern hemisphere, is cold, and South Africa, being on the other side of the equator, is hot. But across the Atlantic, where there is the same conformation and distribution of lands as between the north of Africa and the south of South America, there are not only no monsoons, but the trade winds are most marked of any place on the surface of the globe; and these trade winds, of course, are but the polar current become the surface current within the tropics.

3. In the third place, the extremes of heat in summer and of cold in winter are not so great as indicated by the line of real temperature as the computation would lead us to expect. This remark applies, of course, not to individual and peculiar days, but rather to general average for the hottest and the coldest days. The hottest day by the general average is August 1st, 73°.29, and the hottest week is that ending August 5th, 71°.82; whereas, computation gives for that week 75°.28, a difference of 3°.46; and if in my computation I had corrected for "absorption" or reflection from the atmosphere, the difference would have been several degrees more.

So in winter. The coldest day in the general average by observation is February 3d, 19°.09; but the week in which it occurs, the coldest week in the year, averages only 23°.19; whereas, by computation, it is 19°.08, and if corrected for "absorption," would have been several degrees colder; but without the correction, the difference is 4°.11, which, added to the summer difference, makes 7°.57.

This difference I attribute partly to general influences and partly to local influences that are local and special. Besides all the causes that I have spoken of as influencing climate, there is one more, the effects of which are not to be overlooked altogether. During the summer a large part of the sun's heat is absorbed by the vegetable growth that is going on. In this essay, thus far, I have taken no notice of the theories of heat, but have used terms derived from the old theory of an imponderable, transmissible, measurable substance. I think, however, that that theory has been effectually dispersed, and that it has been shown that the word *heat* is an abstract term, denoting only the condition or property of bodies. But whatever be the theory we adopt, the result is the same as if heat were a substance, which, in the process of vegetable growth, is converted into vital or vegetable force, and thus ceases to appear or to affect anything for the time being as sensible heat. Hence for this cause alone the temperature in the presence of an extensive vegetable growth would not be so hot as if there were no such growth, and the country were a sandy or rocky desert.

In the winter, however, when the ground is covered with snow, the heat is reflected back at once to a large extent, and does not penetrate the mass; nor yet, in its immediate influence, does it appear to produce much effect upon the temperature of the atmosphere into, or rather *through*, which it passes. Hence the temperature, as indicated by a thermometer, will be colder than if there were no snow; and besides this, the snow is always wasting away by evaporation, even in the coldest weather. This process is much accelerated by the direct rays of the sun, and the more so, the hotter those rays may happen to be; consequently a large part of the heat is absorbed, in the process of evaporation, as "heat of liquefaction" for the melting snow.

But besides this, and beside the general influence of our inland lake system, which, as I have already said, extends to all localities in this region, I have no doubt that the immediate proximity of our lake—the Seneca—is manifest in the phenomenon under consideration. The lake is very deep, is never very warm in summer, never freezes over far from the shore, and seldom (not more than once in about five years on the average) accumulates ice enough, even about the docks, to interfere with the steamboat landings.

As confirming and illustrating my position, I introduce statistics derived from observations taken at Canandaigua. The comparative physical position of the two places is indicated as follows:

LOCALITY.	Latitude.	Longitude.	Height above sea, in feet.
Canandaigua	42.50	77.15	(about) 590
Geneva	42.52	77.20	567

the only noticeable difference being 13′ of longitude, or a few miles west and east.

Canandaigua is situated about one mile north of Canandaigua lake, and about 100 feet above its surface; but the lake is much smaller than the Seneca, and at a distance of some three miles from its foot trends westward around a promontory that rises between the village and the main body of the lake. The lake freezes early in the winter or late in the autumn up above this trending point and the promontory just spoken of. Hence the town derives little if any of the warming effects of the open lake and forming ice during the winter, and especially after the first frosts. The half-monthly averages for the two places are as follows:

WINTER.			SUMMER.		
Month.	Canandaigua.	Geneva.	Month.	Canandaigua.	Geneva.
December, 1st half..	28.81	30.28	June, 1st half...	64.64	60.60
do 2d do ..	23.62	26.69	do 2d do ...	66.94	64.81
January, 1st do ..	25.03	24.96	July, 1st do ...	69.48	70.44
do 2d do ..	21.57	25.40	do 2d do ...	69.45	71.14
February, 1st do ..	19.71	23.48	August, 1st do ...	68.75	71.58
do 2d do ..	22.47	26.03	do 2d do ...	65.34	68.09

From this it appears that the average is in our favor by some three or four degrees, in the coldest half month (1st Feb., 3°.77) in that part of the winter when their lake is shut out by frost and otherwise from any influence on their climate, and ours is open and with ice constantly forming on its banks.

In June, however, their climate is warmer than ours, 4°.04 first half, and 2°.13 last half, while our lake has not attained its midsummer heat—for, being very deep, it cools slowly; but in July and August, after the lake has become heated, and so prevents the cooling of the air during the night, etc., our temperature is the highest, 0°.96 the first half of July, 1°.69 for the second half, 2°.83 for the first half of August, and 3°.75 for last half.

I think that nothing more can be needed to confirm the theory I have advanced, of the influence of our lake on our climate.

I will, however, introduce another comparison; that with Ithaca, at the head of Cayuga lake. The physical position of the two places is as follows:

LOCALITY.	Latitude.	Longitude.	Height above sea.
Ithaca	42.27	76.30	417
Geneva..	42.53	77.20	567

Ithaca has the advantage of about half a degree of latitude and fifty feet of elevation, which, combined, make scarcely so much as one degree of temperature in its favor; but it is situated at the *south* end of the lake, whereas Geneva is at the north end. The lakes are much the same in size; about forty-five miles long, with an average width of two or three miles. Cayuga lake, however, is much the shallowest, and freezes over more extensively than the Seneca.

The point of contrast, however, is chiefly this: the one is at the south end, and the other at the north end of a long and narrow valley filled with a body of standing water. Now, from what has been said, we should expect that the place at the south end would receive much more of the warming effects of the lake in winter, and less of the cooling effects in summer, for the reason that in winter, while the water is warmer than the air, and is also giving out heat by the formation of ice, the winds are prevailingly the polar winds from the north; consequently they are warmed by the lake before they reach the town;—while the winds from the pole (the cold winds) pass over land, and from the land to the water, to convey the heat away from us. But in the summer, when the prevailing winds are the return current from the equator, those winds for Ithaca come from off the land, and have not been cooled by the lake until after they have passed the town.

WINTER.			SUMMER.		
Month.	Ithaca.	Geneva.	Month.	Ithaca	Geneva.
December, 1st half ...	32.93	30.28	June, 1st half	63.69	60.60
do 2d do ...	27.98	26.69	do 2d do	66.77	64.81
January, 1st do ...	29.53	24.96	July, 1st do	69.80	70.44
do 2d do ...	27.17	25.40	do 2d do	71.47	71.14
February, 1st do ...	24.13	23.48	August, 1st do	68.90	71.58
do 2d do ...	28.82	26.03	do 2d do	68.37	68.09

Thus, while the influence is quite manifest in the winter, producing a difference of 3°.28 in favor of Ithaca, their average for the winter being 29°.42, ours 26°.14.

In the summer the difference is slight, and is in their favor until the last half of August. For the first half of September their average is 62°.88, ours 63°.34; for the last half, theirs 56°.08, ours 57°.61.

During the whole of the summer their return current comes from over a tract of land which is quite uneven in surface, and has a mean or average temperature considerably lower than Ithaca itself. During the first part of the summer, until about the middle of August, our return current comes, not from the lake at all, but from a point of compass too far west of south to have been influenced by the lake. After the 1st of August, we have a much larger proportion of southeast winds, and then we begin to feel the influence of the lake; and while this influence is in the direction of cooling during the day, it is, in its effects, a retardation of the process of cooling through the night; and thus, as I presume, while our average for the twenty-four hours is greater than theirs, our days are cooler and the nights warmer than at Ithaca.

A reference to the prevailing surface winds, as observed at Geneva, will be interesting and instructive in this connection. Reckoning three observations per day, we have on the average about fifteen observations per month, with no perceptible winds:

Year.	W.	NW.	N.	NE.	E.	SE.	S.	SW.
1855	19.50	9.5	4.50	2.000	2.75	7.5	23.75	6.5
1856	21.50	10.5	2.25	1.875	3.00	8.0	15.00	10.0
1857	18.25	12.0	3.50	2.500	1.25	9.5	21.25	8.5
1858	18.25	10.0	5.00	3.500	3.50	10.5	15.50	7.0
1859	16.00	12.0	2.00	3.500	1.75	10.0	19.00	9.0
Average	19.00	11.0	3.50	2.500	2.00	9.0	19.00	8.0

But as the west, northwest and north winds are the polar current, the northeast and east are the current from the North Atlantic, and the southeast is the current from the South Atlantic coast, the south and southwest being the equatorial current, we have in reality but four currents, proportioned on the average in a year as follows: Polar current, 38.5; North Atlantic, 5; South Atlantic, 9; equatorial current, 27; showing that we are somewhat north of the middle of the temperate zone, so far as the winds and temperature are concerned.

The other winds, averaged for the year, give results equally interesting and instructive:

Current.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
W. ...	17.5	24.0	32.0	20.0	9.5	15.0	13.5	20.0	14.0	17.0	19.0	20.5
NW...	12.5	8.5	10.0	12.5	17.5	10.0	11.0	8.5	8.0	9.0	7.5	11.5
N.....	3.5	2.0	2.5	4.0	5.5	4.0	6.0	3.0	5.0	5.0	2.5	2.5
NE. ..	3.0	3.0	1.5	2.0	4.5	1.5	2.0	1.5	2.5	2.0	3.0	5.5
E.....	3.0	2.5	3.0	5.0	3.5	2.0	1.5	1.0	2.0	0.5	4.0	4.5
SE....	4.5	3.5	5.0	6.0	12.0	11.5	14.0	14.5	11.0	10.0	8.0	6.0
S.	25.5	20.0	14.5	17.5	20.0	15.0	15.0	17.5	18.5	19.0	22.0	19.0
SW...	13.5	10.0	8.5	6.0	3.0	6.0	6.5	6.0	7.0	8.5	9.0	8.0

Or, referring to their distribution for the months, and denoting the polar current P. C., and all others by the letters indicative of their direction, as NE., SE. and SW., we have:

Current.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
P. C...	38.5	34.5	44.5	36.5	32.5	29.0	30.5	31.5	27.0	31.0	29.0	34.5
NE....	6.0	5.0	4.0	7.0	10.0	5.5	8.0	4.5	7.5	7.0	5.5	8.0
SE....	4.5	3.5	5.0	6.0	12.0	11.5	14.0	14.5	11.0	10.0	8.0	6.0
SW. ..	39.0	30.0	23.0	23.5	23.0	21.0	21.5	23.5	25.5	27.5	31.0	27.0

It will be observed that the greater proportion of the southeast winds are from April to November. Some of these are doubtless not South Atlantic currents, but mere "*sea* breezes" from the lake. So also a part of those reported as polar currents, during the summer months, are only "*land* breezes" due to the influence of our lake. Deduct these from the polar currents and it would leave the equatorial current in the predominance from April to December, as stated above.

It should also be remarked that of the winds reported "south," a large portion of them were a few degrees west of south without being southwest. And besides this the direction of our lake from south to north would give us a south wind, when otherwise we should have a wind from the southwest.

4. The number of days between the time when the temperature reaches the average in spring, April 23d, and the time when it reaches it in the autumn, October 23d, is also greater by ten or eleven than the number between October 23d and April 23d; the number being in one case 177, and 188 in the other; that is, our summer half of the year is eleven days longer than our winter half. This is doubtless owing to the influence of the lakes.

We are, however, indebted to this influence for more than the eleven days thus indicated; for, although if the temperature were determined by length of day and altitude of the sun alone, the number of days in the year which are above the average line would be just the same as those that are below it; yet when we take into the account the correction for "absorption," it will be found that the number of days below the line will be somewhat in excess of those above it, and the causes will be greater the higher the latitude, until we reach the polar circle, and it then gradually reaches to zero—the value which it has at the equator also.

5. In the fifth place, I would notice the *waviness* of the line, if I may be allowed to make a word for the occasion.

It will be borne in mind that the average on which this diagram is constructed is for only about twelve or fifteen years. If I had statistics whereby to extend it over a longer space, a hundred years, for example, no doubt much of this waviness would be corrected. Our weather comes in alternations of heat and cold; more especially in the winter half of the year the crest of the cold wave coming on one day one year, and on another in the next, and so on. Hence, when it shall have fallen for several times each day, these waves, when taken together, will average one another.

And yet I am not quite sure that they would. The solstice and equinox are fixed points. At the summer solstice, for example, the sun has reached its northern limit, and from that time it begins to decline southward, until, on the 21st of September, it passes into the southern hemisphere. This is an important fact. "The *belt of calms*," as it is called, swings back and forth with the sun. This is the limit and separation wall between the northern and the southern trade winds, and polar currents in general. It determines the northern boundary of the trade winds, they being felt further north in summer than in winter. It determines, also, the latitude at which the return current passes through the polar current so as to become the surface current; this latitude being some 40° further north in summer than in winter. When now this "balance of the winds" swings over into our hemisphere, it sets back the currents of that hemisphere, and as it is constantly advancing up to the time of the solstice, it is like a large vessel setting rapidly into a narrow channel, driving back the waters until they accumulate against the barriers, and then they return in a high wave and with unusual force, and then being reflected back by the advancing ship, they return again to the barrier, and so on, oscillating back and forth. When the sun begins to recede from the solstice towards the other hemisphere, the return wave moves with an unusual impulse and for a longer time than usual.

Now, there can be no doubt that something of this occurs with the winds; and to this I attribute not only the waviness of our weather, but also the fact that about the time of the equinoxes we have what are familiarly called the "*equinoctial storms.*"

The reality of these storms is made manifest by the following statistics showing the comparative average of the water-fall in the several months:

Month.	Inches.	Month.	Inches.	Month.	Inches.
January........	1.594	May..........	2.933	September.....	2.499
February.......	1.138	June	3.121	October.......	3.122
March	1.888	July	3.281	November.....	2.254
April	3.375	August	3.690	December.....	2.027

It is indeed true that the equinoxes occur in March and September, but the effects of the disturbance could hardly reach us short of a week or ten days; and the averages above given are made out for the calendar months. But if we should make the average for the thirty days commencing with the equinox, the result would not be materially different. Naturally we have more precipitation of vapor in summer than in winter. This is seen in the above statement. But we also see the fact that there is an increase from March to April, being in the month after the equinox nearly double what it was the month before; and also the other fact that there is more in October than in September, 3.122 against 2.499, notwithstanding it occurs in the season when the amount is decreasing towards its winter minimum.

6. Finally, we notice in the spring, commencing May 25th, an arrest of the increasing warmth, and in fact a retrocession for about sixteen days until June 12th, and a similar arrest and retrocession of the increasing cold in autumn, from October 28th until about the 10th of November. It has been a matter of general observation that we have a frost in the last of May or the first of June, and the "Indian summer," as it is called, is an acknowledged "*institution*" of our climate. But the figures and diagram before us put these things into a more definite form than I have ever seen them in before. The temperature increases quite regularly from the time of the greatest cold in February up to the 24th of May, when it reaches in the general average 63°.29, with a maximum for the day of 84°.5, and a minimum of 42°; and with about the same maximum and minimum for the next day, it falls off in the general average to 60°.84, and does not reach 63°.29 again until June 12th, a period of eighteen days. During this time it falls in the general average to 57°.32 for May 28th; it then rises to 62° and something over, for the last day of May and the three first days of June, and then falls to 60° again for several days; and the average for the whole eighteen days is 60°.60, or nearly 3° less than that for the day preceding this period or for those succeeding it.

So in the autumn. The weather grows cold very regularly with the advance of the season, until October 27th, when it is 41°.54, with extremes of 69° and 28°. The next day the average rises to 45°.17, with extremes of 66° and 30°, and does not reach 41°.54 again until the 10th of November, except for a single day, November 8th, when it is 41°.13 with extremes 64°.5 and 29°.5, and the average for the whole twelve days is 45°.64; but unlike the spring frost, the autumn, or Indian summer grows warm to its centre, reaching an average of 48°.25 on the first days in November, and then gradually declining again to the temperature of the 27th of October.

I have no means at my command for ascertaining how extensive these phenomena of summer-frost and autumn-summer may be; nor is it easy to assign a cause for them that will be entirely and altogether satisfactory. I am inclined to think, however, that it may be peculiar to our part of the Northern continent, as the monsoons are to the Indian ocean. This inference, which I make in the absence of all definite statistics, is, of course, purely theoretical, and derived from the views which I proceed to suggest of the cause of this phenomena.

Before proceeding, however, with the theoretical explanation, I would make a remark on the state of meteorological statistics in this respect. Mere vague impression, based on personal feelings and recollections, is a foundation for opinion in meteorology at least, which one learns the more to distrust the more he has occasion to deal with it. Scarcely anything in my experience has been more common than to find people's impressions of the general average of the weather for a given period in conflict with the observed and recorded facts. But again, the statistics as recorded and *summed up* and reported in the published works on climate, afford no indication of such a retardation and retrocession of the advance of the seasons; nor do they, on the other hand, furnish any indication that such phenomena do not occur; for no average but one like that I have made—an average for every day, day by day, through a series of years—could show whether such an event occurs or not; and no such average has before been made, to my knowledge. An average for each month or each half month, nay, an average for each week even, would hardly draw attention to the phenomena.

And now for the explanation. I have referred to the "*waviness*" of the line of real temperature in the accompanying diagram. By referring to the diagram again, we shall see that these two changes in the curvature of the line occur as the first great *wave-reactions* after the equinoxes, when the sun, with the "*balance of winds*," passes from one hemisphere to the other. Coming north in the spring, the sun brings, or rather drives before it, the warmth of his presence; the cold winds are pushed and crowded back on the poles and in the polar regions, until, of necessity, a reaction takes place. Then, too, the winds that reach us at that time from the pole, start in the midst of the very depths of polar winter, night and cold, when the air at the pole has reached its lowest temperature. It passes on its way, as soon as it reaches the sunlight at all, say in latitude 75° or 80°, over accumulated masses of ice and snow, and frozen ground; all of which, so soon as the rays of the sun become sufficient to cause them to begin to thaw at all, need and will take up an immense amount of heat as they pass from the solid state of ice into fluid as water. Hence these winds have but little chance of getting warmed on their way to us. They can scarcely grow warm at all until they get this side of snow and frost. Then, of course, they increase in temperature quite rapidly, the earth over which they pass being warmer in the day time than they are; so that after they shall have reached latitudes some few degrees farther south than ours, their chilling effects can (as I should presume) hardly be felt at all. Nor, if my theory is correct, can anything of this kind be observable in Europe or Asia; not in our latitude south of the great continental mountain range, because all lands south of it are sheltered by them from the winds—not north of it to any considerable extent—because the situation of the mountains arrests the northward wave, to which this is a mere reaction. And for the same reason there can be no such phenomena on our Pacific coast.

And so with the autumn or Indian summer. The sun passing southward into the southern hemisphere, draws after it a curtain of darkness and cold as it passes along; but the earth in the southern part of the temperate zone retains its warmth; the polar current having now more space by the extension of its area from north to south, becomes thinner and remains the upper current longer on its way to the equator than it otherwise would, thus allowing the return current to pass under it as the surface current, spreading the warmth of more southern latitudes over a belt extending across the Atlantic ocean, and as far west as the Rocky mountains, and from north to south some ten or fifteen degrees of latitude. But for the reasons already given, such a phenomenon could hardly occur in the old world any more than that of the summer frosts; and it is doubtful, also, whether either of them can occur to any observable extent anywhere in the southern hemisphere. The effect of this wave and its reaction is doubtless greatly increased in the eastern part of our continent and in the Atlantic ocean, by the fact already pointed out, that they are the great wind-gap of the northern hemisphere. And although the general causes of these phenomena may exist and be active in the southern hemisphere, I doubt whether, without the peculiar conformation of the mountains in our hemisphere, to give them intensity, their influence would be particularly noticeable.

Besides these local causes influencing climates, there are one or two more phenomena suggested by the meteorological observations in my possession, that I will put on record here as worthy of observation:

1. The first is this: It has happened thus far, that when the winter comes on gradually and continues cold through January and the first half of February, without much of what is called the "January thaw," we have an early spring, and the snow passes off and the frost comes out of the ground earlier than when the winter is what is commonly called an "*open*" one. The observations in my possession suggest this rule, and perhaps it is what we should expect on general principles.

2. Again: when there is a large accumulation of snow and ice during the winter in the region northwest of us, and especially to the northwest of the great lakes, the spring, though it may be an early one, is sure to be attended with an unusual number of cold rains, chills, and even frosts. The reason for this is obvious.

It forms no part of my plan to discuss the distribution of rain; but there is one remark that is so connected with my subject, that I will beg a few words more, for the purpose of saying it. As a general rule:

1. The amount of water that falls annually, decreases from the equator to the poles.

2. It decreases from the sea coast as we pass inward towards the centre of the continent.

3. It is, in the northern hemisphere, greater on the south and west sides of mountains than on the north and east sides.

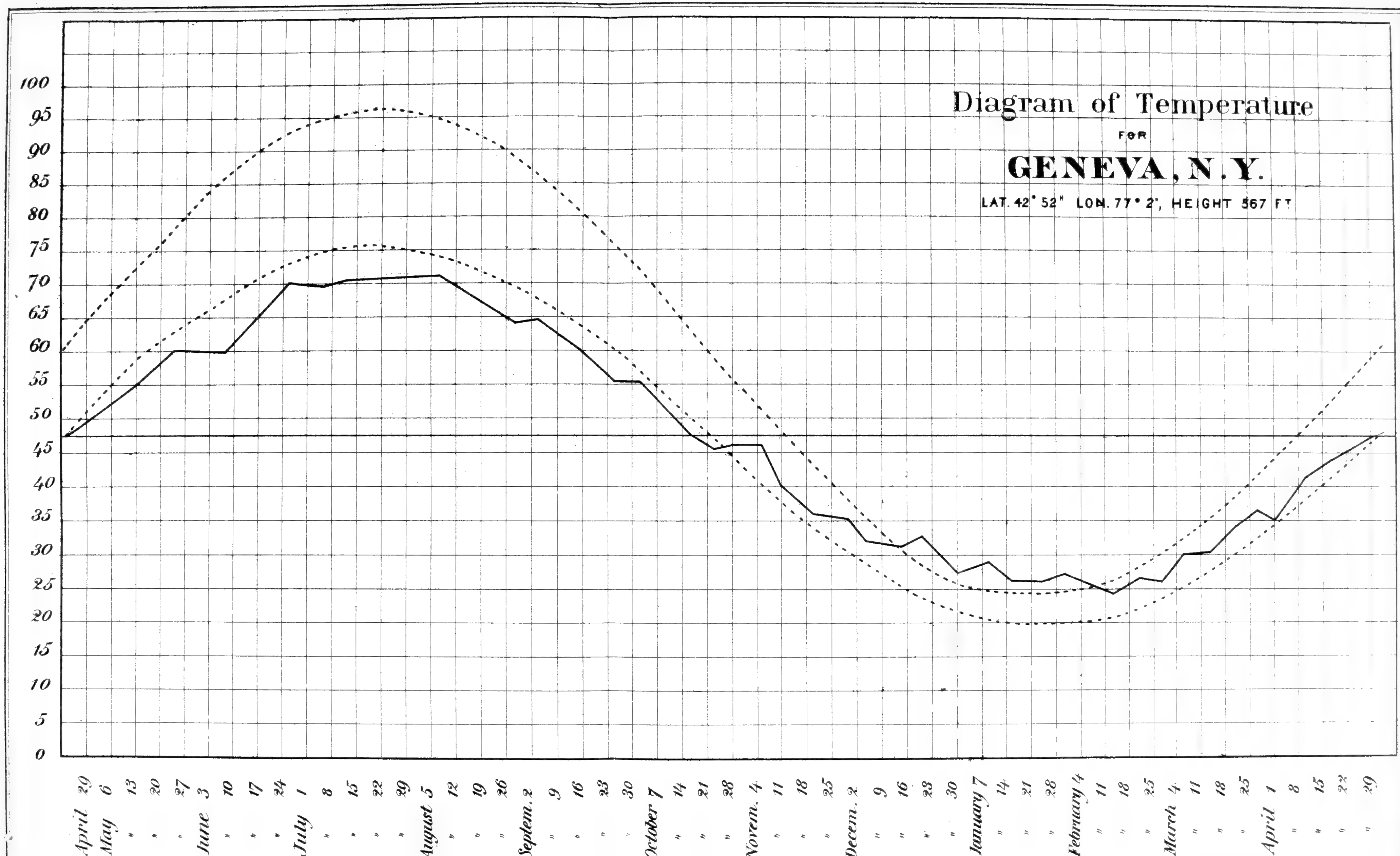
Now, owing to these laws combined, it is doubtful if we should have rain enough for successful agriculture in the western and central States of the United States, were it not for our great lakes. On the coast most of the rain comes from the ocean; but in the neighborhood of the lakes, as Geneva, for example, so far as I can judge, quite one-half of the water that we have in the year, is by evaporation from the lakes, most of which, being west of us, the storms come to us from that direction, and fall with westerly winds; and observation shows that our average amount is scarcely less than that which falls on the sea coast.

The influence of our climatic peculiarities upon man and upon civilization is an important topic, to which our thoughts naturally turn in conclusion of our general subject. Perhaps we have not observed enough yet, to determine fully and finally what this influence is to be. I will, however, make a suggestion.

I doubt if any men, possessing the means of civilization, have inhabited a country in which the two most important elements have been combined in such large proportions—the bracing effect of cold for men, and the growing influences of warmth and moisture for the production of those agricultural products most necessary for him and most largely conducive to wealth. In the high latitudes the winters are too long and cold, as well as the summers too short, for the production of those grains, fruits, etc., which are necessary for a wealthy community and the highest forms of civilization. In fact, when the average temperature of the year falls below 40°, or at least 35°, it is scarcely possible for the population to become dense at all; and even a sparse population can hardly raise so much in the summer as they need for their support during the long and severe winter that ensues; and the faculties of men seem also to be in a measure crippled and stinted by the rigors of the climate. In tropical countries the heat is undoubtedly too great for the production of the highest type of man. Any men would undoubtedly become degenerated in a few generations by the enfeebling influences of such continued heat. Nor is this all. Although there are some forms of vegetable production of the highest, nay of indispensable value to the life of highly civilized men, which can be produced only in the long summers and under the continued heat of a tropical, or nearly tropical sun, yet even in such favored lands those crops which are most necessary, and contribute the largest amount to the wealth of the community, either do not grow at all, or do not succeed well. A simple and sufficient proof of this is found in the fact that land is never worth so much per acre in the tropics, and in latitudes closely bordering upon them, as in latitudes farther removed from equatorial heat. Wheat will scarcely grow at all in the lands best adapted to rice, cotton and sugar-cane. The corn that will grow on those lands is neither so good, nor does it yield so well, as that which we raise in the northern portions of the United States. The same is to be said of the potatoe. And it is a matter of doubt if any crop of cotton, rice, sugar-cane or other tropical production can be made to yield so much wealth to a community, extending over any considerable territory, as the crop of grass and hay which flourish best where those tropical or semi-tropical productions cannot be produced to advantage, if at all.

But for man himself, the bracing effects of cool air are necessary to the attainment of the highest forms of civilization. Warm and moist are the conditions of vegetable perfection; but cool and dry are the best conditions for man's health and mental vigor. Now, I doubt whether anywhere on the globe these contrary and seemingly incompatible conditions are so well combined and blended as in the northern and middle portions of the United States, extending from the arid plains, just east of the Rocky mountains, to the Atlantic coast. The winters are cool, if not cold, and comparatively dry. The total amount of water-fall for the months of December, January, February and March, averages scarcely one and a half inches; and all through the summer, while the moisture is no more than is needed for vegetation, the nights are, for the most part, comparatively cool; and seldom do more than four or five days of heat, that can be regarded as at all oppressive even for us who are accustomed to a temperate zone, occur in succession. Our position as the great wind-gap of the northern hemisphere, to which I have so often referred, is largely concerned in producing this result. The Rocky mountains leaving the Cordilleras of Mexico, are not so situated as to shut off entirely, or to any considerable extent, in the summer, the warm breath of the return current and the moisture which it brings from the Pacific ocean and the Gulf of Mexico; while those mountains are so situated as to give us invariably, even during the hot season, within every few days, the cooling breezes from the north—such as scarcely, if at all, ever visit the inhabitants of the old world in our latitude, except, in fact, on the high lands of Central Asia, where there is neither warmth nor moisture for an abundant vegetation.

What these influences are to be on man's physical condition and development, can be, at present, perhaps, only a matter of conjecture and prediction. But they augur well; they predict a glorious future—a coming civilization such as the world has never yet seen. If man himself, in his intellectual, moral and spiritual training and care of himself, will only do as well for himself as a kind and most beneficent Providence has done for him, in the circumstances and surroundings of his earthly life, nothing more or better could be desired than that which manifestly awaits us.



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(G.)

RESULTS OF METEOROLOGICAL OBSERVATIONS.

I. OBSERVATIONS MADE BY J. B. TREMBLY, M.D., AT TOLEDO, OHIO:

Lat. 41° 38′ 47″.04; long. W. 82° 22′ 17″.75; height 604 feet above sea level.

1. MONTHLY BAROMETRICAL RESULTS FOR THE YEAR 1865.

MONTH.	Maximum height.	Date.	Minimum height.	Date.	Mean height for the month.	Range for month.	Greatest daily variation	Date.	Least daily variation	Date.
January	29.81	30	28.90	17	29.307	0.91	.36	7	.05	25
February ...	29.80	12	28.77	23	29.455	1.03	.62	26	.03	27
March	29.61	26	28.61	21	29.215	1.00	.37	4	.04	5
April	29.72	8	28.86	12	29.388	0.86	.38	11	.02	2
May	29.54	14	28.92	21	29.262	0.62	.19	12	.01	20
June	29.42	6	28.99	26	29.177	0.43	.18	10	.01	23
July	29.51	31	28.94	19	29.295	0.67	.17	22	.01	5
August	29.49	25	29.10	10	29.328	0.39	.19	10	.01	14
September ..	29.52	15	28.99	8	29.341	0.52	.16	8	.01	19
October.....	29.57	31	28.68	10	29.257	0.80	.24	15	.02	24
November...	29.83	10	28.75	30	29.341	1.08	.14	5	.01	18
December ...	29.82	22	28.88	1	29.335	0.94	.44	7	.03	3
Year	29.83	.....	28.61	.....	29.350	0.715	.62	.....	.01	..

2. ANNUAL BAROMETRICAL RESULTS FOR THE YEARS 1860–1865.

YEAR.	Maximum height.	Minimum height.	Mean height for the year.	Range for the year.	Greatest daily variation.	Least daily variation.
1865..............	29.83	28.61	29.350	.715	.62	.01
1864..............	29.85	28.58	29.236	.75	.47	.00
1863..............	29.81	28.47	29.280	.88	.75	.00
1862..............	29.83	28.77	29.297	72	.57	.00
1861..............	29.90	28.88	29.354	.63	.66	.00
1860..............	29.87	28.94	29.330	.68	.61	.00

Mean barometer for 6 years, 29.307.

3. MONTHLY BAROMETRICAL RESULTS FOR THE YEAR 1865.

MONTH.	Maximum height.	Date.	Minimum height.	Date.	Mean temperature of the month	Monthly range.	Greatest daily variation.	Date.	Least daily variation.	Date.	Mean temperature of the warmest day.	Date.	Mean temperature of the coldest day.	Date.
January	46	5	— 1	11	23.460	47.00	29	11	1	26	39.00	5	5.66	26
February	50	22	4	13	29.128	46.00	21	14	1	7	45.00	22	13.00	12
March	72	20	8	10	40.180	64.00	22	14	0	1	58.00	15	17.00	10
April	72	20	29	8	49.352	43.00	34	20	2	28	63.33	26	33.66	8
May	86	16	39	11	59.654	47.00	21	31	3	24	71.66	31	43.33	11
June	93	6	54	26	73.333	39.00	16	15	6	21	82.66	6	64.33	27
July	94	6	55	16	69.341	39.00	20	6	2	16	82.33	6	56.00	16
August	90	3	53	25	68.845	37.00	23	25	8	4	80.33	3	58.33	22
September	90	4	46	19	70.185	44.00	20	4	3	7	79.66	10	59.33	30
October	79	9	32	30	50.179	47.00	27	9	1	27	65.00	9	38.00	28
November	67	16	26	28	41.096	41.00	27	9	3	5	57.33	16	33.00	5
December	51	11	1	23	29.921	50.00	23	23	4	24	49.00	4	7.66	15
Year	94	......	— 1	......	50.389	47.00	34	......	....	......	82.66	......	5.66	......

4. ANNUAL THERMOMETRICAL RESULTS FOR 1860-1865.

YEAR.	Maximum height.	Minimum height.	Mean temperature of the year.	Yearly range.	Greatest daily variation.	Least daily variation.	Mean temperature of the warmest day.	Mean temperature of the coldest day.
1865	94	— 1	50.389	47.00	34	0	82.660	5.66
1864	98	—15	49.987	49.90	37	0	87.330	11.66
1863	95	6	51.069	48.58	28	0	85.330	16.33
1862	97	— 2	51.316	45.25	35	1	87.000	16.33
1861	96	— 4	50.368	46.66	30	0	87.000	9.66
1860	94	10	49.343	44.13	41	2	83.000	2.66
Mean	....	....	50.412	....	....	....	85.386	—10.38

5. MONTHLY WIND AND WEATHER TABLE FOR 1865.

MONTH.	S. W. and W.	N. W. and N.	N. E. and E.	S. E. and S.	Number of clear days.	Number of cloudy days.	Number of variable days.	No. of days in which it rained.	No. of days in which it snowed.	Prevailing winds.
January	67	14	6	6	2	17	12	3	5	S. W. and westerly.
February	35	17	26	6	4	16	8	4	7	Westerly and northeasterly.
March	45	15	27	6	4	16	11	9	5	do do
April	59	12	17	2	8	8	14	10	3	do do
May	30	30	27	6	8	8	15	10	....	do do
June	66	11	12	1	6	5	19	12	....	S. W. and westerly.
July	41	23	28	1	7	8	16	16	....	Westerly and northeasterly.
August	46	24	21	2	5	4	22	12	....	S. W. and westerly.
September	51	10	24	5	3	6	21	14	....	S. W. and northeasterly.
October	49	26	17	1	6	8	17	9	....	S. W. and westerly.
November	46	26	12	6	7	9	14	4	....	Westerly.
December	61	12	3	17	3	12	16	5	5	Southwesterly.
Total	596	220	220	59	63	117	185	100	25	....

6. ANNUAL WIND AND WEATHER TABLE FOR THE YEARS 1860-1865.

YEAR.	S. W. and W.	N. W. and N.	N. E. and E.	S. E. and S.	Number of clear days.	Number of cloudy days.	Number of variable days.	No. of days in which it rained.	No. of days in which it snowed.	Prevailing winds.
1865	596	220	220	59	63	117	185	100	25	Westerly.
1864	608	204	229	57	55	149	162	98	35	do
1863	482	230	300	81	68	157	140	92	35	do
1862	520	205	282	88	80	142	143	103	46	do
1861	580	192	218	105	70	110	185	51	43	do
1860	501	217	229	148	127	161	78	100	34	do

7. REMARKS FOR THE YEAR.

JANUARY.

Weather usual for the month.

FEBRUARY

11. Hazy during the P. M.; moon had the appearance of wading through a bank of snow; atmospherical appearance of the horizon was ominous and threatening, and during the night there was a peculiar squall of snow and wind; it fell like an avalanche, in one almost compact sheet, dark, blinding and suffocating, lasting only for a few minutes, when all was calm and clear.
15. Northeast storm of snow.
22. Rain.
23. Muddy; ice on the river getting unsafe to cross upon.
25. A severe rain storm, with a rapid fall of the barometer.

MARCH

8. Ice moved out of the river.
12. Ferry-boat made her first trip.
14. Blue-birds made their appearance.
15. Robins seen first for the season.
28. Soft-maple trees in blossom.

APRIL

4. Swallows made their appearance.
21. Early peach and apricot trees in blossom.
26. Early cherry and plum trees in blossom.

MAY

3. Apple, pear and all fruit trees in full bloom.
12. Frost in the morning; tender vegetables frosted in many places.

JUNE

1. Early cherries ripe: thirty-six days from the blossom.

JULY

10. Severe northeaster; rained all day.

15 and 16. Rained continuously for thirty-six hours; most severe storm of the season.

30 and 31. Only pleasant days of the month; grain and hay injured very much by the wet weather.

AUGUST

31. The most severe shower occurred at 10:15 P. M., that has visited this locality for many years. The very elements of a furious and terrible storm seemed to be at war with each other; rain poured in torrents; lightnings flashed continuously; an unceasing glimmering of the electric fluid lighted up the horizon; the wind, let loose from all restraint, dashed and lashed the falling waters to a foam; distant, hoarse, and deep-muttering thunder made bass music for the storm.

SEPTEMBER.

Very warm, and a great excess of rain compared with corresponding months of other years.

OCTOBER

1. Frost; first of the autumn.
19. Eclipse of the sun in A. M., dark and cloudy during the time; a gale of wind in P. M.
28. Slight snow squalls.

NOVEMBER.

A very pleasant month; but little rain.

DECEMBER

14. River frozen over for the first time of the season.
15. Skating on the canal.
20. Snow in P. M.; a northeaster, the western border of the storm only reaching this vicinity; it was three days in forming, and was one of those oblong storms in this region that frequently occur in the winter and spring.

The yearly meteorological phenomena, as they regard temperature, amount of rain fallen, and barometrical pressure, were the average of other years; but the distribution of rain and warm weather was very unusual. July and August were very cold; September very warm—so much so as to be exceptional to the general laws of temperature for the months. They were very rainy—September having a greater amount of precipitation than any corresponding month of which we have record.

The result of this unfavorable weather had a disastrous effect upon the agricultural communities in securing the hay and wheat crops; much of it was damaged, and but a very little hay was secured without injury.

The fruit and summer crops were abundant and excellent in quality, and upon the whole, the farmer was well repaid for his toil. October and November were very pleasant, and compensated for the unpleasant weather that preceded them for some three or four months. The Indian summer was much prolonged, and week after week the sun rose from his slumbers with his golden face, and traveled through the hazy mellow atmosphere, shorn of his fiercest rays, sinking at night upon his western couch amid the glories of a thousand splendors; and even stern Winter allowed the genial embraces of summer-like Autumn to encroach upon his season until almost the merry "Christmas bells" admonished him that it was high time that he assumed his sovereign sway and issued mandates from his frigid realms; even then his freezing, blustering way was tempered with mildness, and the Old Year took his departure, bearing but few traces of Winter's mark.

8. SANITARY CLIMATOLOGY AND ITS RELATIONS.

Humidity, heat and cold are the sources from which are produced most of the diseases lying within the geographical limits of the North-western States. From what observations have been made, the sanitary division of diseases indigenous to the above region might, with propriety, be classified as follows:

1. Malarious and non-inflammatory diseases, with their associated epidemics, reaching to the 44th or 45th degree of north latitude, with the summer isothermal of 60°.

2. Pulmonary and inflammatory diseases, with their associated epidemics, extending southward to the 30th degree of north latitude, and winter isothermal of 50°.

All diseases ranging under these classifications, in all degrees of violence, are observed each year by physicians who are called upon to treat them, and who find that they have an intimate physical relation with the seasons, as the isothermal line moves from the south to the north in the spring and early summer, and as it recedes to the south again in the autumn and winter.

Beginning near the middle of June, until the middle of October, all diseases appear to be more or less of a malarious character, and their violence attends a high atmospherical temperature and humidity; and from that time, or about the first of December, until the following April or May, pulmonary and inflammatory diseases principally exist, on account of the low temperature and moisture of the atmosphere. These phenomena in the movement of the isothermal upon diseases are a constant attendant in our sanitary climatology, and is the physical law which seems to govern diseases that are subject to climatic influences.

Perhaps no subject opens for investigation to the intelligent physician a more pleasant study than this of the geographical limitation of disease. Like the studies of natural history—the foundation upon which rests the beautiful structure of the medical art—it each day present something new and interesting within the thought and observation of its most humble student; and could each one take and reduce sanitary observations to a system, it would be a source of gratification to himself, and his record of disease and mortality, when compared with others, would be one of the links needed in the statistics of a sanitary climatology.

9. MONTHLY BAROMETRICAL RESULTS FOR THE YEAR 1866.

MONTH.	Maximum height.	Date.	Minimum height.	Date.	Mean height for the month.	Range for month.	Greatest daily variation	Date.	Least daily variation	Date.
January	30.42	8	28.85	15	29.432	1.57	.06	15	.03	3
February ...	29.86	26	28.94	19	29.384	0.92	.38	15	.02	28
March	29.69	27	28.80	31	29.383	0.89	.46	21	.03	19
April	29.59	6	28.79	23	29.392	0.80	.03	5	.00	11
May	29.48	7	28.57	27	29.186	0.91	.02	21	.00	23
June	29.52	11	28.82	18	29.214	0.70	.22	3	.00	1
July	29.50	9	28.02	4	29.318	0.48	.25	4	.00	10
August	29.55	16	29.95	8	29.285	0.60	.03	8	.01	27
September ..	29.54	15	28.95	11	29.309	0.59	.23	12	.01	29
October	29.79	16	28.94	20	29.358	0.85	.22	22	.02	5
November ...	29.91	5	28.83	10	29.316	1.08	.39	10	.02	26
December ...	29.80	20	28.59	23	29.300	1.21	.32	4	.01	29
Year	30.42	.....	28.02	.....	29.314	2.40	.46	.....	.00	..

10. ANNUAL BAROMETRICAL RESULTS FOR THE YEARS 1860-1866.

YEAR.	Maximum height.	Minimum height.	Mean height for the year.	Mean monthly range.	Greatest daily variation.	Least daily variation.
1866..............	30.42	28.02	29.314	.883	.46	.00
1865..............	29.83	28.61	29.350	.715	.62	.01
1864..............	29.85	28.58	29.236	.750	.47	.00
1863..............	29.81	28.47	29.280	.880	.75	.00
1862..............	29.83	28.77	29.297	.720	.57	.00
1861..............	29.90	28.88	29.354	.630	.66	.00
1860..............	29.87	28.94	29.330	.680	.61	.00

Mean barometer for 7 years, 29.308.

11. MONTHLY THERMOMETRICAL RESULTS FOR THE YEAR 1866.

MONTH.	Maximum height.	Date.	Minimum height.	Date.	Mean temperature of the month	Monthly range.	Greatest daily variation.	Date.	Least daily variation.	Date.	Mean temperature of the warmest day.	Date.	Mean temperature of the coldest day.	Date.
January	57	19	– 1	8	24.673	58.00	24	27	3	7	48.33	19	6.66	8
February	56	23	–16	16	25.497	72.00	25	7	2	25	49.66	23	– 7.00	15
March	58	2	13	26	31.761	45.00	20	10	2	4	50.66	2	13.33	17
April	82	18	30	7	50.907	52.00	39	4	2	23	68.66	18	34.00	7
May	84	19	34	3	55.845	50.00	27	19	7	1	70.33	19	42.00	1
June	92	24	47	18	67.396	45.00	24	8	3	3	80.00	25	50.00	18
July	95	16	61	11	74.577	34.00	21	31	4	27	85.66	16	66.33	10
August	81	13	51	24	65.240	30.00	20	21	2	7	73.66	13	54.66	24
September	84	1	37	22	58.974	47.00	21	22	0	18	78.00	1	51.00	18
October	78	8	32	31	53.149	46.00	25	8	2	29	65.66	20	36.33	31
November	61	8	25	23	40.563	36.00	30	7	2	22	51.66	8	28.33	30
December	53	8	3	30	27.551	50.00	19	8	2	24	47.00	7	13.33	20
Year	95	......	–16	......	47.994	111.00	39	......	0	......	85.66	......	– 7.00	..

12. ANNUAL THERMOMETRICAL RESULTS FOR 1860–1866.

YEAR.	Maximum height.	Minimum height.	Mean temperature of the year.	Mean monthly range.	Greatest daily variation.	Least daily variation.	Mean temperature of the warmest day.	Mean temperature of the coldest day.
1866	95	–16	47.994	47.16	39	0	85.660	– 7.00
1865	94	– 1	50.389	47.00	34	0	82.660	5.66
1864	98	–15	49.987	49.90	37	0	87.330	–11.66
1863	95	6	51.069	48.58	28	0	85.330	9.33
1862	97	– 2	51.316	45.25	35	2	87.000	11.66
1861	96	– 4	50.368	46.66	30	0	87.000	9.66
1860	94	10	49.343	44.13	41	2	83.000	– 2.66
Mean for seven years	....	....	50.050	....	....	....	85.420	– 6.00

13. MEAN TEMPERATURE FOR YEARS 1860-1866.

MONTH.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	Monthly mean for 7 years.
January	28.87	25.55	27.090	34.104	27.254	23.460	24.673	27.285
February......	30.56	33.00	37.317	31.166	31.829	29.128	25.497	29.785
March	42.56	35.88	34.835	35.244	35.717	40.180	31.761	36.596
April	48.37	49.43	49.350	48.615	46.119	40.352	50.907	48.877
May	63.96	55.01	60.147	63.060	63.190	59.654	55.845	60.123
June	64.18	69.48	66.186	68.275	70.400	73.333	67.396	68.412
July	72.00	70.26	79.900	74.507	75.090	69.341	74.577	73.667
August	70.21	71.48	74.170	72.950	71.103	68.845	65.240	70.571
September.....	59.16	62.90	66.064	61.651	61.519	70.185	58.974	62.921
October	50.87	53.38	53.824	44.878	48.000	50.179	53.149	50.611
November	37.33	39.91	40.785	44.163	40.641	41.096	40.563	40.641
December	24.05	38.14	36.125	34.223	27.641	29.921	27.351	31.064
Mean	49.343	50.368	51.316	51.069	49.875	50.389	47.994	50.050

Mean temperature for seven years, 50.050.

14. MEAN TEMPERATURE OF SEASONS FOR YEARS 1860-1866.

SEASON.	1860.	1861.	1862	1863.	1864.	1865.	1866.	Mean for seven years.
Spring	51.630	46.77	47.977	48.973	48.008	47.728	46.171	48.175
Summer	68.790	70.40	73.418	71.910	72.164	70.506	69.073	70.865
Autumn	49.120	52.06	53.557	50.230	50.052	53.820	50.595	51.390
*Winter	29.765	25.53	30.849	30.430	31.106	26.743	26.697	28.918

* Two months—January and February.

15. RAIN AND MELTED SNOW TABLE FOR YEARS 1861-1866.*

MONTH.	1861.	1862.	1863.	1864.	1865.	1866.	Mean.
January	2.125	3.875	2.8750	.3750	.7500	1.7500	1.9582
February	1.375	2.875	3.5630	.9375	1.6875	2.3125	2.1249
March............	5.000	5.562	2.4375	1.9375	1.7500	3.7500	3.4895
April	5.750	4.437	1.8750	4.7500	3.1250	.8750	3.4686
May	4.677	6.000	2.4375	2.1875	2.2500	5.3750	3.6545
June	3.875	3.562	2.5000	3.5000	3.6250	4.6875	3.5415
July	5.125	2.875	3.4375	3.2500	6.0620	4.0000	4.1198
August	3.363	3.375	2.2130	4.2110	3.7500	2.4375	3.2249
September	2.562	2.375	1.6250	7.0060	10.1875	7.1875	5.1571
October	2.312	2.250	3.1250	1.6875	2.2500	2.6250	2.3749
November	3.125	2.500	3.7500	5.8125	.3125	3.1250	3.1041
December.........	1.375	4.312	2.0000	1.5000	3.5625	2.5628	2.5523
Total	39.664	43.998	32.8370	37.1545	39.3120	40.6878	......

* In inches.

16. SNOW TABLE FOR YEARS 1861-1866.*

MONTH.	1861.	1862.	1863.	1864.	1865.	1866.	Mean.
January	13.500	19.25	11.750	12.500	7.500	7.750	12.040
February	2.062	21.00	34.000	3.250	10.750	9.750	13.468
March	9.000	8.75	13.250	7.750	4.750	12.000	9.250
April	5.000	4.00	5.000	5.000	2.250	......	3.541
May	......	.....	......	......	......	......	......
June	......	.....	......	......	......	......	......
July	......	.....	......	......	......	......	......
August	......	.....	......	......	......	......	......
September	......	.....	......	......	......	......	......
October	......	.75	.063	.125	......	......	.156
November	7.000	3.25	.750	6.500	......	......	2.916
December	5.250	6.00	2.000	13.00	3.375	12.175	6.966
Total	41.370	63.00	66.813	48.125	28.625	41.675	......

* In inches.

17. MONTHLY WIND AND WEATHER TABLE FOR 1866.

MONTH.	S. W. and W.	N. W. and N.	N. E. and E.	S. E. and S.	Number of clear days.	Number of cloudy days.	Number of variable days.	No. of days in which it rained.	No. of days in which it snowed.	Prevailing winds.
January	56	15	16	6	3	14	14	4	9	Southwest and westerly.
February	56	13	8	7	2	9	17	2	9	do do
March	44	30	14	5	4	13	14	5	13	do do
April	34	29	21	6	3	5	22	8	......	do do
May	36	36	16	4	10	6	15	9	......	do do
June	61	14	12	3	4	7	19	17	......	Southwesterly.
July	47	13	24	9	4	9	18	15	......	Southwest and westerly.
August	54	27	9	3	5	6	20	16	......	Southwesterly.
September	36	18	27	9	4	13	13	16	......	do
October	51	10	26	6	6	15	10	11	2	do
November	60	11	13	6	3	20	7	8	2	do
December	55	7	13	18	1	16	14	6	14	do
Total	590	224	199	82	49	133	183	117	49	....

18. ANNUAL WIND AND WEATHER TABLE FOR THE YEARS 1860-1866.

YEAR.	S. W. and W.	N. W. and N.	N. E. and E.	S. E. and S.	Number of clear days.	Number of cloudy days.	Number of variable days.	No. of days in which it rained.	No. of days in which it snowed.	Prevailing winds.
1866	590	224	199	82	49	133	183	117	49	Westerly.
1865	596	220	220	59	63	117	185	108	25	do
1864	608	204	229	57	55	149	162	98	35	do
1863	482	230	300	81	68	157	140	92	35	do
1862	520	205	282	88	80	142	143	103	46	do
1861	580	192	218	105	70	110	185	51	43	do
1860	501	217	229	148	127	161	78	100	34	do

19. REMARKS FOR THE YEAR.

JANUARY

2. A beautiful lunar rainbow surrounded the moon at 9 P. M., about 8° in diameter. A slight cirro-cumulus or sondercloud passed over the surface of the moon which, within the extent of the rainbow, was entirely obscured by the iridescence of brilliant colors; from the outer border of the moon to the inner border of the orange color, it was almost a pure silver white, composing one-half of the diameter of the bow. The balance of it was of the same arrangement of colors and vividness of appearance of those that are usually seen in the summer months near the surface of the earth just as a shower is passing away. The peculiarity of the rainbow was its entire circular form and brilliancy of colors.
8. Highest barometer observed in this vicinity, 30.42.
20. A thunder shower at 12:30 A. M. attended with lightning, high wind and rapid falling of the thermometer. The storm moved along the axis of storms of this locality at the rate of forty-five miles per hour; severe cold and high wind continued through the day.
24. Severe northeast snow storm.

FEBRUARY

14. Fine sleighing; snow storm during the day.
15. Very cold; mock-suns and fine solar halos at 9 A. M.; coldest day of the year.
16. Lowest thermometer on record in Toledo.
22. Rain A. M.; blue-birds seen.
24. Robins made their appearance.

MARCH

6. In the forenoon a beautiful set of halos and parhelia were seen for several hours. The halos were of the two kinds—those of 22° in diameter, and those of 46°—some finely colored and some not. The parhelia, or mock-suns, nearest to the sun were vertical with the observer, and colored—the others not—and were situated at the intersection of the halos of 46°. The first or inner halo was highly colored and 22°; the next presented the most

MARCH

6. remarkable appearance ever observed. As seen, it was elliptical and colored; its long diameter was about 30 to 36°, and lateral with the beholder; its short diameter intersected the parhelia of the inner halo of 22°, both above and below the sun. The next halo surrounded the sun, of 46° of diameter, colored laterally, below intersecting the horizon and above reached well nigh the zenith. The next was uncolored, perfect, and of 46°, extending from the sun to beyond the zenith; it evidently was a secondary halo of the large or outer halo that encircled the sun. At the points that it intersected the colored halos, it produced faint but perceptible parhelia, or mock-suns; laterally with the sun there were also partial uncolored halos made from the larger one, whose segments were of halos of 46°; these segments, where crossing the colored halos, produced faint and almost imperceptible mock-suns, so that at one time there were to be seen six halos, perfect and imperfect, and ten parhelia, or mock-suns, colored and uncolored.

13. Northeast rain; ice moving in the river.
14. Ice nearly all out of the river.
20. Thunder shower; very sharp lightning.
28. Good sleighing on the pavements; sleighs out.
31. First spring-like day.

APRIL

3. Swallows seen first for the season.
6. Frost just out; froze two and one-half feet deep.
18. Soft-maple trees in blossom.
19. Navigation opened with Saginaw.
23. Navigation opened with Buffalo.
25. Navigation opened with Oswego.
30. Early cherry trees in blossom.

MAY

3. Frost and some ice in the morning.
19. Trees nearly all in full foliage.
22. Frost in the morning.
27. A very low barometer; 8:30 A. M., 28.56.

JUNE

5. A terrific storm from the southwest, P. M.
18. A very severe, continuous and cold storm, which, in agricultural communities, killed a great number of sheep.

JULY.

Weather usual for the month.

AUGUST

24. Slight frost in the morning.
25. Frost.

SEPTEMBER

14. The equinoctial storm commenced on the 14th and ended on the 21st, which, for duration and violence, was unprecedented by any observations in this vicinity.
22. Hard frost; destroyed most kinds of vegetation that was unmatured.

OCTOBER.

The month as a whole was rather unpleasant, cold and stormy.

NOVEMBER.

Disagreeable weather nearly the whole month.

DECEMBER

10. Canal frozen over, and ground frozen hard enough to bear teams.
11. Skating on canal, first of the season.
12. River frozen over.
17. Sleighing; rather poor; balance of month good winter weather.

The meteorological phenomena for the year were unusual in the extremes that were observed in every department of observation; pleasant and agreeable weather seemed to be an exception for any continuous time. Spring and autumn were disagreeable, rainy, cold and muddy. All kinds of fruit, with the exception of apples, were destroyed by the severe cold and frost. Agricultural products were much injured by the same cause, and wheat was almost an entire failure.

II. OBSERVATIONS MADE BY MM. MARSH (1843-48), WINKLER (1855-59), AND LAPHAM (1860-65), AT MILWAUKEE (WISCONSIN,

Lat. 43° 3′ N.; long. 87° 56′ W.; height 600 feet above sea level.

1. MONTHLY AMOUNT OF RAIN AND MELTED SNOW FOR THE YEARS 1841-1865.

MONTH.	1841.	1843.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1854.
January	0.80	....	1.67	1.30	1.92	1.06	0.91	1.20	0.75	0.89	1.13	....
February	0.33	....	0.35	1.73	0.80	1.25	1.12	0.37	0.33	2.51	1.00	....
March	2.26	....	1.65	1.35	1.24	1.40	1.94	2.31	2.85	0.37	4.56	1.33
April	1.47	....	3.15	1.15	5.33	2.12	1.20	3.24	2.24	1.47	2.64	2.07
May	1.78	....	4.20	0.78	1.33	3.53	3.60	4.08	0.28	6.85	1.95	3.73
June	6.13	....	5.34	3.22	4.05	1.75	4.33	3.73	1.98	4.43	2.46	5.76
July	3.72	0.87	5.05	3.81	3.18	1.43	2.70	2.36	1.99	3.37	3.27	6.15
August	3.85	3.37	3.85	0.80	0.90	1.42	5.10	3.54	9.03	3.15	0.58	0.97
September	7.02	1.57	0.99	4.92	3.27	2.35	2.73	1.25	1.73	2.92	2.30	2.81
October	1.23	1.29	1.74	0.93	0.30	0.83	3.50	3.07	1.00	1.32	4.87	3.60
November	1.70	2.79	1.46	0.24	1.68	4.37	2.50	5.00	2.80	2.08	2.72	0.43
December	4.03	0.85	3.04	0.31	1.26	0.94	3.89	0.94	1.43	1.04	1.85	2.03
Year	34.32	....	32.50	20.54	25.26	22.45	33.52	31.09	26.41	30.40	29.33	......

2. AMOUNT OF RAIN AND MELTED SNOW FOR EACH SEASON DURING THE YEARS 1841-1865.

SEASON	1841.	1843.	1844.	1845.	1846.	1847.	1848.	1849.	1850	1851.	1852.	1854,
Winter	....	....	2.87	6.07	3.03	3.57	2.97	5.46	2.02	4.83	3.17	....
Spring	5.51	....	9.01	3.28	7.90	7.05	6.74	9.63	5.37	8.69	9.15	7.13
Summer	13.70	....	14.24	7.83	8.13	4.60	12.13	9.63	13.00	10.95	6.31	12.88
Autumn	9.95	5.65	4.19	6.09	5.25	7.55	8.73	9.32	5.53	6.32	9.89	6.84

MONTHLY AMOUNT OF RAIN AND MELTED SNOW—CONTINUED.

MONTH.	1855.	1856.	1857.	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.	No. of Years.	Mean.
January	4.05	2.00	0.10	2.15	1.10	0.53	2.15	3.41	3.33	2.15	0.22	21	1.563
February	1.20	1.00	1.85	1.46	1.20	1.40	3.34	0.48	1.85	0.42	3.58	21	1.313
March	1.86	0.15	1.20	2.11	4.42	0.33	1.53	2.10	2.48	2.52	3.89	22	1.994
April	1.80	3.10	3.69	5.15	4.57	0.33	3.65	5.34	1.04	3.01	1.96	22	2.765
May	1.45	3.04	4.60	8.51	3.62	1.34	4.32	5.11	5.21	2.74	1.11	22	3.417
June	3.68	4.13	3.41	4.08	3.97	4.15	1.80	3.86	0.79	0.15	3 57	22	3.490
July	5.56	2.26	3.14	3.86	2.08	1.95	4.87	4.09	2.41	7.07	1.78	23	3.346
August	3.09	0.91	3.01	2.15	0.27	2.80	2.21	2.94	2.62	0.61	4.34	23	2.674
September	6.88	2.70	2.73	3.92	2.35	2.50	3.39	5.03	1.02	2.93	4.67	23	3.130
October	2.01	2.48	3.96	4.59	1.52	2.09	1.48	3.26	2.97	1.63	4.13	23	2.339
November	1.85	4.42	1.50	4.95	3.12	2.61	1.59	1.28	3.51	2.61	0.31	23	2.414
December	2.61	2.83	1.70	1.93	0.64	1.99	1.55	1.37	4.57	1.99	0.52	23	1.883
Year	36.04	29.02	30.89	44.86	28.66	24.02	31.88	38.27	31.80	27.83	30.08	..	30.278

SEASON TABLE OF RAIN AND MELTED SNOW—CONTINUED.

SEASON.	1855.	1856.	1857.	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.	No. of Years.	Mean.
Winter	7.28	5.61	4.78	5.31	4.23	2.57	7.48	5.44	6.55	7.14	5.79	20	4.809
Spring	5.11	6.29	9.46	15.77	12.61	4.00	9.50	12.55	8.73	8.27	6.96	22	8.125
Summer	12.33	7.30	9.56	10.09	6.32	8.90	8.88	10.89	5.82	7.83	9.69	22	9.591
Autumn	10.74	9.60	8.19	13.46	6.99	7.20	6.46	9.57	7.50	7.17	9.11	23	7.833

This Table will be found not only curious and interesting, but highly useful, both at the present time and in the future. It will aid engineers in calculating the value of water powers, the flowage of rivers, and the proper size of bridges, culverts and drains. It shows to the farmer and the emigrant that in Wisconsin the rain is well distributed, not only over the several months and seasons, but through the different years. The general mean annual quantity is 30.278 inches, varying from 20.54 in 1845, to 44.86 in 1858. The greatest amount in one month was 9.03 inches in August, 1850, and the least one-tenth of an inch in January, 1857. The most rain, on an average, falls in June; the least, in February.

III. OBSERVATIONS MADE BY W. C. PIERREPONT, AT PIERREPONT MANOR (NEW YORK):

Lat. 43° 47′ 32″ N.; long. 76° 12′ 31″ W.; 617 feet above tide.

RAIN AND MELTED SNOW PER MONTH IN INCHES.

MONTH.	1859.	1860.	1861.	1862.	1863.	1864.	1865.
January	1.59	1.48	2.27	2.33	2.25	2.46	2.64
February	1.03	1.32	2.47	2.30	2.92	1.53	0.58
March	3.81	1.10	3.12	3.83	2.35	2.23	4.16
April	3.49	1.75	3.90	1.28	2.15	3.31	3.71
May	2.37	1.97	3.67	2.33	3.12	5.92	2.60
June	4.20	2.47	1.90	1.39	3.35	0.78	4.81
July	2.31	4.03	8.11	3.68	3.37	0.80	2.62
August	5.38	3.57	2.60	1.25	3.60	5.14	1.43
September	4.30	6.00	4.07	2.58	2.99	2.74	3.17
October	2.48	3.99	6.20	3.26	5.85	4.29	6.15
November	3.70	4.88	2.44	1.85	4.57	5.76	....
December	4.45	2.06	1.99	3.21	3.03	4.23	....
Year	39.11	34.62	42.74	29.29	39.55	39.19	.....

IV. OBSERVATIONS MADE BY C. DEWEY, D.D., AT ROCHESTER, (NEW YORK):

1. THERMOMETER, BAROMETER, Etc., AT 7 A. M., 2 P. M., AND 9 P. M., FOR THE YEAR 1865.

THERMOMETER.

MONTH.			I.	II	III.	IV.	V.	VI.	VII.	VIII.	IX.
January,	first	half	23.32	20.60	34.33	14.00	97	4	37	25.83	25.34
do	second	do	18.04		36.33	7.00	43	4		24.97	
February,	first	do	19.93	24.27	36.67	9.00	37	— 2	48	24.09	25.65
do	second	do	28.62		42.00	18.00	50	+ 2		27.24	
March,	first	do	30.75	36.79	53.00	12.00	63	6	69	30.17	32.45
do	second	do	42.50		59.00	33.33	75	29		34.64	
April,	first	do	47.35	47.89	63.33	35.00	72	30	64	41.19	44.08
do	second	do	48.43		60.33	39.33	74	33		47.00	
May,	first	do	57.67	57.13	60.67	42.00	70	44	42	52.92	56.33
do	second	do	62.79		73.00	50.33	86	54		59.18	
June,	first	do	68.36	70.08	78.00	61.67	90	57	33	63.31	66.18
do	second	do	71.80		81.33	61.00	90	57		69.08	
July,	first	do	68.35	58.64	77.00	58.67	84	54	31	70.19	70.58
do	second	do	68.91		78.33	57.67	85	56		70.97	
August,	first	do	70.76	67.90	82.00	61.00	91	55	36	70.14	68.61
do	second	do	65.21		77.67	54.67	88	50		67.16	
September,	first	do	72.67	66.99	78.67	65.67	77	63	35	64.14	60.58
do	second	do	61.31		70.00	54.67	76	42		57.03	
October,	first	do	51.69	46.77	63.00	43.67	69	35	41	51.31	48.05
do	second	do	42.18		52.00	35.33	54	28		45.00	
November,	first	do	40.09	39.72	52.67	27.67	63	26	40	41.18	38.10
do	second	do	39.46		56.67	29.00	66	26		35.01	
December,	first	do	34.20	31.10	53.67	15.67	61	12	51	31.07	28.72
do	second	do	28.10		41.33	15.33	47	10		25.81	

Mean of year, 48.16: Range of year, 93.5. General average, 47.06. Highest annual mean temperature 48.30 in 1853, and next 48.26 in 1846, and 48.16 in 1865; all above the general average. For twenty-eight years, sum 1315.81; for 1865, 48.16; for twenty-nine years, 47.04, as above.

In this Table we have, column I, average temperature for each half month, and, II, of each month; III and IV, highest and lowest mean of each month; V and VI, highest and lowest temperature of each half; VII, range of temperature in the month; VIII, average temperature of each half month in twenty-nine years, and, IX, average temperature of each month for the same years.

From the numbers we deduce the mean temperature as above of 1865 and its range of temperature, and then the general average for the twenty-nine years, 47°.06.

It is also seen that the mean temperature of the first half of September exceeds that of any half-month of the year, and that the next to this is that of the last half of June, 71°.80. This is its only occurrence in twenty-nine years.

The temperature was only once below zero, in 1865, viz: 2° below, on February 14.

Barometer and Rain Gauge.

1865.	Mean.	Highest mean.	Lowest mean.	Highest.	Lowest.	Range.	Water.	General average.
January..........	29.40	29.91	28.88	29.92	28.92	1.00	2.83	2.103
February.........	29.44	29.91	28.87	29.94	28.85	1.09	1.74	2.020
March	29.40	29.84	28.62	29.83	28.53	1.32	3.17	2.115
April	29.47	29.82	29.03	29.95	28.93	1.02	3.03	2.461
May	29.42	29.77	29.15	29.81	29.04	0.77	3.30	2.998
June..............	29.50	29.72	29.20	29.78	29.18	0.60	5.43	3.046
July	29.48	29.78	29.23	29.82	29.16	0.66	1.47	3.261
August............	29.53	29.80	29.24	29.83	29.18	0.65	1.04	2.754
September	29.60	29.84	29.41	29.86	29.40	0.46	4.33	3.275
October	29.38	29.80	28.65	29.83	28.55	1.28	4.29	3.289
November	29.48	30.04	28.92	30.12	28.90	1.22	1.70	2.769
December	29.47	29.85	29.11	29.92	28.92	1.00	1.75	2.484

Mean 28.46; range 1.59. Water 34.08; general average 32.525.

As the observations on the barometer began in 1838, the mean for twenty-eight years to the end of 1865, is 29.53 inches. The highest to this time on the barometer is 30.47 inches, January 1, 1839, and the lowest, 28.24; giving the range, 2.23 inches in the twenty-eight years.

Mean Height of the Barometer from the Annual.

Year.	Barometer.	Year.	Barometer.	Year.	Barometer.	Year.	Barometer.
1838	29.59	1845....	29.54	1852.....	29.51	1859	29.45
1839	29.60	1846....	29.54	1853.....	29.56	1860	29.46
1840	29.61	1847....	29.59	1854.....	29.56	1861	29.47
1841	29.56	1848....	29.63	1855.....	29.51	1862	29.47
1842	29.54	1849....	29.58	1856.....	29.55	1863	29.48
1843	29.55	1850....	29.44	1857.....	29.53	1864	29·39
1844	29.53	1851....	29.58	1858.....	29.54	1865	29.46
Mean of fourteen years			29.56	Mean of fourteen years			29.50

Mean of twenty-eight years, 29.53.

Least height of barometer, 1859, March 19th, 28.24; greatest height of barometer, 1839, January 1, 30.47 inches. The first of these gave the lowest mean, 28.63, and the second the highest, 30.38, in the twenty-eight years. October 19th, 1865, barometer 28.55; but the highest that year, 30.12.

The rain-guage has given 34.08 inches of water in the year, which exceeds the general average, 32.525 inches, by 1.56 inch.

The drouth attending the small rains of July and August, which amounted to only 2.51 inches in two months, was closed by rain on September 5th. The grass had been injured, the pastures dried, and the early crops of potatoes and peas were almost destroyed, while Indian corn had made adequate progress in the hot weather. But the copious rain changed the face of nature. Grass at once sprung up with the greatest rapidity, and the fall crops were far larger than had been anticipated. Peaches were more plenty, pears and quinces also; and apples, which were too small to be promising in the first week of September, became abundant, so that thousands of barrels were sent to northern and eastern markets, and especially to the city of New York. The yield of Indian corn was an average one.

The year has been relatively healthful; and the general prosperity of the people, in their great and leading pursuits and business, demands gratitude and praise.

The Seventeen-year Harvest Fly.

We have two species of the Harvest Fly over our country, commonly called *Locusts*, but improperly, for obvious reasons. The *Locust* has a mouth and jaws for eating leaves; but the *Harvest Fly* (CICADA) has only a short tube, or sucker, for obtaining its food. One species of these appears annually over the Northern States in the last part of July, and continues for a few weeks, but it is always in very limited numbers; and this is called the *Dog-Day Harvest Fly*, or CICADA CANICULARIS of Dr. HARRIS. Another species appears once in seventeen years, in the same localities in a given tract, in vast numbers, and is hence named CICADA SEPTEN-DECIM by LINNÆUS. The buzzing, drum-like noise of the males fills the air, to the annoyance of the people within a half mile. In about four weeks the eggs are laid in the younger twigs of the oak, if present, and if not, on other trees, the apple, etc. The localities in this part of the State are in several counties, often only a few miles apart; as in

Monroe county at Brighton and Mendon, and many more; in Livingston, Wayne, Onondaga, Ontario and Cayuga counties, in all of which the seventeen year fly appeared in 1814, 1831, 1848, and 1865. The pupæ come to the surface of the earth in the last week in May or the first week in June; and at Mendon, in the last year, had all appeared by the 11th of June. In Ohio, their appearance at Marietta was in 1795, and in the following seventeenth year regularly; in Pennsylvania, in 1715, and then in each seventeenth year to 1851; in Sandwich, Mass., in 1787, and every seventeenth year to 1855; in Maryland in other series of years; and in South Carolina and Georgia in still another series. In each locality the appearance is regularly each seventeenth year, though a straggler is sometimes seen in other years. These Harvest Flies probably feed on the mucilage or honey-dew of the leaves, by means of their tube or sucker. They cannot eat the leaves or wood, being destitute of mouth and jaws; and it is not yet ascertained that they do any injury to vegetation.

2. RESULTS FROM THE THERMOMETER; AT 7 A.M., 2 P.M., AND 9 P.M., FOR THE YEAR 1866.

MONTH.		Tempera-ture.	Mean.	Highest mean.	Lowest mean.	Highest.	Lowest.	Range.	General average.	Monthly average.
January,	first half	17.78	21.73	34.33	– 0.67	38	– 4	46	25.56	25.22
do	second do	25.44		38.67	11.67	42	7		25.00	
February,	first do	24.19	25.62	39.33	9.67	45	3	56	24.09	25.65
do	second do	27.05		48.00	3.67	53	– 3		27.23	
March,	first do	32.32	29.89	49.33	19.67	58	10	48	30.24	32.37
do	second do	27·64		38.00	15.00	44	12		34.41	
April,	first do	45.82	48.69	65.00	33.33	75	30	55	41.35	44.23
do	second do	51.56		72.00	36.33	85	33		47.14	
May,	first do	51.17	52.43	69.00	40.33	80	37	49	52.87	56.20
do	second do	53.33		70.67	44.33	86	38		59.00	
June,	first do	65.89	66.93	72.00	56.00	84	54	37	63.40	66.20
do	second do	67.98		80.33	56.33	91	54		69.05	
July,	first do	75.93	74.33	86.33	66.33	93	60	35	70.38	70.70
do	second do	72.85		86.00	66.33	95	63		71.04	
August,	first do	64.93	62.63	68.67	60.00	76	58	38	69.97	68.41
do	second do	60.48		66.33	53.33	74	48		66.93	
September,	first do	61.85	57.79	73.67	46.67	81	42	45	64.06	60.49
do	second do	53.70		62.67	46.33	70	36		56.92	
October,	first do	52.64	50.95	65.33	38.33	75	29	47	51.36	48.14
do	second do	49.37		66.33	36·00	76	32		45.13	
November,	first do	41.11	39.61	51.33	30.00	58	21	37	41.18	38.14
do	second do	38.11		55.00	24.33	58	24		35.11	
December,	first do	29.09	25.92	50.33	12.67	54	12	63	31.03	28.63
do	second do	22.96		40.67	5.00	43	– 9		25.72	

Mean, 46.38; annual range, 104. General average of thirty years, 47.03.

On three of the five cold days in January the temperature was below zero; on the last, or 9th, 4° below; but the barometer rose to the highest ever known here, 30.52 inches. December 21st was the coldest known for that month, 9° below, and the barometer 30.05.

MONTH.	Year.	Temperature.	Barometer in inches.
January	1863	1	30.16
February	1863	– 6	30.67
December	1863	17	30.06
November	1862	20	30.20
January	1861	– 4	30.07
January	1860	30	30.09
January	1859	10	30.13
January	1858	15	30.24
January	1858	13	30.23
January	1856	– 3	30.14
February	1855	20	29.57

Even in the cold months there is no close connection between low temperature and high barometer; the last is striking evidence. In the warm months there is less apparent casual influence.

The "heated period" of July was extensive. Here it was limited to five days—the 13th to the 17th. The mean of that continuous period was 83°.4; the highest mean was 86°.3, on the 15th, and the highest at 2 P.M. was 95°, on the 16th. The next highest mean of a day, was 85°.7, in 1856. The mean heat of no four consecutive days here has been so great, or any other heated period, as in last July. On the hottest day the barometer exceeded the average, and on most of the five days.

3. CONTINUATION OF TABLE II IN THE REGENTS' EIGHTEENTH ANNUAL REPORT (1863) FOR 1864, ON THE METEOROLOGICAL REPORT FOR ROCHESTER UNIVERSITY, BEING THE MEANS OF THE HALF MONTHS AND OF THE MONTHS FROM 1864.

	JANUARY.			FEBRUARY.			MARCH.			
	1st half.	2d half.	Month.	1st half.	2d half.	Month.	1st half.	2d half.	Month.	
For 28 years	725.74	706.35	714.29	678.56	761.21	719.76	844.04	962.15	904.31	....
1865	23.32	18.04	20.60	19.93	28.62	24.27	30.75	42.50	36.79	....
1866	17.78	25.44	21.73	24.19	27.05	25.62	32.29	27.64	29.80	....
Sum of 30 years....	766.84	749.83	756.62	722.68	816.88	769.55	907.08	1,032.29	970.99	....
General average	25.56	25.00	25.22	24.00	27.23	25.65	30.24	34.41	32.37	....
Av. first 3 months..	....	....	....	....	....	....	....	....	....	83.24
	APRIL.			MAY.			JUNE.			
For 28 years	1,147.23	1,314.33	1,230.37	1,483.71	1,653.57	1,576.50	1,767.72	1,931.73	1,849.11	....
1865	47.35	48.42	47.89	51.07	62.79	57.13	68.36	71.80	70.08	....
1866	45.82	51.56	48.69	51.47	53.33	52.43	65.89	67.98	66.93	....
Sum of 30 years....	1,240.40	1,414.31	1,326.95	1,586.25	1,769.69	1,686.06	1,901.97	2,071.51	1,986.12	....
General average	41.35	47.14	44.23	52.87	59.00	56.20	63.40	69.05	66.20	....
Av. second 3 months	....	....	....	....	....	....	....	....	....	166.63
	JULY.			AUGUST.			SEPTEMBER.			
For 28 years	1,967.18	1,989.29	1,978.20	1,963.28	1,882.38	1,921.67	1,787.39	1,592.61	1,690.00	....
1865	68.35	68.91	68.64	70.76	65.21	67.90	72.67	61.31	66.99	....
1866	75.93	72.85	74.33	64.93	60.48	62.63	61.85	53.70	57.79	....
Sum of 30 years	2,111.46	2,131.05	2,121.17	2,098.97	2,008.07	2,052.20	1,921.91	1,707.62	1,814.78	....
General average	70.38	71.04	70.70	69.96	66.93	68.41	64.06	56.92	60.49	....
Av. third 3 months.	....	....	....	....	....	....	....	....	....	199.60

	OCTOBER.			NOVEMBER.			DECEMBER.			
For 28 years	1,436.42	1,262.47	1,346.60	1,154.29	976.08	1,064.99	866.85	720.50	802.02	....
1865	51.69	42.18	46.77	40.29	39.16	39.72	34.20	28.10	31.10	....
1866	52.64	49.37	50.95	41.11	38.11	39.61	29.09	22.96	25.92	....
Sum of 30 years	1,540.75	1,354.02	1,444.32	1,235.42	1,053.35	1,144.32	930.14	771.56	894.04	....
General average	51.36	45.13	48.14	41.18	35.11	38.14	31.00	25.72	28.63	....
Av. fourth 3 months	....	....	....	....	....	....	....	....	....	114.91
Total means	....	....	....	....	....	....	....	....	....	564.38
Genl. average, 30 yrs.	....	....	....	....	....	....	....	....	....	47.03

4. SUPPLEMENT TO TABLE II, SHOWING THE LOWEST AND THE HIGHEST MEANS IN EACH HALF MONTH AND OF EACH MONTH, THE YEAR OF THEIR OCCURRENCE, WITH THEIR RANGE AND GENERAL AVERAGE.

MONTH.	Year.	Lowest and highest mean.	Year.	Range.	General average.	Year.	Lowest and highest mean.	Year.	Range	General average.	Year.	Lowest and highest mean.	Year.	Range	General average.
January	1856	16 to 37	1838	21	26	1857	13 to 35	1850	22	25	1857	15 to 32	1858	17	25
February	1856	13 to 35	1853	22	24	1838	12 to 38	1857	26	27	1838	15 to 34	1857	18	26
March	1856	19 to 40	1854	21	30	1843	24 to 41	1859	18	34	1843	22 to 39	1842	17	32
April	1841	35 to 53	1844	18	41	1838	38 to 55	1840	17	47	1838	38 to 53	1844	15	44
May	1841	45 to 61	1860	16	53	1845	52 to 66	1840	14	59	1850	51 to 62	1850	10	56
June	1843	56 to 71	1855	14	64	1839	61 to 78	1858	16	69	1839	60 to 72	1855	12	66
July	1856	66 to 76	1866	10	70	1850	68 to 77	1854	9	71	1843	68 to 77	1866	7	71
August	1839	65 to 76	1853	11	70	1866	60 to 71	1849	11	67	1866	63 to 71	1855	8	68
September	1859	57 to 72	1846	12	64	1842	53 to 73	1865	20	60	1848	57 to 65	1846	8	61
October	1853	47 to 56	1852	10	51	1843	38 to 53	1839	14	45	1843	43 to 54	1839	10	48
November	1843	31 to 50	1849	19	41	1838	27 to 43	1849	16	35	1838	33 to 46	1849	14	38
December	1845	23 to 38	1863	15	31	1838	19 to 33	1843	14	26	1838	23 to 34	1852	12	29
Sum	......	....	......	......	565	......	....	......	......	565	......	....	......	......	564
General average	......	....	......	......	47	......	....	......	......	47	......	....	......	......	47

Against the month the *lowest* mean has its year on the *left*, and the *highest* mean its year on its *right;* next the *range* of these means, and next the average monthly mean of all the years. The sum of these semi-monthly averages, or of the monthly averages, give, on being divided by twelve, the general average temperature of the thirty years. The range *decreases* and the average *increases* from the coldest to the warmest months

5. ANNUAL MEAN TEMPERATURE OF THE THIRTY YEARS.

Year.	Temperature.	Year.	Temperature.	Year.	Temperature.	Year.	Temperature.
1837	45.72	1844....	46.71	1851.....	47.75	1859....	47.32
1838	45.10	1845....	47.01	1852.....	47.09	1860....	47.58
1839	46.72	1846....	48.26	1853.....	48.30	1861....	47.31
1840	47.06	1847....	46.44	1854.....	47.97	1862....	47.38
1841	46.36	1848....	47.94	1855.....	46.76	1863....	47.30
1842	47.44	1849....	47.59	1856.....	44.97	1864....	47.73
1843	44.70	1850....	47.95	1857.....	45.94	1865....	48.16
				1858.....	47.64	1866....	46.38
			655.02				755.33
Mean temperature for 14 years..			46.79	Mean temperature for 16 years..			47.21

The following exhibits the mean of thirty years as derived (1) from the sum of means for the first fourteen and last sixteen years, and (2) from the means of these periods respectively:

Number of Years.	Sum of means.	Number of Years.	Mean.
First fourteen years...........	655.02	First fourteen years..........	46.79
Last sixteen years............	755.33	Last sixteen years...........	47.21
	1,410.35		94.00
Mean of thirty years........	47.01	Mean of thirty years	47.00

Range of annual temperature is from 44°.70 in 1843, to 48°.30 in 1853, amounting to 3°.60.

Average temperature of the four seasons follows:

SEASON.	Sum of three months.	Monthly average.
Spring..	132.8	44.3
Summer	205.3	68.4
Autumn	146.8	48.9
Winter..	79.5	26.5

6. RESULTS FROM THE BAROMETER AND RAIN-GUAGE, 1866

MONTH.	BAROMETER.						RAIN-GAUGE.	
	Monthly mean.	Highest mean.	Lowest mean.	Highest.	Lowest.	Range.	Water in inches.	General average.
January	29.55	30.48	29.13	30.52	29.05	1.47	1.48	2.099
February	29.50	30.01	29.00	30.10	28.94	1.16	2.39	1.936
March	29.44	29.83	29.04	29.84	28.86	0.98	2.71	2.133
April	29.45	29.81	28.76	29.84	28.57	1.16	3.20	2.487
May	29.32	29.65	28.89	29.67	28.77	0.90	2.90	3.076
June	29.42	29.74	28.98	29.75	28.92	0.83	3.90	3.021
July	29.51	29.75	29.31	29.77	29.22	0.55	1.36	3.235
August	29.44	29.74	29.28	29.75	29.22	0.53	4.91	2.827
September	29.51	29.80	29.14	29.84	29.11	0.73	4.11	3.301
October	29.58	30.00	29.13	30.02	29.13	0.89	1.24	3.221
November	29.47	30.10	28.78	30.12	28.72	1.40	3.29	2.738
December	29.43	30.00	28.88	30.05	28.68	1.37	3.24	2.506
Yearly mean.	29.47	Yearly range				1.95	34.73	32.630

The average height of barometer in thirty years is 29.53 inches. Barometer was lowest March 19, 1859, 28.24 inches; next lowest was 28.47, in 1864. It was highest January 8, 1866, 30.52; next to the highest, January 1, 1839, 30.47 inches. The range in these years was 2.28 inches.

The barometer was also higher January 8, 1866, than before on record, at Albany, New York, Mohawk and Geneva, in this State; and at Toronto, Michigan University and Boston.

The water fallen in rain and snow this year is about two inches above the average, which for thirty years is 32.63 inches. The preceding Table contains the monthly averages of water for thirty years, in the last column; the annual averages will be found in Table 7.

Fall of Water in Rain and Snow.

In the following Table (7), the results for the first fourteen years had been already published in the Meteorology of this State (1855); but many numbers there given were incorrect. By recurrence to the originals these have been corrected, and are here accurately presented. Of course, the true means and averages differ somewhat from those given in the Regents' Report for 1864 and 1865. The results should have been as they are now found in the following Table. It contains the sums of water for the first and second half years, as well as for the year. The sum and average water for each month are found at the bottom of the months, and from the monthly averages is derived the average water for the thirty years.

Besides the errors here corrected, there are several in the summing of the Rochester reports in the State Meteorology. The longitude of Rochester is too small by two degrees, which places this city two degrees east of Auburn instead of near as much west of it. The 10° *below* in December, 1847, should be 10° *above*. On same page, 402, the mean temperature of second half of May should be 58°.35, and not 38°.35; and the mean at the bottom should be 36°.75, and not 45°.09. On page 403, the mean of May, 1846, should be 60°.82; and on page 404, the water fallen in 1850 should be 38.46 inches, and not 32.47. On page 143, the water for 1841 should be 33.91, not 30.13; and water for 1847 should be 47.44, not 49.24; and for sixteen years the mean should be 36.56, not 36.68.

7. MONTHLY FALL OF WATER FOR THIRTY YEARS; FROM 1837 TO 1866.

YEAR.	January.	February.	March.	April.	May.	June.	Sum of first half.
1837	0.160	2.500	0.300	0.500	2.820	2.580	11.560
1838	1.700	1.700	1.240	2.140	4.910	1.330	13.020
1839	2.400	2.050	1.350	2.480	4.900	3.400	16.580
1840	1.160	1.370	1.400	2.220	4.130	2.630	12.910
1841	2.130	0.210	3.550	3.270	1.170	1.290	11.620
1842	1.180	2.120	2.890	2.480	2.180	3.660	14.510
1843	2.790	2.620	2.090	2.220	1.830	2.930	14.480
1844	2.210	0.370	1.140	0.720	4.180	3.190	11.810
1845	3.510	2.010	2.620	2.490	2.650	4.480	17.760
1846	2.180	2.920	1.530	1.180	2.340	4.960	15.110
1847	3.010	3.710	0.920	2.650	1.730	2.650	14.670
1848	2.250	1.040	1.770	0.780	4.480	2.130	12.450
1849	1.390	1.290	2.350	1.440	3.810	4.830	15.110
1850	3.030	1.948	1.679	2.560	2.867	1.837	13.921
1851	1.360	2.000	1.380	1.160	2.210	2.150	10.260
1852	1.570	2.080	3.213	4.327	2.080	4.360	17.630
1853	2.470	2.868	2.297	3.245	4.555	1.480	16.915
1854	1.814	2.863	1.073	2.428	2.146	5.473	15.797
1855	3.327	1.460	1.485	2.046	1.957	5.550	15.825
1856	1.940	0.771	1.920	2.325	2.480	1.900	11.336
1857	1.924	3.317	1.991	5.669	3.718	5.194	21.813
1858	1.583	2.379	1.466	2.849	3.440	3.400	15.117
1859	1.370	1.070	2.490	4.030	1.360	1.170	11.490
1860	1.088	1.354	1.643	1.790	1.410	2.382	9.667
1861	2.476	2.980	1.552	3.246	3.880	1.370	15.504
1862	3.510	2.820	5.150	2.130	4.440	2.050	20.100
1863	2.230	2.440	1.490	2.790	1.860	1.370	12.180
1864	2.910	1.180	3.440	3.230	6.540	1.570	18.870
1865	2.830	1.740	3.170	3.030	3.300	5.430	19.509
1866	1.480	2.390	2.710	3.200	2.900	3.900	16.580
Sum	62.982	59.570	64.000	74.635	92.273	86.746	444.096
Average	2.099	1.986	2.133	2.487	3.076	3.031	14.803

MONTHLY FALL OF WATER—CONTINUED.

YEARS.	July.	August.	September.	October.	November.	December.	Sums of second half.	Sum of Year.
1837	1.110	3.720	2.340	5.100	4.160	2.620	19.050	30.610
1838	3.040	3.590	0.870	3.200	1.680	1.060	12.440	25.460
1839	4.200	3.560	1.190	0.560	2.820	1.180	13.510	30.090
1840	3.110	4.090	2.810	2.830	1.710	1.930	16.480	29.390
1841	4.580	1.600	6.140	1.210	4.650	2.530	20.710	32.330
1842	3.690	1.420	5.190	2.200	3.430	2.800	18.730	33.240
1843	2.120	0.700	5.520	4.420	1.070	1.900	15.730	30.210
1844	3.300	1.740	0.680	4.810	2.190	1.640	14.390	26.200
1845	2.750	2.770	4.320	2.840	2.580	1.420	16.680	34.440
1846	2.490	3.850	2.760	6.790	3.610	2.520	22.020	37.130
1847	2.050	5.270	4.250	4.940	3.650	1.310	21.470	36.140
1848	6.160	2.780	2.960	1.770	1.800	4.110	19.580	32.030
1849	0.940	3.620	3.910	4.170	3.310	2.310	18.260	33.370
1850	5.969	1.929	2.951	5.058	3.350	5.280	24.537	38.458
1851	3.580	1.540	1.130	2.140	3.617	2.700	14.707	24.967
1852	4.090	1.330	2.970	3.870	2.855	2.300	17.415	35.045
1853	1.000	2.010	6.833	1.702	2.342	1.723	15.610	32.525
1854	0.252	1.826	5.185	1.635	1.478	3.250	13.626	29.423
1855	5.268	2.633	1.797	4.845	1.060	2.485	18.088	33.913
1856	1.800	2.700	3.520	0.995	1.325	2.680	13.020	24.356
1857	3.580	2.740	1.907	4.215	3.964	4.372	20.778	42.591
1858	4.660	2.880	3.190	0.870	5.700	3.480	20.780	35.897
1859	4.060	5.140	2.860	1.210	1.920	4.620	19.810	31.300
1860	4.498	2.499	3.522	4.714	3.347	1.532	20.112	29.779
1861	5.110	2.500	6.090	2.810	1.410	1.380	19.300	34.804
1862	4.130	2.220	2.360	3.980	2.460	2.340	17.490	37.590
1863	5.030	3.700	1.510	2.720	2.970	2.030	17.960	30.140
1864	1.660	5.490	1.830	5.510	2.660	2.670	19.820	38.690
1865	1.470	1.040	4.330	4.290	1.700	1.750	14.580	34.080
1866	1.360	4.910	4.110	1.240	3.290	3.220	18.130	34.710
Sum	97.057	84.797	99.035	96.644	82.108	75.172	534.813	978.908
Average	3.235	2.827	3.301	3.221	2.738	2.506	17.827	32.630

The average fall of water in the first half year is 14.803; the average fall of water in the second half year is 17.827; general average for thirty years, 32.630.

The amount of water fallen in thirty years, 978.903 inches; annual general average, 32.630 inches; water of first half year, 444.096, is to that of second half, 534.813, as 5 to 6 nearly.

Table 7 shows many facts and indicates conclusions:

1. About one-fifth more water falls in the second than in the first half year.

2. Average depth of water to end of 1866, or for 30 years, is 32.559 inches.

3. *Greatest* fall in a year, 1857, was 42.590 inches; the next, 1864, was 38.690, and 1850, 38.458, and in 1862 was 37.530 inches; the *least* fall in a year, 1858, 24.356 inches; the next, 24.967 in 1851; 25.460 in 1838, and in 1844, 26.200 inches.

4. Greatest fall in a month, September, 1853, 6.833 inches; the next 6.790 in October, 1846, and May, 1864, 6.540 inches; the next 6,160 in July, 1848, and September, 1841, 6,140 inches; the next 6.090 in September, 1861. The least fall in a month, January, 1837, 0.160 inches; the next, February, 1841, 0.210, and then July, 1854, 0.252 inches; the next, April, 1837, 0.500, and then October, 1839, 0.560; the next, August 1843, 0.700, and less than an inch more. Between 1 and 2 inches in 105 months; and in colder months, between 2 and 3 inches in 101; between 3 and 4 inches in 57; between 4 and 5 inches in 34; between 5 and 6 inches in 19; above 6 inches in 6 months.

5. In the 30 years, September gave the *most* water, 99.03, and average 3.30; next, July gave 97.06, and average 3.23; and October, 96.64, and average 3.22; next, May gave 92.27, and average 3.07; and June, 86.74, and average 3.02. In the 30 years February gave the *least* water, 59.57, and average 2.00; next, January gave 62.98, and average 2.1; and March, 64.00, and average 2.13; next, April gave 74.62, and average 2.5; and December, 75.17, and average 2.50.

8. SOME COMMON AND SPECIAL PHENOMENA.

MARCH 17 and 18. Flooding of a part of the city by the sudden melting of the snow and attendant rain.

APRIL 14. Some rain in the afternoon, and at sunset a splendid rainbow, full half circle, with the two narrow and fainter bows below and close to the primary bow. In these small lower bows, the colors are in the same order as in the primary, the red being uppermost, orange and yellow blended, and the green or faint blue the lowest and just perceptible.

April 17. Aurora borealis rose over the north at 8:30 P. M.; brilliant pillars or columns rose towards zenith; about 9 P. M. an arch rose from the upper part of the luminous halo and extended from southeast to northwest, thirty degrees about north of the zenith; at 9:30 and a little south of the place where the arch disappeared, were moving bands of aurora, lying north and south parallel to the magnetic meridian, quite across the canopy from northwest to southeast, first cloudy short masses, then longer parallel bows, all moving towards the zenith, and disappearing a little south of the zenith.

The month has been warm and dry, and farming operations very easy and pleasant.

Sabbath, May 20. Highest temperature of the month, at 2 P. M., 80°; and at 4 P. M. a violent thunder shower began south and west, and extending north and moving eastward. Just after 4, lightning, rain and wind were upon us, and soon hail in abundance, large stones, egg-shape, pear-shape, oval or oblong, and with longer diameter two inches, globular, all solid ice, or with snow in the centre or on one side of the centre, or sometimes with a fine solid crystal of ice in the centre, surrounded with lamellar and irregular formed ice. Beginning at or south of Mt. Hope, where the storm swept over the nurseries it expended its force on the east side of the Genesee, dashing to ruins the glass of conservatories and the windows on the south side of houses, and fine gardens, presenting a scene of desolation a mile long and half as wide. Never had I seen such ruin of buildings and glass, and of rich and promising plants; and I am compelled to say that my words can give no adequate conception of the desolation. And now in the autumn, what a change the summer has effected; how great the growth and beauty and richness of the vegetation now filling the grounds, and giving abundant promise for the products of another year.

On the last Sabbath in August, 1841, a similar hail storm and tornado passed over much the same surface.

Some frost on the 23d and 24th; not much injury done.

May 29. Hay ten dollars a ton.

June. The month had about the average temperature. The 6th gave a severe hail storm in Penfield, destroying wheat and grass for a mile in width, and more in length. Also at Caledonia and Le Roy, a hail storm to the great injury of the crops; and at Caledonia it destroyed many thousand trout in SETH GREEN'S *Troutery*, so successfully managed that some thousands would scarcely be missed. On the 16th, great hail storm at Jamestown. Heavy storm on the 17th at New York. Heavy gale here at the west on the 25th; damage in Buffalo, and some in our city. Great thunder storm along the lower Hudson, and a huge *icehouse* struck with lightning at Poughkeepsie and destroyed.

JULY. The first half was the hottest in thirty years, 74°.9; and the month was the hottest, 74°.3, except 74°.8 in 1855. The "heated period," from 13th to 17th, five days, caused many deaths in New York and some in other places, from the so-called "sunstroke." Fine weather for harvesting.

JULY 27. Atlantic cable laid to-day with success: Ireland and Newfoundland connected and telegrams passed; congratulations between Queen VICTORIA and President JOHNSON.

AUGUST. Weather nearly 3° colder than in thirty years for this month, the mean being 52°.6, and the hottest mean 71°.1 in 1853. Bad harvest weather in France and England. Maize quite behind.

SEPTEMBER has been a cool month; only twice colder in thirty years. Weather favorable for crops of autumn, except the frost of the 22d, which somewhat injured maize, especially in towns south of us. Flowers of shrubby althæa yet fine. Fruits, as pears, plums, quinces, and peaches, not very abundant, but plenty enough for large exportation to less favored places. Apples are scarce aud high in this section. A very healthy summer and season in the vicinity.

OCTOBER was warmer a little than the average. Of course, maize was much improved; and where the frost-bitten was cut up by the roots and set up in small shocks, a large proportion yielded hard corn, while most of the other matured.

NOVEMBER. The temperature, being about the average, was very favorable for the first half; but the last half was rainy and much clouded. Snow from the 22d, frozen fast on the 24th, was melted and gone on the 27th; and there fell snow and much rain near the close of the month which was rather warm.

The meteors were numerous on the 13th and 14th; some hundreds being counted at Yale College, and other places. But the "shower of meteors," expected here, was splendid in England and Scotland, from 1 to 2 A. M. of the 14th especially, and many till day-light. The next display may be expected in 33 years, and on the 15th of November, at an early hour, in Western Asia. Some suppose the shower may be here next year, about the last of the 13th or on the 14th.

DECEMBER. Its first week was unusually pleasant; only once much warmer than this, 39°.4, in December, 1852, 44°.3, in last sixteen years. On the 7th the temperature of the canal was 39°; no ice on the 10th, but on the 12th canal fast frozen. Navigation was to be closed this day by authority, which the season effectually secured this day. In 1865 the canal was closed by ice on the 15th. Quite severe weather on the 20th, and on the 21st the temperature was 9° below at 7, and 10° below 7:30 A. M. The lowest in December before, was 6° below in the last week of 1851 and 1859. This is the coldest in December for the thirty years, as the 10° below in the State Meteorology for December, 1848, is a mistake of *only* 20°.

On the 27th, afternoon, from the west, began a severe and extensive snow storm, with high wind, often a gale, sweeping the snow into great drifts, from Ohio along our latitude and north into Canada West, eastward to Massachusetts and Boston. The wind continued over the 28th, with much snow; and the railroads were so blocked that cars from Albany did not open the passage to that place till in the afternoon of the 29th. East of Albany, the Central railroad was not open till a day later, and hardly then did the cars make the regular trips in Massachusetts. A severer storm has not been over this section, and eastward to the Atlantic, for many years. The storm did not extend south to New York, though some snow fell on the 27th, with rain to carry it off on the 28th, and the streets were dry on the 30th. The snow extended in this section only a few miles to the south of Rochester. In the western part of the State, it was felt south to Pennsylvania.

The productions of the earth have been plentiful, but not great crops: only hay has been considerably below the average, and has been selling here, this month, at from sixteen to twenty dollars a ton. The efforts of speculators have been successful in sustaining high prices of many products of the farm; but prices have begun to decline. With great general health, and an adequate supply of agricultural products and other industry, we ought to praise the Lord with full and faithful hearts for 1866.

(G.)

LONGITUDE OF THE WESTERN BOUNDARY LINE OF THE STATE OF NEW YORK.

COMMUNICATION FROM THE REGENTS.

UNIVERSITY OF THE STATE OF NEW YORK:

Office of the Regents,
Albany, March 10, 1866.

To the Hon. Lyman Tremain,
Speaker of the Assembly;

Sir—I have the honor to communicate, through you, to the Legislature, the Report of Dr. Peters, director of the Hamilton College Observatory, on the longitude of the western boundary of the State, made under the directions of the Regents of the University, by authority of chapter 784 of the Laws of 1857, and chapter 328 of the Laws of 1858.

By the same authority, the longitude of the following places has heretofore been determined:

Dudley Observatory, Hamilton College Observatory, Syracuse, Elmira, Buffalo, Ogdensburgh.

These determinations, made with the highest scientific accuracy, correct serious errors in existing maps, and will render direct and essential aid in constructing an accurate topographical map of the State, the importance of which has long been felt. The means placed at the disposal of the Regents for longitude purposes are now exhausted. There are other points whose position it is important to determine, and it is respectfully submitted to the Legislature that a further appropriation for this purpose should be made.

Though the laws above referred to only directed that longitudes should be determined, the Regents have also had the corresponding latitudes ascertained; and in the case of the western boundary, which is a meridian, or line of longitude, they fixed on the first monument of that line, near the shore of Lake Erie, as the point of latitude to be determined.

Dr. PETERS, in his report, states that he found this monument in a very dilapidated condition, and that "such are the encroachments of the lake on the shore near which it stands, that the site of the stone will soon become a prey to the waves, and it seems desirable that a new and durable monument, more inland, should be erected to mark the partition between the two great States." So important a monument should be replaced only by the united action of the States whose boundary it marks. It is, therefore, respectfully recommended by this Board, that the Legislature, by joint resolution, or otherwise, direct that arrangements be made with the authorities of Pennsylvania for the renewal of the monument.

A brief historical sketch of the transfer of the lands west of this line to the general government, and by the general government to the State of Pennsylvania, and of the survey of this boundary line by the United States Surveyor General, is in course of preparation, and will appear in a future report.

A table of all the latitudes and longitudes, determined under the authority of the aforesaid laws, is hereto annexed.

Respectfully submitted,

By order of the Regents,

JOHN V. L. PRUYN,

Chancellor of the Regents.

REPORT OF DR. PETERS.

HON. O. S. WILLIAMS,
Secretary of the Board of Trustees of Hamilton College:

DEAR SIR—In compliance with directions of the Regents of the University, Hon. J. V. L. PRUYN, Chancellor, I have determined the geographical longitude of the westernmost boundary of the State. According to the Revised Statutes (5th ed. I, p. 80), this boundary should be "a meridian line drawn through the most westerly bent or inclination of Lake Ontario." It was surveyed and mapped in 1790, by ANDREW ELLICOT, as United States Commissioner (Penn. Archives, vol. xii, Map), and has been marked on the field by stone monuments, about three miles apart; the northernmost monument standing near the shore of Lake Erie; the southernmost supposed to be exactly in latitude 42°. To ascertain how near the original definitiom had been agreed with, seemed not to be of my purpose; considering the imperfection of methods and instruments of eighty years ago, an error of many rods is admissible in the situation of the boundary with regard to the meridian of the bent of Lake Ontario. For, since the opposite shore of Lake Erie is below the horizon, and cannot be seen from the southern shore, either an accurate triangulation around the lake, or two absolute longitude determinations, such as only modern means could afford, would have been required. On the other hand, the fulfilment of the second condition, viz: that the boundary should be "a meridian line," was much easier, even in the past century. Assuming, therefore, in this respect, the boundary as correct, it was deemed sufficient to ascertain the longitude of any one point in it, the choice of which being guided only by the convenience of access. After conferring with Governor GEORGE W. PATERSON, at Westfield, I reconnoitered the position of the monument on the shore and the course of the line, on August 7, in company with JEREMIAH MANN, Esq., and thereupon resolved to place the observing station at State Line Station, where the boundary line is intersected by the Lake Shore railroad. Thus not only I had the advantage of personal accommodation, by the hospitality of Mr. D. TAYLOR, but, which was important, the telegraph line there could be made direct use of for the transmission of time signals.

The method pursued differed from that described in former reports only in that the time was determined by altitudes of the sun, taken with a sextant; the transit instrument remaining necessarily at the observatory for occasional checks of the rate of the clock, which Professor O. Root had the kindness to make during my absence.

Leaving Clinton on the 28th of August, and arrived at the station in the evening of the following day, I was favored by the weather in getting corresponding altitudes forenoon and afternoon of the next day. The telegraph line had been placed at our disposal by the superintendent, J. D. Reid, Esq., with the same liberality experienced before, and to the zeal and promptness of Mr. N. Hucker, of the Buffalo office, as to the immediate attendance of Mr. Archibald, we owe the unretarded accomplishment of the transmission of signals on the same evening of August 30. On the subsequent days the altitudes for time were repeated, in order to make sure of the chronometer rate, and, besides, two sets of circummeridian altitudes were taken for latitude, one of the sun and one of the polar star. The position of the observing station relative to the boundary line was determined by a small survey, made with the use of a three inch compass. The distances from the two nearest monuments were ascertained by direct measurement along the boundary. In this, as in the other work, I enjoyed the company of Mr. Elihu Root, as assistant. The sketches annexed to this report will furnish, I hope, a clear idea of the positions.

1. Determination of Longitude.

Before starting, I made the following set of transits at the Hamilton College Observatory:

1865.	Axis.	Star.	No. of wires.	Transit by chronometer.	Level.
				H. M. S.	H. M. S.
August 26	W	α Ursæ minor s. p. ..	2	13 11 49.82	at 13 8 + 0.034
August 26	E	α Ursæ minor s. p. ..	3	13 11 53.37	at 13 13 − 0.003
August 26	E	α Virginis..........	9	13 18 50.59	at 14 15 + 0.041
August 26	E	α Bootis	11	14 10 15.14	....

Comparison: $3^h\ 25^m\ 22^s.5$ clock = $13^h\ 46^m\ 52^s.75$ chronometer.

The instrumental errors resulting herefrom, viz: $k = +\ 0^s.574$, and $c = -\ 0^s.056$, have been substituted in the following transits of Arcturus observed chronographically by Professor Root:

DATE.	Axis.	Star.	No. of wires.	Clock.
				H. M. S.
August 29	E	α Bootis	10	3 36 54.07
August 30	E	α Bootis	11	3 32 58.38

Whence, together with the level correction of $+ 0^s.04$, result the corrections of the clock for the instants of observation respectively:

to sidereal time $+ 10^h\ 32^m\ 37^s.68$, or to mean time, $+ 23^s.42$,
and $+ 10^h\ 36^m\ 33^s.35$, or to mean time, $+ 23^s.17$;

which have been used in reducing the telegraphic comparisons. The rate of the clock and the errors of the instrument were checked again by a complete set of transits after my return, on September 6.

The altitudes of the sun at State Line Station were taken in sets of twenty,—either symmetrically distributed or of equal number in regard to the limbs,—which have been reduced singly, in order to investigate the probable error of each set. For the sake of brevity, I give here only the sets of the first day in full as a specimen, being those upon which the longitude mainly reposes; of the others it may suffice to report the resulting corrections of the chronometer, which, it will be remembered, is rated for sidereal time. There was still one set made on the morning of August 31, but this afterwards has been found not available, on account of some mistake in the shading sun-glasses of the sextant.

ALTITUDE OF ⊙ AT STATE LINE STATION.

1865. August 30, ☿ morning.

Sidereal chronometer.			Double altitude by sextant.			Limb.	Corrected altitude of sun's centre.			Hour-angle computed.		Sidereal time.			△C	
h.	m.	sec.	deg.	m.	sec.		deg.	m.	sec.	deg.	min.	h.	m.	sec.	m.	sec.
6	40	41.5	52	9	35	U	25	44	24	−63	9.16	6	22	44.7	−17	56.8
6	42	28.0	52	47	45	U	26	3	32	62	52.71	6	24	30.8	17	57.2
6	44	29.5	53	34	50	U	26	27	8	62	10.05	6	26	41.7	17	47.8
6	46	20.0	54	11	55	U	26	45	40	61	44.42	6	28	24.5	17	55.5
6	47	39.0	53	36	35	L	26	49	45	61	24.88	6	29	42.9	17	56.1
6	48	51.0	54	2	0	L	27	12	29	61	7.22	6	30	53.7	17	57.3
6	51	4.5	54	48	45	L	27	35	53	60	34.69	6	33	4.2	17	60.3
6	53	11.0	55	34	40	L	27	58	53	60	2.73	6	35	12.4	17	58.6
6	55	55.5	57	37	30	U	28	28	35	59	21.19	6	37	59.0	17	56.5
6	56	40.0	57	50	37	U	28	35	10	59	12.05	6	38	35.7	17	64.3
6	58	17.5	58	27	35	U	28	53	40	58	46.19	6	40	19.3	17	58.2
7	0	12.0	59	7	30	U	29	13	38	58	18.14	6	42	11.9	17	60.1
7	4	5.5	59	29	45	L	29	26	33	57	17.89	6	46	13.5	17	52.0
7	5	15.0	59	51	55	L	30	7	44	57	2.15	6	47	16.7	17	58.3
7	6	12.0	60	12	0	L	30	17	43	56	48.21	6	48	12.8	17	59.2
7	7	52.5	60	47	7	L	30	35	17	56	23.26	6	49	52.7	17	59.8
7	9	18.5	62	21	40	U	30	50	51	56	1.22	6	51	21.1	17	57.4
7	10	25.0	62	45	0	U	31	2	32	55	44.72	6	52	27.2	17	57.8
7	11	18.0	63	4	35	U	31	12	19	55	30.84	6	53	22.9	17	55.1
7	12	30.0	63	30	0	U	31	25	3	55	12.78	6	54	35.4	17	54.6

For these observations was the index error = − 5′ 17′′ (to be added algebraically), determined by contact of the limbs, twice at the beginning and twice at the close, with the same sun-glasses. Moreover has been assumed: the sun's declination = + 8° 53′ 50′′.5, its semi-diameter ter = 15′ 53′′, parallax = 7′′. Not being provided with barometer and thermometer, mean refraction only could be applied; however, by combining morning and afternoon observations, the neglect of the meteorological instruments cannot affect but the second order. After the more correct value for the latitude of the place had been obtained, it became of necessity to repeat the computation of the hour angle (apparent time in arc); and consequently all the reductions have been made in double. By taking the mean of the last column, we get the correction of the chronometer to sidereal time of the place

August 30, $6^h\,57^m\,38^s$ chron. $\triangle C = -17^m\,57^s\,14$, with the probable error $\pm\,0^s.51$,

as the final result from the above set of altitudes.

ALTITUDE OF ☉ AT STATE LINE STATION.

1865. August 30, ☿ afternoon.

Sidereal chronometer.			Double altitude by sextant.			Limb.	Corrected altitude of sun's centre.			Hour-angle, computed.		Sidereal time.			$\triangle C$	
h.	m.	sec.	deg.	m.	sec.		deg.	m.	sec.	deg.	min.	h.	m.	sec.	min.	sec.
14	40	1.5	60	37	8	L	30	30	25	+56	23.21	14	22	6.6	−17	54.9
14	42	18.0	59	48	0	L	30	5	50	56	57.89	14	24	25.8	17	52.2
14	43	31.5	60	27	30	U	29	53	50	57	14.79	14	25	33.6	17	57.9
14	44	29.0	60	6	22	U	29	43	15	57	29.68	14	26	33.2	17	55.8
14	45	28.0	59	44	50	U	29	32	29	57	44.75	14	27	33.7	17	54.3
14	46	24.0	59	25	25	U	29	22	46	57	58.45	14	28	38.6	17	55.4
14	47	26.5	57	58	35	L	29	11	4	58	15.55	14	29	37.3	17	49.2
14	48	55.5	57	27	40	L	28	55	35	58	36.57	14	31	1.6	17	53.9
14	50	19.5	56	58	20	L	28	40	54	58	57.38	14	32	25.0	17	54,5
14	51	5.5	56	41	40	L	23	33	33	59	7.43	14	33	5.3	17	60.2
14	54	32.5	55	27	38	L	27	55	29	60	0.55	14	36	38.4	17	54.1
14	55	50.5	54	59	50	L	27	41	34	60	19.96	14	37	56.3	17	54.2
14	56	53.0	55	39	37	U	27	29	44	60	36.46	14	39	2.4	17	50.6
14	57	52.0	55	20	10	U	27	19	59	60	50.00	14	39	56.7	17	55.3
14	59	1.0	54	55	30	U	27	7	38	61	7.24	14	41	5.9	17	55.1
14	59	59.0	54	35	15	U	26	57	30	61	21.30	14	42	2.3	17	56.7
15	1	16.0	54	6	10	U	26	42	56	61	41.48	14	43	23.2	17	52.8
15	2	47.0	53	35	37	U	26	27	39	62	2.91	14	44	49.1	17	57.9
15	3	55.0	52	6	5	L	26	14	35	62	20.75	14	46	0.7	17	54.3
15	4	36.0	51	50	40	L	26	6	52	62	31.42	14	46	43.6	17	52.4

Index error = − 4′ 59′′; sun's declination = + 8° 46′ 53′′.7; semi-diameter and parallax as before.

In gathering we thus get the following tablet for the chronometer corrections:

No.	1865.	Chronometer time.			$\triangle c$.		Probable errors.
		h.	m.	sec.	min.	sec.	sec.
1....	August 30........................	6	57	38	−17	57.14	±0.51
2....	August 30........................	14	52	50	17	54.58	0.38
3....	August 31........................	14	50	0	17	52.68	0.46
4....	September 2......................	7	45	57	17	39.06	1.50
5....	September 3......................	15	26	18	17	39.04	0.31

Of these the sets Nos. 1, 2 and 3 enter into the longitude determination, and have been combined in the following manner: First, the mean derived from the morning and afternoon observations of August 30, gives, for

August 30, $10^h\ 55^m\ 14^s$ chronometer. $\triangle C = -\ 17^m\ 55^s.86,\ \pm\ 0^s.45,$

which is more independent of constant errors, assumed refraction etc., than any single set, either morning or afternoon. Then the daily rate of the chronometer is most conveniently obtained from a combination of sets No. 2 and 3, and comes

$$= +\ 1^s.90,\ \pm 0.^s59.$$

The mean chronometer time of the telegraph comparisons (which will be given immediately hereafter), made on the evening of August 30, is $20^h\ 50^m\ 0^s$; hence the rate for the intervening $20^h\ 50^m\ 0^s - 10^h\ 55^m\ 14^s = 9^h\ 54^m\ 46^s$,

$$+0^s.78\ \pm 0^s.24,$$

and consequently the correction for the last mentioned instant to sidereal time

$$= -\ 17^m\ 55^s.08\ \pm\ 0^s.51.$$

The comparisons just referred to are made by taps at certain beats of the chronometer, the latter being carried to the telegraph office, only a few steps from Mr. TAYLOR's garden, where the time was taken. A temporary wire had been drawn into the office, so that the circuit went from Hamilton College Observatory to Utica, Buffalo, State Line, Cleveland, and hence back to the Observatory through the earth. Although the distance along the wires thus was nearly 392 miles, the beats of the pendulum at the Observatory were neat and distinct, as heard at the State Line Station; and inversely, the signals given at the latter place were very precisely recorded upon the chronograph at Hamilton College.

SIGNALS FROM STATE LINE STATION.

1865. August 30. ☿

CHRONOMETER.			CHRONOGRAPH READINGS.							Mean.			Reduction.	Reduced mean.		
h.	min.	sec.	sec.	sec.	h.	min.	sec.	sec.	sec.	h.	min.	sec.	sec.	h.	min.	sec.
20	47	00	.54	.58	10	7	52.60	.52	.44	10	7	52.54	−0.66	10	11	51.88
20	46	20	.30	.34	10	8	12.36	.42	.36	10	8	12.36	0.60	10	11	51.76
20	48	40	.99	.94	10	10	31.74	.92	.90	10	10	31.90	0.22	10	11	51.68
20	48	50	.95	.86	10	10	41.77	.86	.81	10	10	41.85	0.19	10	11	51.66
20	49	00	.99	.93	10	10	51.81	.75	.69	10	10	51.85	0.16	10	11	51.67
20	49	40	.94	.85	10	11	31.80	.74	.77	10	11	31.82	0.05	10	11	51.77
20	49	50	.73	.71	10	11	41.70	.70	.71	10	11	41.71	0.03	10	11	51.68
20	50	00	.79	.74	10	11	51.76	.74	.69	10	11	51.74	0.00	10	11	51.74
20	50	30	—	.60	10	12	21.55	—	.50	10	12	21.55	+0.08	10	11	51.63
20	50	40	—	.61	10	12	31.56	.53	.53	10	12	31.54	0.11	10	11	51.65
20	50	50	.55	.56	10	12	41.58	.54	.52	10	12	41.55	0.14	10	11	51.69
20	51	00	.60	.58	10	12	51.54	.53	—	10	12	51.56	0.16	10	11	51.72
20	51	30	.40	.42	10	13	21.30	—	—	10	13	21.37	0.25	10	11	51.62
20	51	50	.44	.48	10	13	41.40	.52	.43	10	13	41.43	0.30	10	11	51.73
20	52	00	.42	.43	10	13	51.40	.42	.37	10	13	51.40	0.33	10	11	51.73

As explained in former reports, the taps were made each time at five consecutive second-beats, the middle one of which is noted in the first column, and the corresponding chronographic time in the fourth, columns two, three, five and six containing only the fractions of the seconds recorded. The eighth column serves for reducing the mean time intervals of the different comparisons to one common epoch, so that the figures of the last column may be viewed almost as if they were different observations of one and the same middle epoch, thus exhibiting an estimate of the accuracy of the comparisons. The mean of these now gives the equation

$20^h\ 50^m\ 0^s$ chronometer $= 10^h\ 11^m\ 51^s.71$ clock by chronograph,

hereto adding

$-\ 17^m\ 55^s.08$ chronometer, and $+\ 23^s.10$ clock,

as the corrections (found before) of chronometer and clock respectively, we obtain

$20^h\ 32^m\ 4^s.92$ State Line sidereal time
$= 10^h\ 12^m\ 14^s.81$ Hamilton College mean time
$= 20^h\ 49^m\ 30^s.51$ Hamilton College sidereal time,

and hence the difference in longitude,

$17^m\ 25^s.59$,

with the probable uncertainty of about half a second. We may add hereto the, however insignificant, reduction of $+\ 0^s.02$ from the transit to centre of dome, and further $-\ 0^s.04$ for wave and armature time. By survey the observing station (see Plate I) was found to be situated east from the boundary line 1,062 feet, which are equivalent to $14''.12$ in arc or $0^s.94$ in time,—since 1^s of this parallel corresponds upon the spheroid, as determined by Bessel, to 1,128.17 feet. The final result for the longitude, therefore, is:

The Western Boundary Line of the State of New York $27^m\ 26^s.51$ West of the Observatory of Hamilton College;

or,

$5^h\ 19^m\ 3^s.63$ West of Greenwich,

the longitude of the Observatory being $5^h\ 1^m\ 37^s.12$ west of the latter place.

2. *Determination of Latitude.*

For eliminating constant errors, which arise in determining latitudes by altitudes when these are taken only on one side (north or south) of the zenith, a series of altitudes of the sun was combined with one of the polar star.

CIRCUMMERIDIAN ALTITUDES OF ⊙.

1865. September 3. ⊙.

Chronometer.			Double altitude by Sextant.			Limb.	Corrected altitude of sun's center.			Resulting Latitude. lower limb.			Resulting Latitude. upper limb.		
h.	m.	sec.	deg.	m.	sec.		deg.	m.	sec.	deg.	m.	sec.	deg.	m.	sec.
10	41	13.5	108	50	10	L	54	38	14	42	14	59.0	42	..	....
10	43	37.0	109	0	2	L	54	43	10	42	15	13.0	42	..	....
10	45	40.0	110	12	57	U	54	47	51	42	..	....	42	14	29.0
10	48	30.0	110	24	5	U	54	53	25	42	..	....	42	13	50.0
10	50	54.0	110	31	38	U	54	57	11	42	..	....	42	13	41.0
10	52	43.5	110	35	55	U	54	59	20	42	..	....	42	13	58.0
10	55	31.0	109	37	0	L	55	1	40	42	14	51.0	42	..	....
10	57	44.0	109	42	30	L	55	4	24	42	14	13.0	42	..	....
11	0	31.0	109	45	15	L	55	5	47	42	14	52.0	42	..	....
11	2	57.0	109	47	52	L	55	7	6	42	14	49.0	42	..	....
11	4	56.5	110	54	40	U	55	8	43	42	..	....	42	13	52.0
11	6	45.0	110	54	40	U	55	8	43	42	..	....	42	14	10.0
11	8	26.5	110	54	30	U	55	8	37	42	..	....	42	14	18.0
11	10	34.5	110	53	55	U	55	8	20	42	..	....	42	14	18.0
11	22	59.0	109	30	0	L	54	58	10	42	15	18.0	42	..	....
11	24	48.0	109	25	40	L	54	56	0	42	15	3.0	42	..	....
11	27	9.5	109	18	55	L	54	52	37	42	14	55.0	42	..	....
11	29	19.0	110	17	22	U	54	50	3	42	..	....	42	13	51.0
11	31	12.0	110	10	22	U	54	46	33	42	..	....	42	13	52.0
11	35	41.5	108	45	15	L	54	35	47	42	15	10.0	42	..	....
Mean......................................										42	14	56.3	42	14	1.9

Mean from both limbs 42° 14′ 29.1 ±3″.69.

It was necessary here to keep asunder the results from lower and upper limbs because of their unusually large difference, which probably has originated by the unsteadiness of the artificial horizon, the wind often disturbing the quicksilver. The index error of the sextant for the preceding observations was = − 4′ 17″, and the sun's declination has been assumed = + 7° 22′ 56″.5, its semi-diameter = 15′ 54″, parallax = + 5″. With the chronometer correction to sidereal time of $-17^m 39^s$ (as given before), apparent noon is found to have been at $11^h 8^m 9^s.0$ chron., or the greatest elevation of the sun, from which more conveniently for computation the times are counted, happened at $11^h 7^m 55^s.2$ chron.

ALTITUDES OF A URSÆ MINORIS.

1865. September 3. ☉ evening.

Chronometer.			Double altitude. (uncorrected.)			Resulting latitude.			
h.	min.	sec.	deg.	min.	sec.	deg.	min.	sec.	
18	58	13	84	4	10	42	14	10.0	....
19	1	3	84	6	8	42	14	10.0	....
19	3	57	84	8	20	42	14	11.0	....
19	8	20	84	12	45	42	14	36.0	....
19	12	24	84	15	35	42	14	41.0	....
19	15	13	84	17	15	42	14	31.0	....
19	19	20	84	19	35	42	14	4.0	....
19	21	4	84	21	55	42	14	40.0	....
Mean....................................						42	14	22.9	±3.70

The index error was = + 2′ 15″ (mean of 8). The correction of the chronometer = − 17^m 38^s, and the special tables in the Greenwich Nautical Almanac have been used in the reductions.

Resuming, we have therefore for the latitude of the observing station:

From ☉ - - - - - - - - - - - -	42° 14′ 29″.1	± 3″.69
From *α* Ursæ min. - - - - -	42° 14′ 22″.9	± 3″.70
Mean - - - - - - - - - - - - - -	42° 14′ 26″.0	± 2″.74

3. *Co-ordinates of the Monuments.*

As has already been stated, the distances from the two nearest monuments have been measured along the boundary supposed to be a meridian, and the northernmost monument, or that nearest the shore of Lake Erie, was found

9,795 feet north of the parallel of the observing station;

the second monument

6,471 feet south of the same.

It would seem as if the two stones were intended to be three miles = 15,840 feet apart; the present measurement makes the distance 426 feet greater. But for the purpose here in view, this difference was not deemed of sufficient importance to warrant the trouble of a repetition of the measurement, the more so as, notwithstanding various inquiries and researches, the report of the Commissioners, which should give information about the details of their operations, has not yet been found. From the sketch No. 1 it will be seen that the line crosses the great chasm of the Twenty Mile Creek, the shores of which I connected by the aid of a triangle.

Since one degree of the meridian measures, in this latitude, 364,395 feet, or $1'' = 101^f.221$, we find the two monuments resp. $1'\ 36''.77$ north and $1'3''.93$ south of the parallel of the observing station, and therefore, with the latitude determined for the latter,

The Latitude of the monument near the Shore of Lake Erie,

$42^\circ\ 16'\ 2''.8$.

This result admits of a direct comparison with what the Commissioners have found. According to a kind communication from Dr. Woolworth, the inscriptions, which formerly were on the stone now dilapidated, are recorded upon a map in Hazard's *Pennsylvania Archives*, Vol. xii, and were the following:

On the west side:	On the east side:
TERRITORY ANNEXED TO THE STATE OF PENNSYLVANIA, NORTH LATITUDE 42° 16′ 13″ VARIATION 25° WEST.	MERIDIAN OF THE WEST END OF LAKE ONTARIO, STATE OF NEW YORK, 18 MILES AND 52.5 CHAINS FROM THE NORTH BOUNDARY OF PENNSYLVANIA, AUGUST 23 1790.

Considering the small probable error of our determination, we hardly can hesitate to pronounce the latitude of the Commissioners as too great by about ten seconds. Herewith is connected another consideration of perhaps more importance. The inscription reports the distance from the north boundary of Pennsylvania to be 18 miles 52.5 chains; assuming this measure, which converted into arc corresponds to $16'\ 13''.2$, to be correct, it would follow that the north boundary of Pennsylvania is in latitude $41^\circ\ 59'\ 49''.6$, and not on the parallel of 42°—as in conformity with the treaties it should be. The difference is in favor of Pennsylvania by about 1,000 feet, and it would add to that State, if the same amount continues over the whole stretch of the parallel east to the Delaware river, nearly 42 square miles. Before adopting, however, this conclusion as unexceptionable, it would be necessary to verify the latitude of the boundary in question directly, by employing the best modern means and methods.

It remains still to examine, at least approximately, the assumption that the boundary marked by the Commissioners is a meridian line. For it is clear, if the former deviates from the true meridian by an angle which may be denoted by α (counted positive to the NW.), the coördinates of the monument will require the corrections of $+ 72''$ sin. α in longitude, and of $+ 19''$ sin. α in latitude. For determining the declination (variation) of the magnetic needle, the following observations were made at State Line Station:

1865.	Sid. time.			Sun's	Compass reading.		Azimuth computed.		Magnetic meridian concluded.	
	h.	m.	sec.		deg.	min.	deg.	min.	deg.	min.
August 30.	16	59	35	Center....	78	0 N. W.	79	45 N. W.	1	45 N. W.
do 31.	5	45	52	do	82	40 S. E.	85	5 S. E.	2	25 N. W.
do 31.	5	49	7	do	82	10 S. E.	84	31 S. E.	2	21 N. W.
do 31.	16	31	0	do	82	0 N. W.	85	39 N. W.	2	39 N. W.
September 3.	16	53	50	N. Limb..	80	40 N. W.	83	55 N. W.	3	15 N. W.
do 3.	16	55	20	S. do ..	81	5 N. W.	84	12 N. W.	3	7 N. W.
Mean									2	35 N. W.

Now, in running the line, the direction which best agreed with it was found to be, with the same compass, 2° 30′ NE. magnetic, wherefore we infer that the angle, above denoted by α, at the utmost can be but very small.

In this occasion may be pointed out the interesting fact, that the variation of the needle has decreased from 25° W., as it was in 1790, according to the inscription referred to above, to $2\frac{1}{2}$ degrees, or at the rate of about 0.3 degree per year.

In recapitulating, the final result for the position of the boundary monument near the shore of Lake Erie is therefore:

LATITUDE 42° 16′ 2″.8 North.
LONGITUDE 79° 45′ 54″.4 in arc,
$= 5^h\ 19^m\ 3^s.63$ in time, West of Greenwich.

This important monument is now in a very bad condition. What remains of it consists of a slab four inches thick, two feet in length and reaching about one foot above the ground, with its longer faces placed parallel to the meridian (see sketch on Plate 1). The upper portion, which once contained the inscription, is evidently cut off by willful destruction. But a greater danger even is threatening these remnants by the inroad of the lake. Squire MANN, who formerly owned the adjacent lot, and to whom I am indebted for much valuable information about the locality, stated that within his recollection the distance from the stone to the edge of the bluff, upon which it stands, was several rods, while now it is only seven feet. It must be expected, therefore, that within a few years the site of the stone will become a prey of the waves, and it seems desirable that a new and durable monument, more inland, be erected to mark the partition between the two great States.

I remain, with great respect,

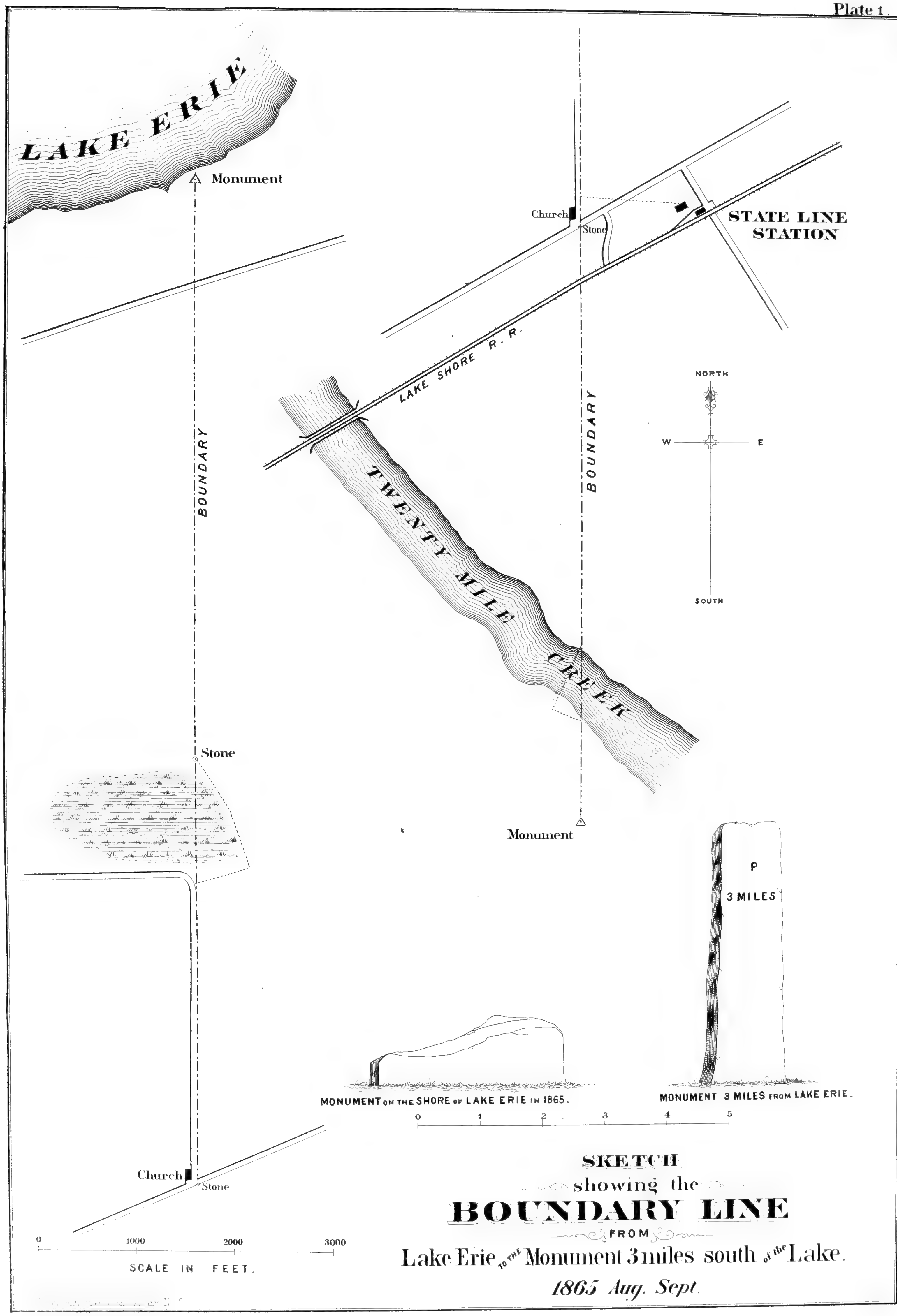
Yours, very obedient,

C. H. F. PETERS,

Director Observatory.

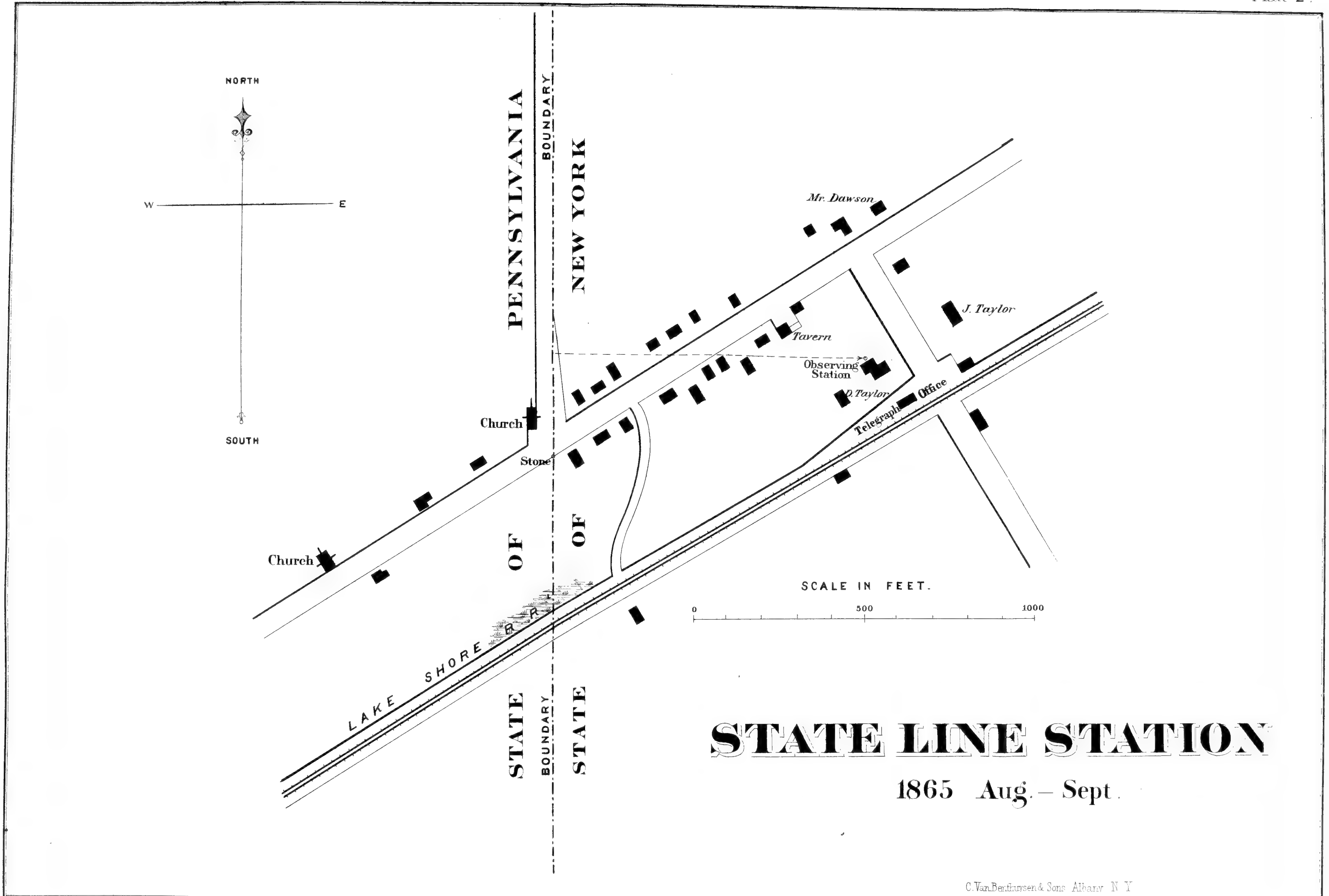
HAMILTON COLLEGE OBSERVATORY, *February*, 1866.

Plate 1.



SKETCH
showing the
BOUNDARY LINE
FROM
Lake Erie to the Monument 3 miles south of the Lake.
1865 Aug. Sept.

Plate 2.



STATE LINE STATION
1865 Aug. – Sept.
NORTH
SOUTH
W
E
PENNSYLVANIA
BOUNDARY
NEW YORK
STATE OF
BOUNDARY
STATE OF
Mr. Dawson
J. Taylor
Tavern
Observing Station
D. Taylor
Telegraph Office
Church
Church
Stone
LAKE SHORE R R
SCALE IN FEET.
0
500
1000
C. Van Benthuysen & Sons Albany N. Y.

SUMMARY STATEMENT, SHOWING THE LATITUDE AND LONGITUDE OF CERTAIN PLACES AS DETERMINED UNDER THE DIRECTION OF THE REGENTS OF THE UNIVERSITY; ALSO FOR CAMBRIDGE AND NEW YORK CITY, AS DETERMINED BY THE UNITED STATES COAST SURVEY.

[The Longitudes are reckoned from Greenwich.]

LOCATION.	Latitude.			Longitude in time.			Longitude in arc.		
	deg.	min.	sec.	h.	min.	sec.	deg.	min.	sec.
Dudley Observatory	42	39	49.55	4	54	58.231	73	44	33.45
Hamilton College Observatory	43	3	16.05	5	1	37.012	75	24	16.08
Syracuse (Court House)	43	3	00.00	5	4	37.007	76	9	16.00
Buffalo (Light House)	42	52	46.36	5	15	33.067	78	53	25.00
Elmira Observatory	42	6	25.00	5	7	13.090	76	48	28.05
Ogdensburgh (steeple of Presbyterian Church)	44	41	59.00	5	2	1.063	75	30	24.05
Western boundary of New York State (Monument near Lake Erie)	42	16	3.08	5	19	3.063	79	45	54.04
Cambridge Observatory	42	22	48.00	4	44	30.066	71	7	23.04
New York (Rutherford Observatory, cor. Second av. and Eleventh street)	..	..	.....	4	55	55.063	73	58	54.43

(H.)

FACTS AND OBSERVATIONS TOUCHING THE FLORA OF THE STATE OF NEW YORK.

By CHARLES H. PECK.

In undertaking a work hitherto performed by another, it is my purpose to follow mainly the plan adopted by him.

It is with pleasure that I acknowledge my indebtedness to him for a considerable portion of the material for this report; also to Professors A. Gray and L. Lesquereux for aid in authentically determining difficult species, and to Messrs. C. F. Austin and E. C. Howe, for liberal contributions of facts and specimens.

It is very desirable that those who may discover within our limits, species, or even well marked varieties, new to the State, should forward good specimens of their discoveries, that a sample of the plant and the name of its detecter may go into the State Herbarium together. All such contributions will be duly acknowledged.

In the following list, when no name is annexed to the station or stations, the plant has been found therein by the writer:

SPECIES GROWING SPONTANEOUSLY IN THE STATE AND NOT BEFORE REPORTED.

Thalictrum purpurascens, L. Throughout Rockland Co.; the variety *ceriferum*, Austin, growing with it: C. F. Austin.

Sisymbrium canescens, Nutt. Ogdensburgh, July 3d, 1866. G. W. C. A stray from the West.

Alyssum calycinum, L. Buffalo, 1867. G. W. C.

Lechea novæ-cæsareæ, Austin. Rockland Co.: C. F. Austin.

Dianthus armeria, L. Greenport, Long Island. Aug. 1866: Mrs. Elizabeth E. Atwater. New York Island. D. F. Day.

Linum sulcatum, Riddell. Rockland Co.: C. F. Austin.

Agrimonia parviflora, Ait. Rockland Co.: C. F. Austin.

Sedum ternatum, MICHX. Albany Rural Cemetery; running wild, 1867. G. W. C.

Epilobium hirsutum, L. Tivoli pond near Albany, 1866. Well established.

Solidago thyrsoidea, E. MEYER. Mounts Marcy and Whiteface, Essex Co. Long known to belong to the State.

Nabalus racemosus, HOOK. Near Tappan, Rockland Co.: C. F. AUSTIN.

Campanula rapunculoides, L. Roadsides, Herkimer Co., and near Richfield Springs, 1866. G. W. C.

Pyrola oxypetala, AUSTIN. Woods near Deposit, Delaware Co.; the only known habitat: C. F. AUSTIN.

Satureia hortensis, L. Along the Hudson River railroad between Poughkeepsie and Garrison Station. August, 1867. G. W. C.

Vinca minor, L. Buffalo, 1866 and 1867. Perpetuates and somewhat extends itself by the root. G. W. C.

Atriplex rosea, L. Streets of Albany, 1867. G. W. C., C. H. P. Introduced.

Polygonum lapathifolium, AIT. "Borders of Cayuga Lake. CHICKERING & BREWER." Gray's Manual.

Callitriche heterophylla, PURSH. "New York to Illinois and southward." Gray's Manual.

Carya microcarpa, NUTT. Rocky woods near Sneeders Landing: C. F. AUSTIN.

Lemna torreyi, AUSTIN. Long Island: C. F. AUSTIN, W. W. DENSLOW.

Wolffia columbiana, KARSTEN. Orange Co.: C. F. AUSTIN. Dr. ENGELMANN informs me that the plant found by Mr. PAINE in Lake Ontario is *Wolffia braziliensis*, WEDDELL. I have not seen Mr. PAINE's specimens.

Naias indica, var. *gracillima*, BRAUN Mss. Plains west of Albany, 1867. Growing in water one to two feet deep, associated with a small condensed form of *Naias flexilis*. No specimens of the European plant are accessible for comparison, but our plant is believed to be the variety mentioned.

Goodyera menziesii, LINDL. "Woods, Western New York." Gray's Manual.

Spiranthes romanzoviana, CHAMISSO. "Herkimer and Otsego counties." Gray's Manual.

Spiranthes graminea, var. *walteri*, GRAY. Meadows and pastures, Rockland Co.: C. F. AUSTIN.

Eleocharis quadrangulata, R. BR. "Outlet of Oneida Lake, A. H. CURTISS:" Gray's Manual.

Scirpus sylvaticus, L. Crown Point, G. T. STEVENS: Plains west of Albany, 1867.

Carex scirpoidea, MICHX. Mount Whiteface and Lake Avalanche, 1867.

Carex sterilis, WILLD. Bergen Swamp, Genesee Co., 1865. G. W. C.

Carex aperta, BOOTT. North Elba, Essex Co., 1867.

Carex houghtonii, TORREY. Lake Placid, Essex Co., 1867.

Cheilanthes vestitia, SWARTZ. New York Island: W. W. DENSLOW.

MUSCI.

Sphagnum sedoides, BRID. Wet rocks at Lake Avalanche and on Mt. Marcy; sterile. This differs from *S. pylaesii*, BRID., in being destitute of branches, or having only short ones. It will probably prove to be only a form of that species.

Sphagnum lindenbergii, SCHP. Slopes of Mt. Whiteface; sterile. Stems rather robust, 4′–6′ long, with three layers of cortical cells; branches usually five in a fascicle; stem leaves amplexicaul and more or less fulvous at the base, deflexed, oblong-spatulate, obtuse, eroded at the apex, areolation not fibrillose, narrow at the base, much broader at the apex of the leaf; branch leaves lanceolate, truncate and toothed at the apex, wavy on the margins when dry, bordered with two or three rows of narrow linear cells, utricles thick walled, destitute of pores.

Astomum sullivantii, BRYOL. EUROP. Fields and wet lands, Orange Co.: C. F. AUSTIN. Near Troy: E. C. HOWE. Fruits in April.

Weisia serrulata, FUNK, Sam's Point, Ulster Co.: C. F. AUSTIN; sterile. Closely cæspitose, 4″–10″ high; leaves lanceolate and linear-lanceolate, strongly papillose, the margins plane papillose-serrulate, often more strongly toothed near the apex; capsule oval, erect; operculum short-rostrate.

Rhabdoweisia fugax, BRYOL. EUROP. Rocks, Catskill Mts.

Dicranum polycarpum, EHRH. Mt. Marcy, July.

Dicranum rufescens, TURN. Clay soil and banks by roadsides, Orange Co.: C. F. AUSTIN, Nov.

Barbula fallax, BRYOL, EUROP. Damp shaded rocks, Fort Edward: C. E. HOWE, Rockland Co.: C. F. AUSTIN; Helderberg Mts. Differs from *B. unguiculata* in its leaves which are not apiculate and which are gradually narrowed from the rather broad ovate base to the point.

Orthotrichum obtusifolium, SCHRAD. Trees. Saratoga Springs: G. W. C. Sterile.

Orthotrichum obtusifolium, var. *papillosum*, LESQX. North Elba. Papillæ of the leaves longer and bifid or trifid at the apex.

Schistidium agassizii, SULLIV. & LESQX. Rocks, Luzerne, Warren Co.: G. W. C.; sterile.

Splachnum ampullaceum, L. "In a wooded swamp on an old log. Moreau, Saratoga Co.:" E. C. HOWE, June.

Meesia longiseta, HEDW. Wet places. Moreau, Saratoga Co.: E. C. HOWE, June.

Bryum lescurianum, SULLIV. Rockland Co.: C. F. AUSTIN.

Bryum uliginosum, BRID. Crevices of wet rocks, Moreau: E. C. HOWE. Haverstraw, Rockland Co.: C. F. AUSTIN, June.

Bryum pallescens, SCHWAEGR. Rockland Co.: C. F. AUSTIN.

Bryum pallens, SWARTZ. "The Narrows," at the base of Mt. Whiteface; July. Stems 3″–6″ high; leaves ovate-lanceolate, slightly recurved on the margin, the costa excurrent; inflorescence diœcious; capsule, seed bearing part short, the neck very long, slightly curved and gradually tapering into the pedicil; annulus broad.

Mnium cinclidioides, HUBEN. Swamps, Ulster Co.: C. F. AUSTIN; sterile. Resembles *M. punctatum*, but the stems are more slender, the leaves slightly toothed toward the point and destitute of a conspicuous thickened margin.

Mnium medium, Schp. Moist shaded banks and ground in woods; Fort Edward, E. C. Howe. Sand Lake, Rens. Co., and Helderberg Mts., May. Distinguished from *M. affine* by its hermaphrodite inflorescence; from *M. drummondi* by its larger size, deeper colored pedicels and by its leaves being toothed to the base and more contorted when dry.

Mnium drummondi, Brch. & Schp. Woods; Fort Edward: E. C. Howe. Sand Lake and Adirondack Mts. May.

Mnium rostratum, Schwaegr. Wet rocks along rivulets and in ravines; Saratoga Co.: E. C. Howe. June.

Atrichum crispum, James. Brooklyn (Capt. Pike legit.): C. F. Austin.

Pogonatum urnigerum, Brid. Gravelly banks by roadsides; North Elba.

Leskea denticulata, Sulliv. Tappan, Rockland Co.: C. F. Austin. Sterile.

Anacamptodon splachnoides, Brid. Trees; Rockland Co.: C. F. Austin.

Myurella julacea, Bryol. Europ. Rocks summit of Mt. Marcy. Not yet found elsewhere in the United States. Sterile. Stems sparingly divided, erect, compact, 6″–1′ high; leaves very closely imbricating, broadly ovate, obtuse, not papillose, the margins nearly entire.

Hypnum scitum, Beauv. Base of trees and prostrate trunks in woods: Luzerne, G. W. C. North Greenbush and Adirondack Mts. July.

Hypnum sarmentosum, Wahl. Springy places; Mt. Marcy. Sterile. Stems rigid, branched, 2′–5′ high; leaves oblong-lanceolate, obtuse, cuspidate, costate beyond the middle, cells at the base enlarged, pellucid. It may be distinguished from *H. stramineum* by its more robust stems, cuspidate leaves and red color. In American specimens the stems are often simple.

Hypnum hamulosum, Bryol, Europ. Old logs in mountain woods; Shawangunk Mts.: C. F. Austin. Adirondack Mts. Stems elongated, filiform, creeping, loosely pinnately branched, the branches gracefully curved; leaves subsecund, lanceolate, long acuminate, serrate above, ecostate; perichætial leaves strongly serrate; capsule oblong-oval, suberect, straight or very slightly curved; inflorescence monœcious.

Hypnum dimorphum, Brid. Base of trees (*Thuja occidentalis*) in deep woods; Adirondack Mts.

Hypnum polygamum, Bryol. Europ. Swamps and wet places. Warren, Herkimer county: J. A. Paine. Catskill Mts. July.

Hypnum lescurii, Sulliv. Rockland Co.: C. F. Austin.

Hypnum sylvaticum, L. Rocks in woods; Sand Lake and Adirondack Mts.

HEPATICÆ.

Riccia sorocarpa, Bischoff. Buffalo: G. W. C. "Frond solid, orbicular, radiately divided ($\frac{1}{2}'$–$\frac{3}{4}'$ in diameter) pale green or glaucous both sides; laciniæ bifid or subdichotomous, carinate-sulcate, much thickened and furnished with a few inconspicuous white scales underneath; lobes oblong, acutish or obtusish, not infrequently retuse, the margins plane and naked, erectish or somewhat inflexed; sporangia aggregated near the base of the laciniæ, the spores escaping through a chink in the upper surface." C. F. Austin.

Riccia bischoffii, HUBEN. Rockland Co.: C. F. AUSTIN. "Frond solid, orbicular (or by abortion semicircular) 6″–1′ in diameter, cinereous green, naked and sometimes purple underneath; laciniæ obcordate or obcordate-oblong, depressed-canaliculate, the margins thickish and somewhat ascending, ciliate; the upper surface minutely cavernous or pitted; sporangia aggregated near the middle of the laciniæ. A rather variable species, probably including both *R. palmata* and *R. tumida*, LINDLEY." C. F. AUSTIN.

Jungermannia inflata, HUDS. Wet rocks. Common, stems slender, erect or ascending, 6′′–1′ long; leaves deeply concave, suborbicular, bifid, the lobes obtuse; perianth terminal. It sometimes forms dark olive green or blackish patches several feet in extent.

Jungermannia taylori, HOOK. Mt. Marcy.

Jungermannia sphacellata, GIES. Rocks on mountains. Mount Whiteface. Sterile. Stems simple or fastigiately branched, 1′–2′ long; leaves concave, orbicular, clasping at the base, with a shallow but acute sinus at the apex, lobes obtuse. It forms dense, dark green or blackish patches on dry rocks in alpine regions.

Jungermannia obtusifolia, HOOK. Adirondack Mts. A small form, differing from the ordinary one only in size.

Frullania aeolotis, NEES. Damp shaded rocks; Sand Lake.

Lejunia clypeata, SCHWEIN. Rockland Co.: C. F. AUSTIN.

Radula obconica, SULLIV. Base of trees; Helderberg Mts.

NEW STATIONS OF RARE PLANTS—REMARKABLE STATIONS OF COMMON ONES—NOTABLE VARIETIES AND OBSERVATIONS.

Aquilegia canadensis, L. A variety with yellow flowers, near Poughkeepsie: S. TENNEY. A white flowered variety near Crown Point: G. T. STEVENS. Also near Schenectady.

Hydrastis canadensis, L. Orange Co.: C. F. AUSTIN.

Nymphœa tuberosa, PAINE. This is the *Nymphœa* of Niagara river. *Nymphœa odorata*, the species of Schuyler and other lakes of Herkimer and Otsego counties is very variable in the size of the leaf and flower; and a clear form of the var. *minor* is in Summit lake. This, like the *N. tuberosa*, has "tuberiferous" rhizomes: G. W. C.

Sisymbrium thaliana, GAUD. Newark, Wayne Co., 1867: E. L. HANKENSON.

Hypericum ellipticum, HOOK. Luzerne, Warren Co., 1867. An unusual form with sepals and petals, sometimes four: G. W. C.

Vaccaria vulgaris, HOST. Albany, 1867: G. W. C. Newark, 1867: E. L. HANKENSON.

Lychnis vespertina, SIBTH. New York Island, 1866. W. W. DENSLOW, T. F. ALLEN.

Sagina procumbens, L. Utica; abundant in the pavements of Whitesboro and Liberty streets, 1866. G. W. C.

Medicago sativa, L. Albany; grounds about the Reservoir. Eradicated with difficulty: H. MARTIN.

Lespedeza stuvei, NUTT. Poestenkill, Rens. Co., 1867: E. C. HOWE.

Pyrus coronaria, L. Near Port Jervis: C. F. Austin.

Rosa setigera, Michx. Newark, 1867: E. L. Hankenson.

Parnassia caroliniana, Michx. Tivoli pond, near Albany.

Saxifraga aizoides, L. Portage; left bank of the Genesee river, between the second and third fall. June 16th, 1867: D. F. Day.

Sedum acre, L. Lockport, 1867. Naturalized: G. W. C.

Solidago bicolor, var. *concolor*, Gray. Plains between Albany and Schenectady, 1867.

Solidago puberula, Nutt. Luzerne, 1867: G. W. C.

Xanthium spinosum, L. West Troy, about the Roy factories, 1867: H. Martin.

Galinsoga parviflora, Cav. Albany, 1867: G. W. C.

Leucanthemum vulgare, var. *tubuliflorum*, Tenney. Near Poughkeepsie: S. Tenney.

Artemisia biennis, Willd. Cohoes, about factories, 1867: G. W. C.

Sonchus arvensis, L. Angola, Erie Co., 1865; Richfield Springs, abundant, 1866: G. W. C.

Rhodora canadensis, L. Sam's Point, Ulster Co.: C. F. Austin.

Pyrola secunda, var. *pumila*, Paine. Head of Little lake and of Mud lake, near Richfield Springs, 1866: G. W. C.

Euphorbia platyphylla, L. Cohoes, 1867.

Thymus serpyllum, L. Orange Co.: C. F. Austin.

Polemonium cœruleum, L. Head of Little (Weaver's) lake, near Richfield Springs, 1866: G. W. C.

Blitum bonus-henricus, Reichenbach. Roadsides; Mohawk and near Richfield Springs, 1866: G. W. C.

Atriplex patula, var. *littoralis*, Gray. Salina, Richfield Springs and Buffalo: G. W. C., Newark, 1867: E. L. Hankenson. Possibly a distinct species.

Salsoli kali, L. Sandy embankments near Newburgh. W. R. Gerard.

Alnus serrulata, Ait. Common on dry sandy soil between Albany and Schenectady.

Salix longifolia, Muhl. Cohoes and banks of the Hudson above Albany. This species is subject to the attacks of a small, gall-making, hymenopterous insect, the *Euursalicis-nodus*, Walsh. In the last named locality its work has been so extensive that but few of the young shoots and branches are free from the galls in which the insect passes the early stages of its existence. The sparse fruit and short leaves indicate the injury which the plant sustains.

Pinus resinosa, Ait. Sand Lake and Catskill Mts.

Larix americana, Michx. East Greenbush; a tree bearing proliferous cones, the branch being prolonged from the apex of the cone.

Potamogeton praelongus, Wulfen. Lake Placid. Luxuriant specimens were found growing in water not less than eight to ten feet deep; the leaves often ten inches long. 1867.

Calopogon pulchellus, R. Br. Center Station, between Albany and Schenectady, growing in dry hard soil, but in the vicinity of bogs.

Juncus scirpoides, var. *macrostemon*, Gray. Wet sand, Staten Island: C. F. Austin.

Cyperus nuttallii, TORR. Luzerne, 1867: G. W. C.

Scirpus pauciflorus, LIGHTFOOT. Portage: G. W. C.

Scirpus debilis, PURSH. Luzerne, 1866: G. W. C.

Rhynchospora fusca, ROEM & SCHULTES. Calamity pond, Essex Co., growing, with *Carex oligosperma*, *C. rostrata* and *C. lenticularis*.

Carex cephalophora, MUHL. Ithaca. A variety with the upper half of the spikes staminate, and in one instance the upper spike entirely staminate: H. B. LORD.

Carex tentaculata, var. *gracilis*, BOOTT. Wet places by roadsides; Catskill and Adirondack Mts.

Phalaris canariensis, L. Utica; bank of the Mohawk, 1866. G. W. C.

Bouteloua curtipendula, var. *aristosa*, GRAY. Junction of the Central and Saratoga Railroads, 1867.

Triticum caninum, L. Sand Lake. The slender indigenous form found growing on a rocky wooded hill, remote from cultivation.

Isoetes echinospora, var. *braunii*, ENGELM. Small pond back of the Mountain House, Catskill Mts., Sept., 1866: G. W. C. Outlet of Luzerne lake, Warren Co. A very small form. Aug. 1867: G. W. C.

MUSCI.

Sphagnum subsecundum, NEES. Fort Edward: E. C. HOWE. Rockland Co.: C. F. AUSTIN.

Andræa rupestris, TURN. Shawangunk Mts.: C. F. AUSTIN.

Dicranum drummondi, C. MULL. Shore of Lake Placid.

Fissidens taxifolius, HEDW. Fort Edward: E. C. HOWE. Albany.

Fissidens osmundioides, HEDW. Poestenkill. E. C. HOWE. Adirondack Mts. Sterile.

Conomitrium julianum, SAVI. Grafton, Rens. Co.: E. C. HOWE. Sterile.

Blindia acuta, DICKS. Abundant on perpendicular faces of rocks at Edmund pond, North Elba.

Barbula fragilis, WILS. Ulster Co. C. F. AUSTIN. Sterile.

Grimmia olneyi, SULLIV. Haverstraw: C. F. AUSTIN.

Schistostega osmundacea, WEB. & MOHR. Adirondack Pass; also in the Pass between Mt. McIntyre and Mt. Colden; in both stations growing on loose soil adhering to the roots of trees prostrated by the wind. This rare moss has been found on the White Mts. of New Hampshire by T. P. JAMES, Esq., and at Lake Superior by H. GILLMAN, Esq.

Tetraplodon mnioides, L. fil. Mt. Whiteface.

Bryum annotinum, HEDW. Luzerne. G. W. C.

Bryum wahlenbergii, SCHWAEGR. Fort Edward: E. C. HOWE. Fertile specimens.

Polytrichum juniperinum, var. *alpestre*, BRYOL. EUROP. High tops of the Adirondack Mts.

Leskea nervosa, SCHWAEGR. On prostrate trunks of trees; Adirondack Mts. This plant produces pistillidia, but no antheridia and consequently no fruit.

Hypnum blandowii, WEB. & MOHR. Bank of the Ausable river near the base of Mt. Whiteface.

Hypnum squarrosum, L. Swamps, Sand Lake.

Hypnum diversifolium, BRYOL. EUROP. Near Troy: E. C. HOWE. New York Island: W. W. DENSLOW.

Hypnum boscii, SCHWAEGR. Fort Edward: E. C. HOWE. Sterile. New York Island: W. W. DENSLOW. Fertile.

Hypnum stramineum, DICKS. Mt. Whiteface.

Hypnum revolvens, SWARTZ. Caledonia: G. W. C. Sterile.

Hypnum fluitans, L. Poestenkill: E. C. HOWE. Fine fruiting specimens, found entirely submerged and closely resembling European floating forms.

Hypnum stellatum, SCHREB. Richfield Springs: G. W. C. A variety of a bright green color, with scarcely any tinge of yellow.

ALBANY, *November*, 1867.

(I.)

OBSERVATIONS ON THE INTERNAL APPENDAGES OF THE GENUS ATRYPA;

With a Notice of the Discovery of a Loop, connecting the Spiral Cones.

By R. P. WHITFIELD.

The internal appendages of the genus Atrypa (*Dalman*), have long been known to consist of a pair of spiral cones, placed side by side, with their apices directed towards the cavity of the dorsal valve. The lamellæ forming these cones have been described and figured as having their origin on the socket-walls of the dorsal valve, then suddenly deflected outwards, running parallel with the inner margin of the valve. At the point where they are abruptly deflected, is figured a pair of short, pointed, crural processes, directed toward each other, but not connected.

This appears to be all that has hitherto been known regarding these appendages; although, judging from analogy, we might reasonably suppose that, as most genera of Brachiopods having spiral cones have been found to possess some sort of loop or crural process connecting them, that Atrypa would not be destitute of some similar arrangement.

By carefully cutting and preparing favorable specimens, I have found that in place of the short crural processes so often figured, there is an entire and continuous loop connecting the spiral cones, in a very similar manner to that shown by Prof. Hall to exist in his genus Zygospira, but having its connection with the spiral ribbons, at a point relatively much nearer to their origin on the hinge-plate; still more distant, however, than the points figured by Mr. Davidson and others. This loop, so far as yet observed, is confined to the rostral or posterior part of the shell, and never passes over or in front of the spires as in Prof. Hall's genus. From its origin on the posterior portion of the first volutions of the spires, the loop curves gently forward and upward; the central or elevated portion lying between and behind the cones, and forming a more or less abrupt curve, or prolonged into a point directed towards the dorsal valve. In some specimens where the origin of the loop is on the outer portion of the first volution of the spire, the ribbon of the loop, and that of the spire, are parallel for a short distance, that of the spire lying uppermost. Where the origin is near the attachment to the hinge-plate, the loop has the appearance of being a continuation of the principal band; while the junction of the crura is more abrupt, they appearing only as supports of the spires.

The typical species of the genus (*A. reticularis*) is known to exist in most of the geological formations from the Clinton group to the Chemung group inclusive, as well as in deposits of similar age in Europe. In the different formations it often presents peculiarities which are sometimes quite characteristic of the beds in which they occur; so much so, that several of them have been described by different authors as distinct species, in consequence of their possessing features considered by them to be of specific importance. At the present time, however, authors most conversant with the subject agree in considering them only as varieties of the typical form.

I have succeeded in ascertaining the existence and form of this loop in several different varieties of *Atrypa reticularis*, as well as in *A. spinosa* of Hall, and I find that in the different varieties of *A. reticularis* it is subject to considerable variations of form. If, on further investigation, these differences should prove to remain constant in the several varieties, which I am inclined to believe they will, they may, when considered in connection with the differences in external features and perhaps some modifications in the form of the spiral cones, serve as guides in establishing specific characters in this group of shells, which has so long troubled naturalists, and refused to conform to divisions founded on external characters alone.

I am aware that the practice of founding species on insufficient characters is often more injurious than beneficial; but where species really exist in nature, it is well to know them, and to know the features which characterize them, however obscure they may be. It was the hope of bringing to light some feature in this group of shells, which might serve to determine more positively the relations these various forms, occurring in the different geological deposits, bear to each other, that induced me to continue the investigations, after discovering the existence of the loop connecting the spires, more than two years ago. I had hoped to continue them much farther than I have yet done, previous to making known the results; but circumstances have made it necessary to publish them at the present time.

The differences described below, are some of the principal ones noticed in the several varieties under which they are given. Of their importance, I leave others to judge.

The loop was first noticed in immature specimens from the Niagara group, occurring at Waldron, Indiana. In the adult specimens from this locality, the usual form of the shell is lenticular, with the dorsal valve a little the most convex; the surface not very finely ribbed, but very squamose. The ribbon, or band forming the spiral cones, is wide; the junction of the loop with the principal ribbon is at a point distant from their attachment to the hinge-plate, and not far from the point of greatest width of the shell. The loop is strong and but moderately curved upward, with a broad gentle curvature. The spire, in a specimen of moderate size, consists of about twelve volutions; the cones are erect, their apices a little posterior to the centre of their bases.

In the Shaly limestones of the Lower Helderberg group, we have a form with a very ventricose dorsal valve, the ventral being only moderately so: the surface is rather more finely ribbed than in the preceding variety, but not so squamose. In this one the ribbon is slender, and the junction of the loop much nearer to the hinge-plate; while the loop is extended into a long slender point, slightly recurved near its extremity, and reaches to about half the height of the spiral cones. The cones consist of about fourteen volutions, and are situated very much as are those of the Waldron specimens (Plate I, fig. 1).

Besides the difference of the external characters of this variety, as well as of the loop and spires, there is a very noticeable peculiarity in the beak of the ventral valve. The entire beak, to the outer limits of the widely distant teeth, is solid; the inner face being excavated, forming a smooth, depressed or concave area which extends about one-eighth of an inch below the apex (Plate I, fig. 2), the curvature conforming to that of the beak of the opposite valve, which closely fills it. (A similar depressed area is shown by Prof. HALL to exist in *Rhynchonella increbescens.*) In young and immature individuals, there appears to have been a perforation passing beneath this depressed area; and perhaps in its earlier stages of growth the deltidial portion may have been of separate pieces, but in adults it is one solid thickened mass; being, as DALMAN supposed, actually imperforate. I do not remember to have seen this feature in any other variety or species of the genus. Those of the upper rocks, of which separate valves are not uncommon, are always extremely thin at this point; the deltoidal space usually being open, from the loss of the deltidial plates at an early period of growth.

In the limestones of the Upper Helderberg group, at the Falls of the Ohio, there occurs a form which is much larger than those of the Lower Helderberg limestones. The ventral valve of this variety is flattened, and usually a little concave toward the front, and the surface rather coarsely striate, especially in the upper part of the shell. In this one, so far as seen, the spiral ribbon is broad, the junction of the crura with it abrupt, and at the posterior limit of the first volution; the loop is directed forward and reaches upward to some distance, but not so far as in those from the Shaly limestones. The volutions of the spires appear to be about fourteen or fifteen (Plate I, fig. 3).

The variety occurring so abundantly in the soft shales of the Hamilton group of New York, is similar to the last in form and size, the striæ rather finer. In a very perfect individual of moderate size, the loop is not so much elevated in the middle as in that one; the volutions of the spiral cones number twenty-two, and are very closely arranged; the attachment of the loop and principal band, nearly the same (Plate I, figs. 4 and 5). There is another variety found in rocks of this age at Independence, Iowa, which is often of large size and extremely ventricose on the dorsal side: the striæ are fine, and closely arranged. In a specimen of this variety, the volutions are only fifteen, and the upward curvature of the loop very slight.

In *Atrypa spinosa*, Hall, the loop curves upward but little, and extends forward more than in *A. reticularis* from the same beds, while the volutions of the spire are about fifteen. The principal distinction is in the form of the spiral cones, and in the ribbon (Plate I, figs. 6 and 7). One of the cones in the specimen used has been injured, which may have had some influence in producing the modifications of the apex. The form of the cone differs in having the upper part curved; the apex being directed backward, or towards the beak of the shell: the first basal volutions are nearly straight on their inner sides, and the anterior extremity acutely pointed, while the ribbon is abruptly widened near this part.

I have been inclined to believe that the difference in the loop and spires mentioned above may prove to be of some value in determining whether these different forms are really distinct species, or only changes superinduced by a difference of conditions existing at certain localities during the life of the animal. I have not yet carried the investigations far enough to satisfy myself fully of the permanency of these internal differences in specimens of the same type. The fact of different varieties being often restricted to a certain geological position is, however, good grounds for supposing that the peculiar internal features may also be retained.

The extreme form of the loop noticed in those from the Shaly limestones would indicate that there would also be considerable difference in the soft parts of the animal, from those with shorter loops; and it then becomes a question as to what changes these parts of a species can undergo. The external form of those from this position is not very unlike those from the Niagara group of Lockport, N. Y., except in generally being more ventricose; that one seldom becoming gibbose. From those occurring at Waldron, Ind., it varies in the finer striæ, and in the inequality of the valves. The Upper Helderberg specimens from the Falls of Ohio scarcely vary externally from those of the shales of the Hamilton group of New York, except in the coarser striæ, but very materially in the spires.

I have not been able to examine any European specimens of *A. reticularis;* nor have I found any American examples of *A. aspera* in a condition to show their internal characters, unless the *A. spinosa* of HALL can be considered as of that species, which is scarcely probable.

[NOTE.—The foregoing article was prepared for the Nineteenth Report on the State Cabinet, as communicated to the Legislature April 2d, 1866; but owing to the delay in printing, and the amount of material to be set up before it, it has been detained until the present date. During the autumn I have visited several localities of the Hamilton group in Northern Iowa; at one of which (Waverly) I saw numbers of specimens of Atrypa showing sections of the spires, and I observed that the volutions composing the cones vary in number with the increase in age and size of the shell; while specimens of the same size have about the same number of volutions. I might also mention in this connection, that Prof. HALL has in his possession a small specimen of *A. nodostriata,* sent to him by Dr. ROMINGER, which had been cut to show the spires; but not far enough to reveal the loop; but by cutting a little more, I found the loop well preserved. It is comparatively strong, and has considerable forward curvature. The spires have only six volutions, owing probably to the immature condition of the shell.]

EXPLANATION OF PLATE I.

FIG. 1. View of a specimen of *Atrypa reticularis* from the Lower Helderberg group of Albany county, N. Y., showing the form and position of the loop and spires. The view is obliquely from above and behind. Enlarged.

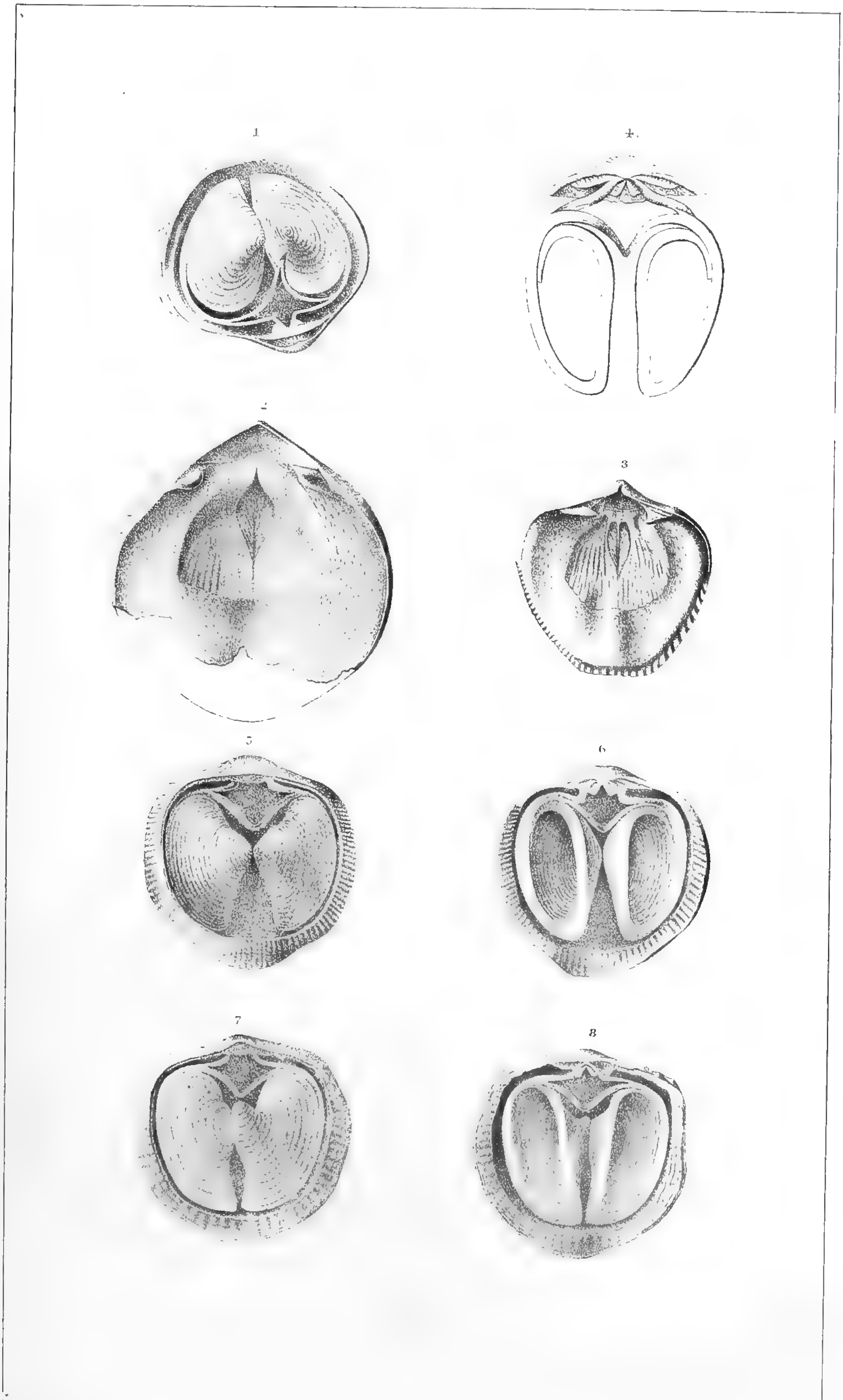
FIG. 2. Interior of a ventral valve; from the same position and locality as the last, enlarged to show the depressed area and solid beak.

FIG. 3. Interior of a ventral valve of *A. reticularis* from the Hamilton shales, showing the form of the beak as existing in very perfect specimens; for comparison with fig. 2. The specimen is in Prof. HALL's collection, and the figure borrowed from the Pal. of N. Y., Vol. IV.

FIG. 4. An enlarged outline figure of the first volutions of the spires with the loop and crura attached to the hinge-plate. The specimen from which the figure was drawn is from the Falls of Ohio, and belongs to the collection of Prof. HALL, from whom it was obtained for manipulation.

FIGS. 5 and 6. Dorsal and ventral views of a specimen from the shales of the Hamilton group of New York, showing the form of spires and loop.

FIGS. 7 and 8. Dorsal and ventral views of a specimen of *Atrypa spinosa*, HALL, from the Hamilton shales of New York, showing the form of spires and loop. Figs. 5–8 are natural size.



R. P. Whitfield, del. Swinton, lith

(J.)

NOTICE OF VOL. IV OF THE PALÆONTOLOGY OF NEW YORK.

In consequence of the delay in the completion of the plates of this volume, which are to accompany the text, it cannot be issued until some time during the year of 1867; although about two hundred pages were already printed in 1865.

The volume is entirely devoted to the Brachiopoda of the Upper Helderberg, Hamilton, Portage and Chemung groups; giving essentially a Monograph of this class of fossils of the Devonian period. The genera are arranged in a certain zoölogical order, and the title of each plate indicates the formation to which the species it contains belong.

The order adopted, and the list of genera under which species are described or discussed, are as follows:

Lingula,
Discina,
Crania,
Pholidops, = Pseudocrania,
Orthis,
Streptorhynchus,
Strophomena,
Strophodonta,
Chonetes,
Productus,
Strophalosia,
Productella,
Spirifera,
Cyrtina,
Cyrtia,
Trematospira,
Rhynchospira,
Nucleospira,
Retzia,
Athyris,
Meristella,
Meristina,
Pentagonia,
Atrypa,
Cœlospira,
Rhynchonella = Stenocisma,
Leiorhynchus,
Leptocœlia,
Camarophoria,
Pentamerus,
Stricklandinia,
Pentamerella,
Gypidula,
Amphigenia,
Rensselæria,
Terebratula,
Cryptonella,
Centronella,
Tropidoleptus,
Vitulina.

The linguloid forms of this period have not exhibited the characteristics of the Lower Silurian form LINGULEPIS, and are for the present continued under the old Genus LINGULA; of which we have in the Upper Helderberg group the following species:

Lingula ceryx,
L. desiderata,
L. manni; all new species.

In the Hamilton group we have:

Lingula exilis,	*Lingula punctata* (n. s.),
L. ligea,	*L. nuda* (n. s.),
L. ligea var.,	*L. densa* (n. s.),
L. palæformis,	*L. delia* (n. s.),
L. leana (n. s.),	*L. alveata* (n. s.),
L. maida (n. s.),	*L. spatulata*.

In the Chemung group we have:

Lingula melia,
L. cuyahoga; both new species.

Under the Genus DISCINA are the following in the Hamilton group, including the Marcellus and Genesee slates and the Tully limestone:

Discina minuta,	*Discina seneca* (n. s.),
D. humilis (n. s.),	*D. media* (n. s.),
D. grandis,	*D. tullia* (n. s.),
D. randalli (n. s.),	*D. lodensis*,
D. doria (n. s.),	*D. truncata*.

In the Chemung group are:

Discina neglecta (n. s.),
D. elmira (n. s.),
D. alleghania,
D. newberryi (n. s.).

The Genus CRANIA occurs in a single species, the *C. aurora* (n. s.), in the Schoharie grit.

In the Hamilton group are:

Crania hamiltoniæ,
C. crenistriata, and
C. gregaria, or the young of *C. hamiltoniæ*.

In the Chemung group, a single species, *C. leoni*, is known.

Of the Genus PHOLIDOPS, two species, *P. areolata* (n. s.), and *P. hamiltoniæ*, occur in the Hamilton group.

Of the Genus ORTHIS, the following species are described from the Upper Helderberg group:

Orthis peloris (n. s.),	*Orthis similis* (n. s.),
O. lenticularis,	*O. cleobis* (n. s.),
O. alsus (n. s.),	*O. idas* (n. s.) = *eryna*,*
O. mitis (n. s.),	*O. propinqua*.
O. livia,	

In the Hamilton group are the following species:

Orthis solitaria,	*Orthis penelope*,
O. lepida,	*O. cyclas*,
O. vanuxemi,	*O. idoneus* (n. s.),
O. leucosia,	*O. tulliensis*.

In the Portage and Chemung groups, we have:

Orthis carinata,	*Orthis leonensis* (n. s.),
O. tioga (n. s.),	*O. thiemei*, and
O. impressa,	*O. leucosia ?*

Under the Genus STREPTORHYNCHUS, several species heretofore described are referred to *Strophomena* (*Streptorhynchus*) *chemungensis*, CONRAD, under which, as varieties, are arranged *Strophomena bifurcata*, *S. arctostriata*, *S. pectinacea*, and *Orthis perversa* (HALL); *Streptorhynchus pandora* (BILLINGS); *Orthisina arctostriata* and *O. alternata* (HALL); *Orthis inequalis* and *O. pravus* (HALL, Iowa Report.) The species is extremely variable, having a great vertical and horizontal distribution, and appears under many phases.

The *Strophomena rhomboidalis* (WAHLENBERG) = *S. rugosa* (RAFINESQUE) occurs in the Schoharie grit, and is abundant in the Corniferous limestone, but is unknown in the Hamilton and Chemung groups.

The Genus STROPHODONTA extends throughout the series; and two species, the *S. demissa* and *S. perplana*, are found from the Schoharie grit to the Chemung group inclusive. The species recognized in the Upper Helderberg group are:

Strophodonta demissa,	*Strophodonta inequiradiata*,
S. perplana,	*S. patersoni*,
S. alveata,	*S. hemispherica*,
S. callosa,	*S. inequistriata*,
S. parva,	*S. ampla*.
S. crebristriata,	

* See Sixteenth Report New York State Cabinet, p. 35.

In the Hamilton group are found:

Strophodonta concava,
S. *perplana*, CONRAD (which has been described under the names *Strophomena perplana*, *S. pluristriata*, and *S. delthyris*, CONRAD; and as *S. nervosa*, *S. crenistria*, and *S. fragilis*, HALL);

Strophodonta demissa,	*Strophodonta inequistriata*,
S. nacrea,	*S. junia.**

In the Chemung group are found:

Strophodonta cayuta (n. s.),	*Strophodonta perplana* var. *nervosa*,
S. mucronata,	*S. demissa.*
S. cœlata (n. s.),	

In the Genus CHONETES, we find verified in a very satisfactory manner the observations made by Count VON KEYSERLING, in regard to the direction of the tubes or spine-bases in the area of the ventral valve. These tubes are directed from the hinge-line towards the apex of the valve, and parallel to the sides of the triangular fissure. They appear on the crest of the area as little pustules or elongated tubular spines, which may be either vertical to the hinge-line or directed outwards.

In the Upper Helderberg and Hamilton groups, we have the following species:

Chonetes hemispherica,	*Chonetes pusilla*,
C. arcuata,	*C. setigera*,
C. acutiradiata,	*C. scitula*,
C. lineata,	*C. lepida*,
C. yandellana,	*C. coronata*,
C. mucronata,	*C. logani.*
C. deflecta,	

The occurrence of this last named species in the Tully limestone is a fact of great interest, carrying back the appearance of this species to a much earlier epoch than had heretofore been known. The species occupies a limited area in the Tully limestone of New York, and is not known in the Chemung group within the State; though found in the sandstones of the same age in Ohio, and in the beds at the base of the Burlington limestone in Iowa and Illinois.

In the Chemung group we have the recurrence of *Chonetes scitula*, *C. lepida* and *C. setigera;* with a new and remarkable species, the *C muricata*,

*S. JUNIA = *S. textilis*, Pal. N. Y., Vol. IV, p. 108; the latter name being a synonym.

which has the apex truncated and the surface of the ventral valve ornamented with spines, but having the vascular markings peculiar to the genus.

Under the head of PRODUCTUS and STROPHALOSIA, the relations of these genera and of the Genus AULOSTEGES are discussed. The Devonian species, sometimes referred to STROPHALOSIA, are shown to have a narrow area, but with internal vascular impressions like PRODUCTUS. The absence of an area in the Genus PRODUCTUS is not uniform, as is shown in *P. costatus* of the Carboniferous system in America; and the same has been shown by Mr. DAVIDSON to be true of *P. sinuatus* and *P. semireticulatus* of Europe.

In comparing the American Devonian forms of Productidæ with the STROPHALOSIA of the Permian system, the former have a greater width on the hinge-line, and in this respect more resemble typical PRODUCTUS; while the narrow cardinal area and hinge-teeth assimilate them with STROPHALOSIA. Notwithstanding this feature, the vascular markings are like PRODUCTUS.

At this epoch we have the earliest known appearances of these forms, the type of which becomes extravagantly developed in the Carboniferous period, and waning during the Permian epoch, is presented for the most part in degenerate modifications of the typical forms. Although we cannot shut our eyes to this fact of development to what may be termed the perfection of the type, and its more abrupt decline, we are either compelled to extend the characters of PRODUCTUS so as to cover the two forms or modifications indicated, or else to propose a distinct designation. The latter course has been adopted, and the name PRODUCTELLA is proposed for the strophaloid Productids of the Devonian period.

The Subgenus PRODUCTELLA is compared as follows, in Pal. N. Y., Vol. IV, page 153:

"These shells differ from STROPHALOSIA in the extremely narrow linear cardinal area, greater extension of the hinge-line, more extreme arcuation or ventricosity of the ventral valve in many or most of the species, and especially in the direction and termination of the renform vascular impressions, which resemble those of AULOSTEGES and of some species of PRODUCTUS. It differs from PRODUCTUS in the constant presence of an area, hinge-teeth and sockets."

Under this genus are enumerated and described, from the Upper Helderberg and Hamilton groups, the following species:

Productella subaculeata,	*Productella dumosa,*
P. navicella,	*P. exanthemata,*
P. shumardiana,	*P. tullia* (n. s.),
P. spinulicosta,	*P. subalata.*
P. truncata,	

From the Chemung group, we have:

Productella hirsuta,	*Productella striatula* (n. s.),
P. hirsuta var. *rectispina,*	*P. hystricula* (n. s.),
P. boydii,	*P. costatula* (n. s.),
P. rarispina,	*P. costatula* var. *strigata,*
P. lachrymosa,	*P. arctirostrata,*
P. lachrymosa var. *lima,*	*P. bialveata* (n. s.),
P. lachrymosa var. *stigmata,*	*P. onusta* (n. s.).
P. speciosa,	

So great a number of fossils of this type, in many localities, and particularly in the western part of the State, give a carboniferous aspect to the strata; and leaving out a few forms which gradually disappear in the western extension of the formation, the palæozoic evidence might be regarded as decidedly favoring this view. The distinction, however, between Devonian and Carboniferous faunas is based as often upon geographical as chronological relations.

The Genus Spirifera is fully represented in the rocks under consideration. In the Upper Helderberg group, we have:

Spirifera duodenaria,
S. macra,
S. raricosta and
S. grieri, ocurring both in the Schoharie grit and in the limestone above; which latter likewise contains the following species:

S. gregaria,	*Spirifera segmenta,*
S. oweni,	*S. arctisegmenta,*
S. acuminata,	*S. euruteines,*
S. macrothyris,	*S. euruteines* var. *fornacula,*
S. unica (n. s.),	*S. mannii,*
S. disparilis,	*S. divaricata,*
S. varicosa,	*S. fimbriata.*
S. varicosa, var.,	

The last named species occurs also in the Oriskany sandstone and Schoharie grit. Several of the species indicated above are known in their perfect condition only in the limestones of this age in Ohio and adjacent States of Indiana and Kentucky.

In the Hamilton group, the most abundant and widely distributed species is *Spirifera mucronata.* In the same group are the following:

Spirifera	*tullia* (n. s.),	*Spirifera*	*medialis,*
S.	*formosa,*	*S.*	*medialis* var. *eatoni,*
S.	*sculptilis,*	*S.*	*angusta,*
S.	*ziczac,*	*S.*	*macronata,*
S.	*granulifera,*	*S.*	*subumbona.*
S.	*marcyi,*		

Spirifera acuminata and *S. fimbriata* recur in this group; the latter is not uncommon.

Several species heretofore described are indicated as doubtful, requiring further material and investigation.

The Portage group has furnished only the *Spirifera lœvis;* which has much the general aspect of a Carboniferous form.

In the Chemung group, we have:

Spirifera mesacostalis,
S. *mesastrialis,*
S. *disjuncta,* with its numerous synonyms and the species represented in a great variety of aspects;
S. *alta* (n. s.),
S. *prœmatura* (n. s.).

The chapter on SPIRIFERA is concluded with some remarks upon the geological and geographical distribution of the species of Spirifers, the hinge-structure, etc.; which have already been published.

The name AMBOCŒLIA is continued, being regarded as presenting sufficient distinction from SPIRIFERA; and in the Hamilton group are recognized:

Ambocœlia umbonata,
A. *preumbona.*

In the Chemung group, *A. umbonata* var. *gregaria.*

On page 263 of the volume are some observations on the Genus CYRTIA of DALMAN, and CYRTINA of DAVIDSON.

So long since as in 1858, Mr. DAVIDSON, in his Introduction to the Study of the Brachiopoda, had expressed some doubts as to the value of the Genus CYRTIA of DALMAN; and later investigation had shown that the typical species of that genus does not differ from SPIRIFERA. At the same time, some forms usually referred to the Genus CYRTIA possess a peculiar modification of the dental plates, with a largely developed median septum and punctate structure of the shell. For these forms, Mr. DAVIDSON has proposed the name CYRTINA. All the American species heretofore referred to CYRTIA, and which have been reëxamined, prove to belong to CYRTINA. Of these we have *C. pyramidalis* in the Niagara group, *C. dalmani* in the Lower Helderberg group, and *C. rostrata* in the Oriskany sandstone.

Three species are described in the present volume, from the rocks of New York, viz:

Cyrtina biplicata, from the Schoharie grit;
C. crassa (n. s.), from the Corniferous limestone;
C. hamiltoniæ, from the Hamilton group; and a variety of the latter from the Chemung group.

A species from the Hamilton group in Iowa, *C. curvilineata* (?), is noticed.

The Genus TREMATOSPIRA, proposed in Vol. III, Pal. N. Y., and published in the Tenth Report on the State Cabinet, is represented in the Hamilton group by two species:

Trematospira gibbosa,
T. hirsuta.

The Genus RHYNCHOSPIRA is represented by only a single species, the *R. lepida*. The *R. nobilis* from the Hamilton group, formerly referred to this genus, presents some points which render its generic relations more nearly with TREMATOSPIRA.

The genus NUCLEOSPIRA is represented by a single species, the *N. concinna*.

The observations on the Genera ATHYRIS and MERISTELLA are as follows:

GENUS ATHYRIS (M'COY).

The Genus ATHYRIS was established in 1844 by Prof. M'COY, upon certain species separated from the TEREBRATULÆ; and when restricted according to the original types of that author, includes a very natural group of shells, but which nevertheless possesses many external features in common with the later established Genera MERISTA and MERISTELLA, and from which the species are distinguished by important internal characters.

The shells of the genus are variable in form, being suborbicular, transverse or elongate, subglobose or depressed, and sometimes subangular. The typical species are depressed suborbicular. The structure of the shell is fibrous; the surface in most species is strongly marked by concentric striæ, and some of them are strongly lamellose, with the lamellæ becoming fimbriate or pectinate. In this aspect, as well as in general form, these shells have a resemblance to some of the Spirifers with short area and rounded cardinal extremities. The surfaces are sometimes obscurely radiatingly striate; but these striæ are usually subordinate to the concentric striæ or lines of growth, and it may be doubted whether any well authenticated species of the genus has conspicuous radiating striæ or costæ.

The apex of the ventral valve is usually or perhaps always perforated by a rounded foramen, the lower side of which is formed by the umbo of the opposite valve. When the valves are separated, this foramen communicates with a triangular space which opens into the main cavity of the valve. This triangular fissure, which in older shells is usually occupied by the beak of the opposite valve, has at some time during the animal's life been closed by deltidial plates.

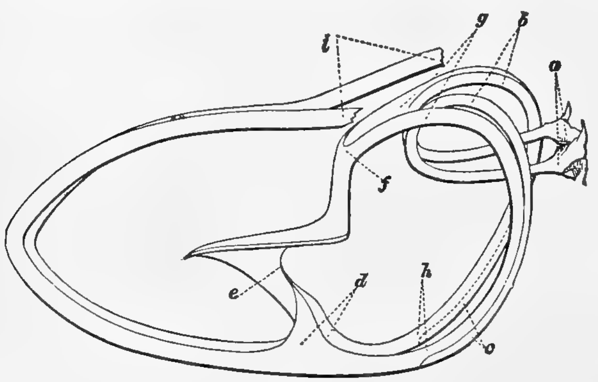
The dorsal valve is furnished with a strong cardinal process, the centre of which is often depressed and spoon-shaped, but sometimes thickened and convex. The crura proceed from each side of this plate anteriorly; while the posterior and lateral margins become more or less thickened, or elevated into ridges bordering the teeth-sockets.

The muscular area is somewhat variable in form; but in the ventral valve it is oval or ovate, more or less flabelliform. The occlusor muscular imprints are marked upon the shell, and upon the cast, by a narrow elongate scar; while the divaricator muscles occupy a wider space on each side, and are usually strongly striated. In the dorsal valve the muscular area is narrow, and often divided by a low longitudinal crest or septum. The space outside of the muscular scars is papillose or papillose-striate, and often beautifully marked by vascular impressions. The spires are complicated by intermediate lamellæ.

The European species of ATHYRIS (*A. pectinifera*, *A. roissyi* and *A. concentrica*), as shown by WOODWARD, DAVIDSON and others, have the spires complicated by accessary lamellæ, which, rising from the connecting loop, are intercalated between the first and second turns of the normal lamellæ, and have their extremities free.

Although the presence of spires has been long known in the American species, I believe no one has hitherto shown their analogy with the European forms. In the determination of our species, however, and their relations with MERISTELLA, it became necessary to make a careful study of all the internal characters upon which generic and specific distinctions might be founded; but since all the specimens were essentially solid, it has been a labor of no little difficulty to determine accurately the true character of these internal appendages. By carefully cutting down the specimens of *A. spiriferoides*, which is very similar to the *A. concentrica* of Europe, the disposition of the spiral lamellæ has been found as shown in the following diagram, which represents only the central portion of the spirals to the end of the first volution.

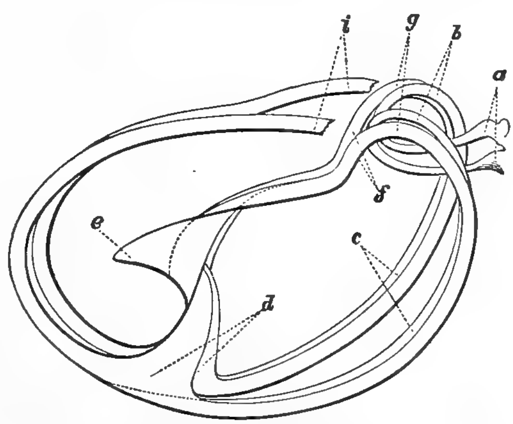
The origin of the crura, or point of attachment to the hinge-plate, is indicated in the figure at *a*, from which the two lamellæ proceed for a short distance in a nearly direct line forward, but are soon bent upwards and recurved upon themselves as shown in the figure at *b*, whence they are again bent downwards into the cavity of the dorsal valve. From this point the lamellæ follow very nearly a direction parallel to the external contour of the shell, being the exterior bands indicated by the dotted lines to *c*. Farther on, these become expanded and send off from each one a projecting process at *d*, and thence are united in a solid plate at *e*, forming the loop which connects the two parts of the spiral arms. It will also be observed that the lamellæ are twisted, the exterior part at *d* becoming the interior at the point of junction of the two parts. This plate, formed by the junction of the lamellæ is sharply bent backwards almost in the plane of the longitudinal axis of the shell; and thence rising nearly at right angles, becomes bifurcated at *f*, giving origin to the accessary lamellæ *g*, which are recurved in a plane essentially parallel to the first volution of the spire, and coalesce with it at the points indicated by the dotted lines *h*, thus acting as an additional support to the primary lamellæ of the spire in its first volution. The lamellæ are represented as cut away at *i*, showing but a single volution. The remaining portions of the spires consist of simple volutions arranged in a conical form.



Under this genus we have the *Athyris spiriferoides*, an abundant and widely distributed form in the Hamilton group; and the *Athyris vittata*, occurring in the limestone of the Upper Helderberg group; and also in the Hamilton group of Iowa.

The internal spires of this species, in their first volution and in the accessary lamellæ, are quite distinct from those of *A. spiriferoides*. The accompanying figure is an illustration of the first volution of its spires, with the accessary lamellæ.

The bases of the crura are shown at *a*, and these projecting a short distance forward make a somewhat abrupt retral curve, turning back in the direction indicated by the dotted lines *b;* and thence descending into the cavity of the dorsal valve, follow essentially the curvature of its outline, as indicated at *c*, to a point anterior to the middle of the length of the spiral curve. Here the branches of the loop are given off at *d;* and these projecting vertically into the cavity, are turned abruptly forward, and beyond the dotted line, form a solid pointed plate which projects far towards the anterior limits of the spires at *e*. The posterior portions are produced backwards, and gradually ascending, continue parallel and in close proximity as far as *f*, where they diverge, sending off a fillet on each side which at *g* assumes the curvature of the normal lamellæ of the spire, following the same course into the cavity of the valve, and extending forward to the origin of the process forming the loop, they are united to the proper spiral lamellæ at *h*, which then continue simple as shown in their extension to *i*.



A second species in the Hamilton group is the *Athyris cora*. In the Chemung group we have the *Athyris angelica* and the *A.? polita*.

GENUS MERISTELLA (Hall).

The Genus Meristella, separated from Athyris on account of its different external characters and muscular impressions, is represented as follows:

Meristella nasuta, in the Schoharie grit and Corniferous limestone ;
M. scitula, *M. doris*, } in the Corniferous limestone.
M. barrisi, *M. haskinsi*, *M. rostrata*, } in the Hamilton group ;
M. meta (n. s.).

In the Chemung group, this type is feebly represented by some casts of an undetermined species.

The *Meristella unisulcata* of the Corniferous limestone is referred to the Subgenus ? PENTAGONIA of COZZENS, and its varieties of form illustrated. The species is of rare occurrence in the Hamilton group.

The reëxamination of the shells of this group has developed some farther knowledge of their internal structure.

The general observations upon the Genus MERISTELLA are as follows:

The shells of this genus are oval, ovoid or suborbicular, elongate or rarely transverse; valves unequally convex, with or without a median fold or sinus; beak of the ventral valve often with a circular foramen, and incurved over the umbo of the dorsal valve. Area none; valves articulating by teeth and sockets; surface smooth, or with fine concentric lines of growth, and with very fine, indistinct or obsolete, radiating striæ.

The interior of the dorsal valve is marked by the presence of a strong hinge-plate or cardinal process; and from the base of this proceeds a thin longitudinal septum, which often extends for half the length of the valve.

The interior of the ventral valve shows a triangular fissure below the beak, which joins a semi-circular perforation at the apex. At the base of this fissure are two strong teeth, which extend in the thickened or slender plates to the bottom of the cavity, and curve around the upper part of the muscular area, which is broadly triangular or ovate.

There is sometimes a thickening of the shell at the base of the rostral cavity, which abruptly limits the muscular impression; but there is neither septum nor rudiment of one as in MERISTA.

In well preserved specimens of *M. haskinsi*, where the apex is not too closely incurved, the ventral beak has a circular foramen, and the triangular space below, which is usually filled by the beak of the dorsal valve, is closed by two deltidial pieces anchylosed in the centre. The latter feature has been observed in *M. barrisi*, and probably existed in all the species at some period of their growth.

The study of the interior has shown that the thickened bases of the crura extend forward for a short distance, or bend abruptly to the ventral side, but recurving, descend into the cavity of the dorsal valve, following its contour and that of the ventral valve in their succeeding volutions. In the bottom of the dorsal valve, the lamellæ, in the course of the first volution, are united by a loop which is produced by the extension of a slender process from the band on each side, and these are united at a greater or less distance from their origin. Beyond this junction the parts of the loop again divide, and each one is produced in a curving band which arches forward on the ventral side, and thence returning is reunited to the sides of the loop at or near the junction of the parts before noticed.

These features are illustrated in the accompanying diagram; fig. 1 being an oblique lateral view of the central portion of the spires of *Meristella arcuata*, and fig. 2 a view of the same parts from the dorsal side.

FIG. 1.

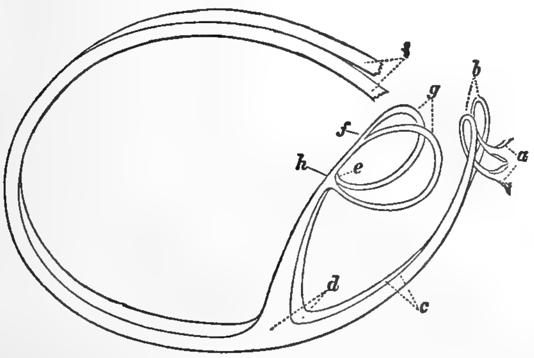
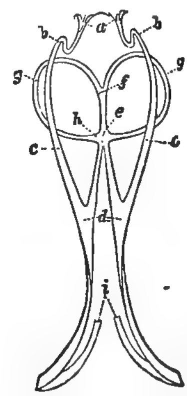


FIG. 2.



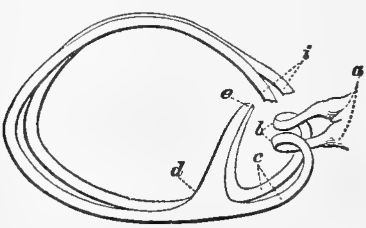
In these figures, *a* indicates the origin of the crura; *b* the recurvation of the lamellæ, which may be as represented, or with a simple retral bending without recurving upon itself in some species; *c* is the continuation of the lamellæ, which at *d* give off the processes forming the loop, and these become united at *e* and continue simple to *f*, where they bifurcate and continue in the direction *g*, returning again to the centre, and reuniting with the loop at *h*, or near the junction of the two parts before mentioned.

These characters of the spires and loop have been observed in the *M. lævis*, *M. arcuata* and *M. princeps* of the Lower Helderberg group, and in the *M. barrisi* of the Hamilton group; while the *M. nasuta* presents a slight modification in the extension of the parts of the loop, which ally it more nearly with ATHYRIS.

When compared with the spires of ATHYRIS as shown in the figures already given under that genus, as well as the illustrations of DAVIDSON and other authors, the differences are obvious. The parts of the loop in this genus, instead of curving forward and there uniting and turning backward and bifurcating, to form the accessary lamellæ, are continued from their origin obliquely backwards into the cavity of the ventral valve, and, then recurving upon themselves, are reunited laterally; while in ATHYRIS they are intercalated between the first and second turns of the spire, and coalesce with the lamellæ of the latter.

At the same time an examination of the Niagara species referred by me to the Genus MERISTELLA presents a different condition of the interior, and shows the lamellæ of the spires united by a simple loop only.

This feature is illustrated in the accompanying diagram of *Meristella* (*Meristina*) *maria*, which represents a single turn of the spiral lamellæ, from their origin at *a*, to *i* where the bands are cut off. The thickened bases of the crura are represented at *a*; *b* is the point of recurvation, *c* the continuance of the lamellæ in the dorsal cavity, and *d* the expansion on the inner side into long processes which unite at *e*, forming the loop.



The same characters have also been observed with equal distinctness in *M. nitida* of the Niagara group. In neither of these species is there any indication of accessary lamellæ as in ATHYRIS, nor evidence of the extension of the loop beyond the point *e*; and we are therefore induced to believe that the simple character of the spires in these forms will constitute another distinction, which may conveniently be termed MERISTINA.

GENUS ATRYPA (DALMAN).

The Genus ATRYPA, as applied to forms strictly congeneric with *Atrypa reticularis*, embraces but few species, and these are regarded by some palæontologists as merely varieties of still fewer species.

In this volume, the *Atrypa impressa* of the Schoharie grit is continued as a distinct species: although resembling the *A. reticularis* in general features, it presents a wide departure from the forms of that type in other strata; and if we are to regard these varieties as due to physical causes, the nature of the sediments, etc., then there is reason to believe that in other instances the same physical influences have produced changes which are recognized without hesitation as of specific value.

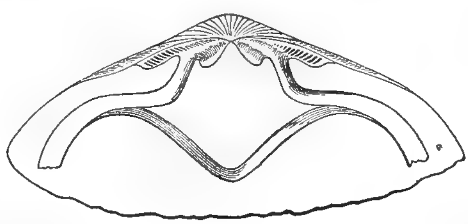
The *Atrypa reticularis*, in its various phases, occurs in the Corniferous limestone, the Hamilton and Chemung groups.

The *Atrypa spinosa* (HALL), or *Atrypa aspera* (SCHLOTHEIM), is recognized as a very distinct and well marked species, occurring in the Corniferous limestone, Hamilton and Chemung groups. In the Hamilton group it is more abundant and better preserved than in any other formation; and occurring in the same beds with *A. reticularis*, it never approaches that one in character; there is no difficulty in distinguishing the one from the other; and the same is true of these forms in the Chemung group. It is also observed that the same distinction between these species exists in Illinois and Iowa.

The *Atrypa hystrix* of the Chemung group is likewise regarded as a distinct species, though possessing many features of an extravagant *A. spinosa*.

A species of Atrypa, closely resembling the *A. marginalis* of Dalman, occurs in the Corniferous limestone. This species, *Atrypa pseudomarginalis*, is of rare occurrence in the rocks of New York.

While this volume has been going through the press, Mr. R. P. Whitfield has made examinations of the internal appendages of several forms of Atrypa, and has found that the short processes, usually represented near the base of the crura, do actually unite, forming a loop which connects the spires, as shown in the accompanying figure of *A. reticularis*.



From collections made in Iowa during the geological survey, and from others more recently made, in different places in that State, by Mr. R. P. Whitfield, at points more than a thousand miles west of New York, we learn that in all localities the distinction between *Atrypa reticularis*, or its representative, and the associated species, is more strongly marked than in the eastern collections, and there is nowhere any indication of a gradation from the one to the other. At Waterloo, in beds which are apparently of the age of the Upper Helderberg group, there occurs a form with distinct narrow plications, a regularly convex dorsal valve, and a flat or concave ventral valve. It is not very unlike a strongly plicated form from Refrath in Germany, or approaching *A. insquamosa* of Schnur.

At Independence and Waverly the specimens resemble the finely plicate *Atrypa prisca* from Refrath, with the margins compressed, the dorsal valve very convex, and the ventral valve flattened or concave towards the margin. They have very conspicuous concentric lamellæ. Some of the specimens are two and a half inches in diameter, and the volutions of the internal spires vary from twelve to twenty, according to the age of the shell.

The *Atrypa aspera*, or its representative, in the beds at Independence and Waverly, has the dorsal valve very gibbous, with the ventral valve nearly flat or concave towards the margins. In the higher beds at Rockford there is a form, in which the valves are more nearly equal in convexity, the plications fewer, and the shell has the aspect and character of *A. hystrix* of the Chemung group in New York. We are able, therefore, in the rocks of this age, to recognize over a wide area four varieties of form and surface marking which are pretty constant, two of which may be referred to the type of *A. aspera* and two to that of *A. reticularis*.

A single species of Cœlospira occurs in the Corniferous limestone, which, so far as known, possesses no characters differing from *Cœlospira concava* of the Lower Helderberg group.

With this genus are concluded all the genera bearing calcified spires: these appendages, though probably possessed by some of the following genera, were doubtless fleshy or cartilaginous organs, and have not been preserved.

Under the Family Rhynchonellidæ, the species usually referred to the Genus Rhynchonella are shown to differ from recent species referred to that genus; while at the same time the internal structure and appendages of the typical species of the genus (*R. loxia*) remain unknown or unillustrated. Under these circumstances, the name Stenocisma, proposed by Mr. Conrad in 1841, is revived, and applied to most of the rhynchonelloid forms of the rocks under consideration. Since, however, Rynchonella has come to be so well known, and many of the species have been described under the generic designation, the name is still retained. The following species are recognized in the Carboniferous limestone:

Rhynchonella	(*Stenocisma*)	*tethys*,
R.	*S.*	*billingsi* (in place of *R. thalia* of Billings; name preoccupied);
R.	*S.*	*carolina* (n. s.),
R.?	*S.?*	*royana* (n. s.).

In the Hamilton group, we have:

Rhynchonella	(*Stenocisma*)	*horsfordi*,
R.	*S.*	*sappho*,
R.	*S.*	*congregata*,
R.	*S.*	*prolifica* (n. s.),
R.	*S.*	*dotis* (n. s.),
R.	*S.*	*carica* (n. s.).

From the Chemung group the following species are described:

Rhynchonella	(*Stenocisma*)	*eximia*,
R.	*S.*	*stephani* (n. s.),
R.	*S.*	*duplicata*,
R.	*S.*	*contracta*,
R.	*S.*	*orbicularis*,
R.	*S.*	*sappho* var.

The *Rhynchonella venustula* = *R. cuboides?* and *R. subcuboides* of former reports is left under the Genus RHYNCHONELLA, though with doubt regarding its true relation. This species is known only in the Tully limestone, and occupies a very restricted vertical range.

The Genus LEIORHYNCHUS is retained for such forms as *L. limitaris* and *L. quadricostata*, which present, among other distinguished features, a division or bifurcation of the plications on the mesial fold and sinus. The species recognized as belonging to this genus are:

Leiorhynchus	*limitaris*,	*Leiorhynchus*	*kelloggi* (n. s.),
L.	*mysia* (n. s.),	*L.*	*sinuatus* (n. s.),
L.	*quadricostata*,	*L.*	*mesacostalis*,
L.	*multicosta*,	*L.*	*globuliformis*,
L.	*iris* (n. s.),	*L.*	*dubius* (n. s.).

Under the Genus LEPTOCŒLIA, the *L. acutiplicata* is the only species recognized.

The Genus CAMAROPHORIA has been observed in a single smooth species, the *C. eucharis*, from the Upper Helderberg limestones.

Some of the pentameroid forms, heretofore referred to the Genus PENTAMERUS, are placed under new genera, on account of certain peculiarities of their internal structure. The reasons for this course are given in the following observations on the Genera PENTAMERUS, PENTAMERELLA, STRICKLANDINIA, ANASTROPHIA, AMPHIGENIA, RENSSELÆRIA, etc.

The Genus PENTAMERUS was proposed by Mr. SOWERBY in 1813, to indicate the peculiar internal structure of *P. knightii*, which is the type of the genus. DALMAN,* objecting to SOWERBY's name, on the ground that the shell was not five-chambered, proposed the name GYPIDIA as a substitute; but the latter has not been adopted by naturalists.

Since that time much information has been obtained regarding the disposition of the internal parts of the shells of this genus, through the

* Petrefacta Suecana, in Konigl. Vet. Acad. Handl., 1827.

labors of the European palæontologists DE VERNEUIL, KING, BARRANDE, M'COY, SUESS, DAVIDSON, SALTER and others. In the meantime, however, other species have been referred to the genus, which, having the general external characteristics of PENTAMERUS, still possess features that render their union with that genus incompatible; and farther study has shown the necessity of separating them. Among the European forms which are regarded as strictly referable to the genus, are *P. knightii* (Sow.), *P. vogulicus* (DE VER.), *P. galeatus* (DALM.), *P. sieberi* (VON BUCH), *P. pelagicus* (BAR.), and *P. optatus* (BAR.); while *P. oblongus* and *P. lens* have the characteristic features of the genus less conspicuous, the exterior being smooth and the form less rotund. *Pentamerus liratus* and *P. microcamerus* have a straight hinge-line and distinct area.

In 1859, Mr. BILLINGS proposed the separation of certain forms from the typical PENTAMERUS, under the name of STRICKLANDIA (STRICKLANDINIA*), which he describes as follows:

GENERIC CHARACTERS. Shell usually large, elongate, oval, transversely oval or circular, sometimes compressed: valves nearly equal; a short mesial septum in the interior of the ventral valve supporting a small triangular chamber beneath the beak as in PENTAMERUS. In the dorsal valve, no longitudinal septum, spires or loop; the whole of the internal solid organs consisting of two very short or rudimentary dental plates, which, in some species, bear prolonged calcified processes for the support of the cirrated arms. In all the species, the ventral valve has an area more or less developed.

* * * * * * * * *

This genus includes three English species, which have been long known under the names of *Pentamerus lens*, *P. liratus* and *P. lævis*. All these, and the three Canadian species, abound in rocks of the age of the Middle Silurian, such as the Llandovery rocks of Sir R. MURCHISON, and the Clinton and Niagara groups of the New York geologists. No species have as yet been found either above or below the Middle Silurian. On the other hand, the Genus PENTAMERUS occurs more or less frequently in all formations from the Black river limestone to the Devonian inclusive.

The European *Pentamerus liratus* undoubtedly belongs to a genus distinct from *P. knightii*, having a straight hinge-line, an area on the ventral valve, with a sensible mesial depression and corresponding elevation on the opposite valve. The species has likewise a short septum, and supports a small triangular pit in the ventral valve; while in the dorsal valve the hinge-plate is divided, and the parts are extended in long lamellæ into the interior of the valve. The *Pentamerus microcamerus*, M'COY (= *Spiri-*

* In consequence of the name being preoccupied in botany, Mr. BILLINGS has proposed to change to STRICKLANDINIA.

fera? lævis, SOWERBY), belongs also to the same group, having a straight hinge and narrow area, with a short V-shaped pit; characters unlike those of true PENTAMERUS. At the same time the *Pentamerus lens* and *P. lævis*, which are, by Mr. BILLINGS, united with *P. liratus* under the Genus STRICKLANDINIA, appear to me to differ very widely from that species. They have no area in the proper acceptation of that term, and the hinge-line is not extended. In the ventral valve, the long V-shaped pit is supported on a septum which sometimes extends for nearly half the length of the valve. Moreover, the dorsal valve in the American species, *P. oblongus*, is marked by the presence of very extended lamellæ, which are united at their origin and spread laterally till their free margins meet the corresponding margins of the lamellæ forming the V-shaped pit in the ventral valve; and running parallel with it for nearly its entire length, they then become vertical, and are continued as far as the middle of the length of the valve, where their extremities apparently become free. In these features, there is no essential difference between *P. oblongus* and *P. knightii* or *P. geleatus*.

In *Pentamerus lens*, or a closely allied form, from Anticosti, the dorsal valve possesses similar characters, and there is no area on the ventral valve. Restricting the designation to such forms as *P. liratus* and *P. microcamerus* among the European species, there is good ground for the separation; but the other species do not appear to me congeneric. Through the kindness of Sir W. E. LOGAN, I have been permitted to examine the American species of STRICKLANDINIA, *S. gaspensis*, *S. canadensis* and *S. anticostensis* (BILLINGS), and also the species referred to the European *P. lens*. The first two appear to me to be congeneric with *P. liratus*, and do possess the characters of the genus as described. Limiting, therefore, the application of the term as here indicated, I think we have a well marked genus, which, typified by the species above named, may also include others heretofore referred with doubt to SPIRIFERA. I conceive, however, that our appreciation of generic limitations will not be enhanced by including under the same term the *P. lens* and *P. oblongus* = *P. lævis*.

Though at first restricting the genus to the Middle Silurian formations, Mr. BILLINGS has, at a later period, included under STRICKLANDINIA the *Pentamerus elongatus* of VANUXEM = *Rensselæria elongata* (HALL), a Devonian species. This form was first placed under PENTAMERUS, from its resemblance to *P. oblongus;* and I finally referred it to RENSSELÆRIA, from the generally similar shape, similar muscular impressions of the dorsal valve, and the prismatic or punctate texture of the shell; having at that time an imperfect knowledge of the interior structure of the ventral valve. Now this species has no area on the ventral valve; but it has a V-shaped pit supported by a septum precisely as in PENTAMERUS; while both the muscular impression of the dorsal valve, and the structure of the hinge-plate, are precisely the same as in RENSSELÆRIA. I cannot see, therefore, upon what ground this shell should be associated with *P. liratus*, *P. gaspensis*, *P. canadensis* and *P. anticostensis*, which have a straight hinge-line, an area on the ventral valve with a septum supporting a short V-shaped pit, a different muscular imprint and hinge-processes of the dorsal valve, and a fibrous or lamellose structure of shell, and are otherwise externally marked in a very characteristic manner.

I have taken some pains to bring together specimens of *P.* (*R.*) *elongatus*, and we have now the means of knowing its real characters to a very considerable extent. As before observed, the dorsal valve presents all the characteristics of RENSSELÆRIA in its hinge-structure and muscular impressions: there is the same narrow foramen beneath the hinge-plate, a pedicle-opening, and the filling of this is preserved in several specimens of the casts; while this portion of the separated valve shows the same features in a most unequivocal manner, and it is quite impossible to point out any characters by which it may be separated from the same part of the shell in RENSSELÆRIA. The crura are free from near their origin, and have been traced for some distance within the cavity, and gently curving to the ventral side; but their termination is unknown. When, however, we examine the hinge of the ventral valve, we find a modification of the dental plates, which are prominent in RENSSELÆRIA (as shown in fig. 3, *g*, *h* and *m*, Plate CVIII, Palæontology of New York, Vol. iii), but which are here produced anteriorly and united at their dorsal margins. The incipient septum in the bottom of the valve of RENSSELÆRIA becomes developed, and sustains the united bases of the dental plates; and we have the V-shaped pit and central septum of PENTAMERUS.

In the separated valves of this species, the margins of the triangular fissure of the ventral valve are as clearly defined, and as free from area, as are the valves of ATHYRIS or MERISTELLA.

Generic significations must have some limit, and we cannot consent to unite three so widely differing and well marked types as *P. liratus*, *P. gaspensis*, etc. with *P. oblongus* and *P. lens* on the one hand, and *P. elongatus*, on the other.

There is also another type usually included under the Genus PENTAMERUS, which may be separated with advantage. This one is represented by *P. reversus* (BILLINGS), *P. verneuili* and *P. interplicatus* (HALL), etc. In these forms the relation of the valves, as in typical PENTAMERUS, is reversed, and the interior structure presents other important differences. For these I shall propose the name of ANASTROPHIA.

There is still a farther separation required among the pentameroid forms, or an extension of the characters of the genus. The *Pentamerus occidentalis* of the Iowa Geological Report presents externally a depressed dorsal valve, with a median fold on the lower valve; while there is a distinct area bordering the fissure, and this area is vertically striated as in many of the Spirifers. The ventral valve has the trough-like pit, formed by the junction of the lamellæ, greatly extended and extremely incurved, and the dorsal lamellæ or crura are divergent and present some peculiarities.

It is doubtless unsafe to base a distinction of genera upon external characters alone; and even with a partial knowledge of the interior structure, we may be misled, but this group of shells presents itself to us under an aspect that will admit of the following arrangement:

1. *Pentamerus* proper, having rotund or gibbous forms, with the ventral valve prominent in the middle, and the dorsal valve flattened or depressed towards the front; lamellæ of the dorsal valve distinct: *P. knightii*, *P. galeatus*, *P. pseudogaleatus.*

2. Elongate forms with the valves subequally convex, lobed or subsinuate; internal structure essentially as in *P. knightii*, and of which *P. oblongus*, *P. lens?* are typical forms.

3. Forms ovate, more or less rotund, with a sinus on the ventral valve and a mesial fold on the dorsal valve; internal structure of the ventral valve as in *P. knightii.* Dorsal valve with the crura or lamellæ of the hinge-plate conjoined so as to form a separate trough-shaped cavity, which unites with the inner surface of the valve; a narrow area on each side of the fissure, and a flattened space or false area along the cardinal margin of the valve. *P. aratus* and *P. papilionensis* are of this type. Genus PENTAMERELLA.

4. Forms more or less elongate, lobed or with mesial fold and sinus; hinge with an extended area on the ventral valve: internally a short V-shaped pit in the ventral valve supported by a septum. In the dorsal valve, the crura are free almost or quite from their origin (as in SPIRI-

FERA), and forming no vertical lamellæ. *P. liratus* and *P. microcamerus* are European forms of this type = the Genus STRICKLANDINIA of BILLINGS; of which *S. canadensis*, *S. brevis*, *S. gaspensis* and *S. anticostensis* are characteristic forms.

5. Short gibbous or ventricose forms; the ventral valve much the larger, with or without mesial fold, a large fissure, and elongate much incurved trough-shaped pit. Dorsal valve depressed in front: an area on both valves; that of the ventral valve striate as in SPIRIFERA; lamellæ of dorsal valve separate and diverging. Genus GYPIDULA, of which *G.* (*P.*) *occidentalis* and *G. læviusculus* are types.

6. Rotund or gibbous forms, with the valves, as in ordinary PENTAMERUS, reversed. The ventral valve is the smaller, gibbous in its upper part, depressed or sinuate below, with the V-shaped pit sessile for nearly its entire length; a small flattened space on each side of the fissure. The dorsal valve is ventricose, larger than the ventral, with prominent umbo. The hinge-plate is extended in gradually converging vertical lamellæ which are joined to the shell throughout their length, while the crura are extended into the cavity in thin free lamellæ. Genus ANASTROPHIA,* of which *Pentamerus verneuili*, *P. interplicatus* and *P. reversus* are types.

7. Forms elongate, not lobed. Ventral valve with connected dental lamellæ, forming a trough supported on a septum. Dorsal valve with free crura: no area. Shell-structure punctate. Genus AMPHIGENIA: type *Pentamerus elongatus* (VANUXEM) = *Amphigenia elongata.*

These modifications of a type, of which, until recently, but two genera have been recognized, are well marked in nature, and they seem to me to demand some farther recognition than that of subordination to the Family RHYNCHONELLIDÆ. I shall therefore propose the Family PENTAMERIDÆ to include the genera above enumerated, as well as the Genus CAMAROPHORIA, and probably TRIPLESIA and some of the species of CAMARELLA,† and perhaps also the Genus GYPIDIA of DALMAN, making *G. conchydium* the type.‡ In this arrangement, it appears to me that we

* I am aware that Mr. SHALER, of the Museum of Comparative Zoölogy at Cambridge, in a Bulletin of that Institution, has proposed the name BRACHYMERUS for these forms; but since that name is preoccupied for a genus of COLEOPTERA, it cannot be adopted in this relation; and my own determination of the generic distinction of these forms having been made long since, I shall adopt the name proposed above.

† I cannot recognize the rhynchonelloid typical species of CAMARELLA as congeneric with many of those more recently placed under that genus by its author.

‡ In the revision of the PENTAMERIDÆ, I am by no means sure that the Genus GYPIDIA will not be recognized. I have under consideration at the present time an American species of similar

have a well-marked family of BRACHIOPODA which has existed from the earliest palæozoic epoch, and has continued throughout the entire series to its close.

Under the Genus PENTAMERELLA are placed *P. arata* (= *Pentamerus aratus*), *P. papilionensis* (= *Pentamerus papilionensis*), *P. micula* (n. s.), *P. obsolescens* (n. s.), and *P. dubia* (= *Spirifer dubius*, HALL, Thirteenth Report on State Cabinet).

The Genus GYPIDULA includes *G. occidentalis* (= *Pentamerus occidentalis*, HALL, Geol. Report of Iowa), and *G. læviuscula* (n. s.).

The term AMPHYGENIA is proposed to include the original *Pentamerus elongatus* of VANUXEM, which possesses characters unlike any other genus of the pentameroid family; the *A. elongata*, and a variety *undulata.* The species formerly described as *subtrigonalis* appears to be only a variety of the *A. elongata.*

The Genus RENSSELÆRIA is recognized with doubt, and a single species, *R.? johanni*, is noticed from rocks of the age of the Upper Helderberg group in Iowa.

The Genus TEREBRATULA is recognized in the following species:

Terebratula	*lens*,	*Terebratula*	*elia* (n. s.),
T.	*sullivanti* (n. s.),	*T.*	*jucunda* (n. s.),
T.	*harmonia* (n. s.),	*T.*	*navicella* (n. s.),
T.	*rœmingeri*,	*T.*	*simulator* (n. s.).

It has been found necessary to preserve the generic term CRYPTONELLA for some of the species originally placed under that genus, as will be seen from the following citation, pages 392 and 393 of the volume.

GENUS CRYPTONELLA (HALL, 1861).

Shells equilateral, inequivalve, elongate, oval or ovoid; valves unequally convex, without median fold or sinus, or with this character moderately developed and principally towards the base of the shell. Ventral valve with beak extended or incurved, perforate; foramen terminal, the lower side formed by two small triangular deltidial pieces, or, in their absence, by the umbo of the opposite valve. Shell-structure finely punctate. Surface smooth, or with concentric striæ. Valves articulating by teeth and sockets, the dental lamellæ of the ventral

external character, presenting certain modifications of the hinge-plate in the dorsal valve, which will require a distinct designation.

valve extending downwards into the cavity of the shell. The muscular impressions in the dorsal valve are strongly marked above, and extend in two narrow separated impressions more than halfway to the front of the shell: the ventral cast shows elongated muscular and vascular impressions.

The species of this genus are more elongate than MERISTA and MERISTELLA, and those now known are less distinctly marked by mesial fold and sinus; while the beak is more attenuate, often a little flattened, and rarely so closely incurved, as in the genera cited. The punctate structure of the shell is a distinguishing character.

This genus was first described as above cited, and figures of the exterior form and of the interior of the valves were given in the Fifteenth Report. The results of some farther investigations were given in the Sixteenth Report, and an illustration of what was supposed to be the internal appendages of the shell. About the same time it was discovered that some punctate shells of the same general form possessed the loop of TEREBRATULA proper; and it became a matter of great interest, and still greater difficulty, to determine the internal structure of the species. I had referred to this genus the *Terebratula lens*, *T. lincklæni*, *T. rectirostra* and *T. planirostra*, species described in a preceding report. Having ascertained that the internal loop in *Centronella glans-fagea* is essentially similar to that of *C. julia* (WINCHELL), a species having the external form of CRYPTONELLA, I supposed it possible that the two genera might be merged into one. Since that time, I am not aware that any farther investigations have been made, tending to throw light upon this subject.

It has therefore appeared to me very desirable to learn, if possible, the internal structure of any one of those species which I originally referred to the Genus CRYPTONELLA. Of two of these, *C. rectirostra* and *C. planirostra*, I have fortunately been able to obtain an exposition of the form and structure of the loop, as will be shown in the illustrations of the species.

The crura have the general form of those in WALDHEIMIA, extending in a long recurved loop, with long processes descending into the ventral valve, between which and the apex of the shell the crura are united by a transverse band, differing in this respect from that genus, while the muscular impression and extended beak offer other distinctions.

I have thought it desirable, therefore, to continue the name CRYPTONELLA to include these two authentic species; while the other two species are included under it from their general form.

I have continued the *Terebratula lens* under that genus, without knowing its internal structure, but from its external similarity with those which have proved to belong to that genus.

These investigations have clearly shown how difficult, or even impossible it is to refer to their proper generic relations these fossils from external form and character alone.

The following species are retained under this genus: *Cryptonella rectirostra*, *C. planirostra*, *C. iphis* (n. s.), *C. lincklæni*,* and a doubtful form, *C.* (*Terebratula*) *eudora*, from the Chemung group.

Under the Genus Centronella are described the *C. glans-fagea*, *C. alveata*, *C. impressa* and *C. glaucia* (n. s.).

A farther study of the genus Tropidoleptus has revealed certain features of internal structure, which seem to ally it with the Terebratulidæ.

The typical species of this genus is a concavo-convex shell, having the general form of Leptæna and Strophomena, and was originally described by Mr. Conrad as *Strophomena carinata.* It differs from all the genera of Strophomenidæ in both external and internal characters, and, for these reasons, has been separated. The shell is externally strongly ribbed, and the texture is finely punctate throughout its substance. The ventral area is well defined, narrow and linear. The fissure or foramen is very large and wide, and is excavated above the area line, coming quite up to the beak, and sometimes even including the apex which is worn away or absorbed.

The teeth, which are a little separated from the margins of the foramen and not continuations from it, are strong and thickened below, while they are deeply crenulated on the summit and exterior margins. There is a narrow low median ridge in the cavity of the valve; and the divaricator muscular impressions have not been satisfactorily observed.

The dorsal valve has a narrow area, and a wide and strong cardinal process which nearly or quite fills the foramen of the opposite valve. This process is often simple exteriorly, above the limit of the smooth or striated pseudo-deltidium which covers it near the hinge-line; but just within the valve it is broadly grooved in the middle, usually with two small deep pits just within the external smooth callosity, and on each side there is a groove and accessory lobe, frequently not conspicuous. The divisions made by the median groove diverge and terminate below

* This species has proved to be a true *Terebratula.*

in obtuse processes which have some similarity with the bases of crural processes in ORTHIS, but have more analogy with the Terebratulidæ. These processes are sometimes clearly broken at their termination, but are often smooth as if the roughened surface had been cicatrized during the life of the animal. Below these forks of the process there is a narrow median crest or septum which reaches beyond the middle of the valve, and sometimes nearly to the front. From the limbs of the thickened divergent processes there proceed slender crura, which, at first bending slightly outwards, send off a short spur into the ventral cavity and are thence directed forwards, and gently curving, join the median crest, to which they are attached, forming a loop of peculiar character. The occlusor muscular impressions have rarely been seen with any degree of distinctness; but the depressions just at the termination of the crural processes, and on each side of the median ridge, are striated; and this striation often extends in a wide flabelliform expansion, probably due to vascular impressions. Towards the margin, the interior of both valves is strongly pustulose. In the accompanying wood-cuts, fig. 1 represents the interior of the dorsal valve, and fig. 2 a longitudinal section of the valve; *j*, cardinal process; *b*, crenulated teeth-sockets; *c*, crural processes; *l*, loop; *s*, septum.

FIG. 1.

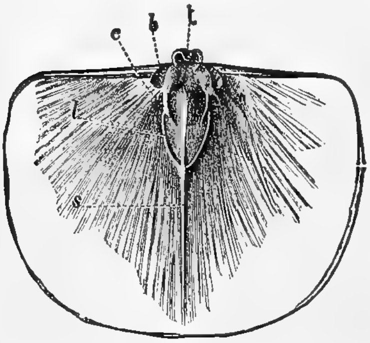
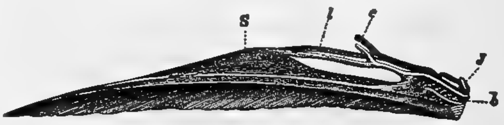


FIG 2.



In the punctate texture of this shell, it differs from either of the Genera LEPTÆNA, STROPHOMENA or STROPHODONTA; but this might not be an objection to admitting TROPIDOLEPTUS into the family, were the other characters coincident. The area is longitudinally striated, and presents a different aspect from any of the STROPHOMENIDÆ, but has analogy with some of the Orthides. The teeth are not extensions of the lamellæ bounding the foramen, but distinct from it and deeply crenulate or lobed, and inserted into corresponding crenulate sockets in the dorsal valve. The form of muscular impressions, so far as known, is not very dissimilar to those of STROPHOMENA or ORTHIS.

In comparing the form of the cardinal process and its appendages, we shall find it almost entirely similar to that of the LEPTOCŒLIA, as shown in two authentic species (*L. flabellites* and *L. fimbriata*), and the muscular impression of the ventral valve is quite like that of the same species.

The exterior extremity of the cardinal process presents considerable variety of aspect, when a large number of individuals are examined. In some of them this part, if stripped of the external callosity of pseudo-deltidium, would have the main process bilobed, with a sinus a little below the apex, and an accessory lobe on each side similar to some of the species of PRODUCTUS.

The *Tropidoleptus carinatus* is the typical species of the genus. A western form has been described under the name *T. occidens*.

The relations of the Genus VITULINA are not fully established. The shell-structure is punctate, with a papillose surface, a high area on the ventral valve, with a large triangular fissure. The genus embraces a single species, the *Vitulina pustulosa*.

The author, both in the preface and the body of the volume, has made acknowledgments to many gentlemen for their liberality in furnishing specimens for study and illustration during the progress of the work. Among those specially named are Dr. G. A. WILLIAMS, of Boonville, Mo.; Dr. JAMES KNAPP, of Louisville, Ky.; Dr. C. RŒMINGER, of Ann-Arbor, Mich.; Major S. S. LYON, of Jeffersonville, Ind.; Mr. O. ST. JOHN, of Waterloo, Iowa; Col. E. JEWETT, of Utica, N. Y.; JOSEPH SULLIVANT, Esq., of Columbus, Ohio; the late Dr. MANN, of Milford, Ohio; Prof. WRIGHT, of Hamilton, and J. DECEW, Esq., of Cayuga, Canada West.

A special tribute is paid to the late LEDYARD LINCKLAEN, Esq., of Cazenovia, with whom the author enjoyed an uninterrupted friendship of many years, and who at all times liberally aided the progress of geological investigation, and contributed to the State Museum and the Natural History publications of the State.

The drawings illustrating the species have all been made by Mr. R. P. WHITFIELD and lithographed by Mr. F. J. SWINTON, and the proof sheets have been revised by Mr. JOHN PATERSON.

ALBANY, *December*, 1866.

(K.)

INTRODUCTION TO THE STUDY OF THE GRAPTOLITIDÆ.

By JAMES HALL.

The following pages are essentially a reprint of the introduction to the descriptions of the Graptolites of the Quebec group, published in Decade ii of *Figures and Descriptions of Canadian Organic Remains.* The discovery of those remarkable Canadian forms in 1864 served for the first time to give us a true idea of these fossil remains, and to elucidate much that had before seemed inexplicable or obscure in the fragmentary portions described. The publication of the descriptions and figures of the Graptolites of the Hudson River group in Vol. i (1847) of the *New York Palæontology* had added considerably to our knowledge of their forms; but the later discoveries, both in America and Europe, have given a new interest to this group of fossils.

In the description of the general and structural characters of the Graptolites in the Canadian Decade, I have made use of New York and Western forms for illustration; and in the present instance I have borrowed from that work such illustrations as seemed to me necessary to present the characteristic features of the group without regard to locality. I still hope to present, at some future time, the results of a re-investigation and revision of the Graptolites of the rocks of New York; but as this work may be some time delayed, this introductory notice of the Family Graptolitidæ, in the interim, may be of some use to the student of palæontology.

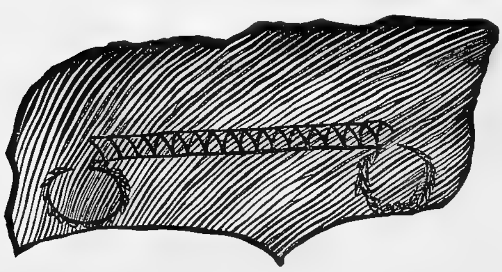
In the arrangement of the subject matter and the discussion of the parts of the Graptolite, I have followed the order of arrangement and essentially the use of the terms adopted by M. Barrande in his "*Graptolites de Bohême*," a statement which I had intended to precede the introduction to the Decade above referred to. Were we to adopt the names of parts proposed by HUXLEY and ALLMAN in their studies of the Hydrozoa, it would require some changes of the language used in the description of the parts of the Graptolite; and while there may be advantages in the application of such terms, I can see little objection to retaining those already in use.

I. Nature and Form of Graptolites.

The name *Graptolithus*, originally proposed by LINNÆUS in the first edition of his "*Systema Naturæ*" (1736), was applied by him to objects of entirely different character from those now known as Graptolites, and included fucoidal and other markings of the rock surfaces, dendrites and ruin-marble.

In the twelfth edition of his *Systema* (1767), LINNÆUS included under this generic form several species, only one of which, the *G. scalaris*, cited from his Scanian Travels, is a true Graptolite according to the modern restriction of the generic term. The figure of this species has been several times reproduced by authors; and very recently, Mr. CARRUTHERS, in the INTELLECTUAL OBSERVER, has published a fac-simile of the original, which I have copied, as well as the translation of LINNÆUS's description, from "*Skanska Resa*," p. 147. Figure 1 is fac-simile of the original figure of *Graptolithus scalaris*.

FIG. 1.



Petrefaction of Graptolites of a curious kind, found in a slab of slate that had been broken to pieces; the black characters of which, upon the gray stone, resembled a line such as might be printed by a coin on its edge, and often terminate in spiral ends.

In this case, the spiral ends can have had no connection with the linear fossil figured, but belong to a very distinct species, perhaps to *G. convolutus* of HISINGER (Pl. 35, Sup. fig. 7), or to a similar form. To all persons acquainted with these fossils, the figure of LINNÆUS represents a Graptolite so preserved as to show the cell-apertures directed, partially at least, towards the upper margin; but there has been a difference of opinion among naturalists as to whether it belongs to a species with a single series of cells (*Monograptus*), or to one with a double series (*Diplo-*

graptus), but imbedded in such a manner as to show a single series, which would accord with the description of LINNÆUS, while at the same time the oblique direction of the cell margins (serratures) is more in accordance with a Graptolite having a single series of cells; but if the upper line, limiting the linear figure, be a part of the fossil, it could not have belonged to the latter group. The fact that it is wider than ordinary forms of *Monograptus* would not, in my opinion, be a strong argument against its beloning to that group; for at that period figures of fossils were not always drawn in their true proportions. I have, however, been inclined to believe the original to have been a *Diplograptus*, partly perhaps from a name applied by LINNÆUS, and also from the fact that we meet with numerous specimens in this group presenting scalariform figures, as I have had occasion to show, while they occur more rarely and less distinctly among the others. It is scarcely probable that the figure of LINNÆUS was intended to represent a fossil with rectangular cellules, like *Climacograptus*, notwithstanding the figure of *Prionotus scalaris* of HISINGER is of that type; nor does it seem to me at all certain that the latter is identical with the species of LINNÆUS.* This question, however, is of minor consequence, since there is no longer any important difference of opinion among naturalists as to the general nature and character of the fossil referred to in this description and figure of *Graptolithus*.

Until within a few years the Graptolites were, with two or three exceptions, known only as simple, straight, or slightly curving linear stipes or stems, usually lying in the same plane upon the slaty laminæ in which they were imbedded. Nearly all these were evidently fragmentary, and though varying somewhat in their proportions, rarely exhibited anything that could be regarded as the commencement or termination of their growth or development. These bodies originally consisted of slender tubes, composed of a corneous or chitinous substance, and having more or less gibbosity; but in their flattened condition, seldom preserve more than a film of carbonaceous matter of extreme tenuity between the layers of fissile slate in which they usually occur. The slender stipes present a range of serratures either on one or both sides. Under more favorable circumstances, these serratures are discovered to indicate the apertures of cellules, symmetrically arranged in reference to each other, and to the axis of the linear stipe. Others show parallel entire margins, with transverse indentations across the central portion of the stipe.

* I have elsewhere endeavored to show that *G. scalaris* is a diprionidian form, exhibiting only one margin.

This appearance we now know to be due to the direction of the pressure upon the body exerted at right angles to the cellules, and which will be explained in the sequel.

The earliest opinion regarding these fossils was that they were of vegetable origin;* and they have been thus considered by some authors even at a very late period. Brongniart, in his great work, *Histoire des Végétaux Fossiles*, has figured two species among the Algæ. This reference was followed in the earlier part of the Geological Survey of New York, by Conrad, Mather, Vanuxem and Emmons. The animal nature of the Graptolite was first recognized by Walch, who figured two species which he describes as small toothed Orthoceratites. His view was subsequently maintained by Wahlenberg, and after him by Schlotheim, who referred them to the Cephalopoda, regarding them as extremely slender Orthoceratites. This opinion may have received support from specimens in such condition as *G. scalaris*, where the indentations are limited on each side by a continuous margin; but in such as present a single or double series of marginal serratures, the analogy seems very remote. Professors Geinitz and Quenstedt advocated the same view at a much later date; though it has since been abandoned by these authors, from more extended investigations. Bœck supposes the Graptolites may have been the arms of Radiata or Cephalopoda.

Professor Nilsson first suggested the true relations of these fossils, and maintained that Graptolites were Polyparia, belonging to the Family Ceratophyta. Dr. Beck, of Copenhagen, regarded them as belonging to the Group Pennatulidæ, of which the Linnean *Virgularia* is the most nearly allied existing form. Sir Roderick Murchison has adopted this view of the relations of the Graptolites in his *Silurian System*.† General Portlock has fully recognized the Graptolites as Zoöphytes, and has pointed out their analogy with *Sertularia* and *Plumularia*.

The relations of Graptolites with the Cephalopoda had already been fully disproved by M. Barrande (in the first chapter of his "*Graptolites de Bohême*"), before the abundant materials for the refutation were discovered in the remarkable forms of the Quebec group; and most naturalists were already agreed in referring these bodies to the Class Polypi, to which they doubtless belong.

* Bromel (*Acta Upsala*, p. 312, 1727), referred the Graptolites of Sweden to the fossil leaves of grasses.

† *Silurian System*, page 694; and letter of Dr. Beck, pp. 695–6.

More recently, Mr. M'Crady, of South Carolina, has published a paper on the "*Zoölogical Affinites of Graptolites*,"* in which he has endeavored to show the similarity of the graptolitic forms with the echinoderm larvæ, as illustrated by Müller. There is certainly much resemblance between the enlarged figures given by that author and some forms of Graptolites in the shales of the Hudson river valley; while some of the figures with central discs have a more remote analogy with certain forms from the Quebec group. Some of the toothed rods of the echinoderm larvæ likewise bear a resemblance to the Graptolites figured by Mr. Suess;† and there are still farther analogies pointed out by Mr. M'Crady, which, however, may not be regarded as of equal value by the greater number of naturalists.

For my own part, although admitting the similarity of form and of some of the characteristics which were very kindly pointed out to me by Mr. M'Crady, long before his publication, I cannot recognize the analogy sought to be demonstrated. The establishment of the fact that these toothlets or serratures are the extension of true cellules, each one having an independent aperture, and communicating with a common canal, should offer convincing argument against these bodies being other than polyp-bearing skeletons. But in following the extensive series of forms now presented to us, we have much evidence to show that some of these were attached to the bed of the ocean, or to other bodies; while the greater proportion of the species and genera appear never to have been attached to the sea-bottom.

It may not be easy to determine precisely the family to which these graptolitic forms should be referred; nor is it certain that the extensive series now presented can all properly be referred to a single family. Gen. Portlock has suggested that these bodies may constitute "several genera belonging even to more than one order."‡ That they are true Polypi, belonging to the Hydrozoa, I believe we shall be able to show, both from analogies already established by various authors, and also from their mode of development or reproduction as exhibited in some of the species.

The specimens which have usually been observed or represented are simple disconnected stipes, doubtless the dismembered or fragmentary

* "Remarks on the Zoölogical Affinities of the Graptolites, by John M'Crady, made before the Elliott Society of Natural History of Charleston, S. C., at the meeting of July 15, 1857." [Extract from the Proceedings, vol. i.]

† *Naturwissenchaftliche Abhandlungen*, Vierter Band, Tab. viii and ix.

‡ *Geological Report on Londonderry*, &c., p. 318.

portions of fronds, which, presenting in the different species great varieties of form and aspect when entire, are nevertheless composed of parts so similar that these fragments, though indicating specific differences, offer little clue to a knowledge of the entire form.

Taking these species which, in the form of their cellules and in the separated fragments of the frond, would be referred to *Graptolithus* proper,

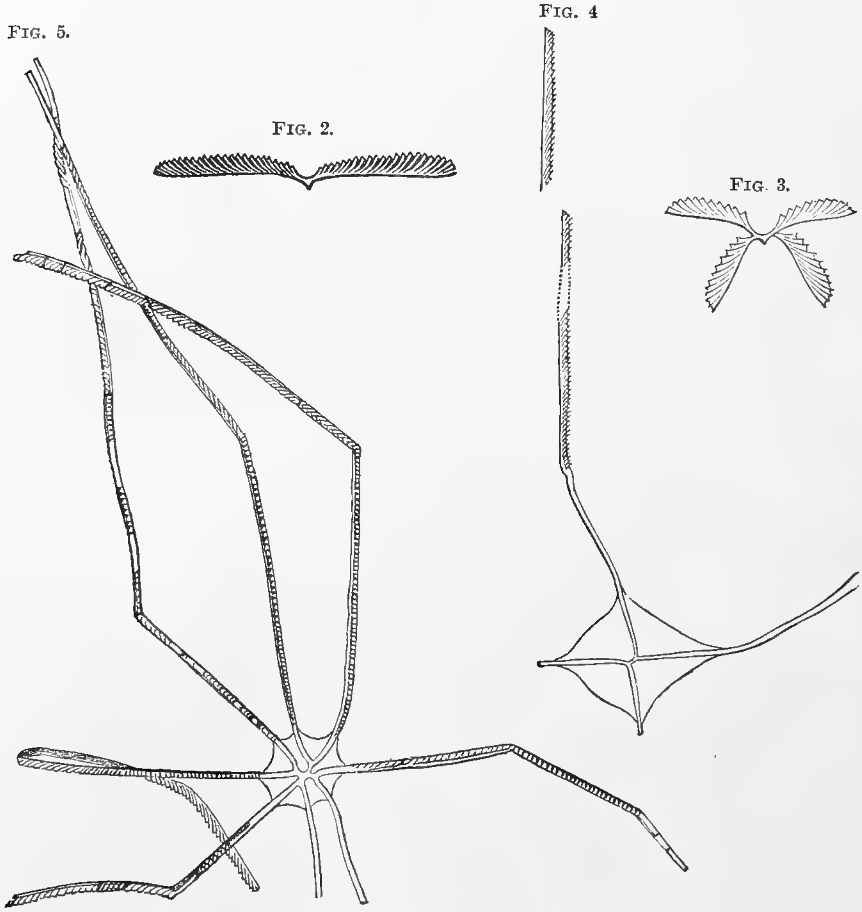


Fig. 4

Fig. 5.

Fig. 2.

Fig. 3.

and tracing them, as we are now able to do in many species, to their perfect condition, we find a great variety of form and mode of growth. In the simplest of these, we have two stipes diverging from a radicle or initial point; and the parts remain so complete as to admit of no doubt that this is the entire skeleton of the animal. The cellules near the base of the stipe are not so fully developed, while also those near the extremities have not reached their full dimensions; and the last one is sometimes barely perceptible, or just assuming its form from the common body. These characteristics are perceptible in figure 2 of *Graptolithus* (*Didymograptus*) *pennatulus*.

In the next stage we have four simple stipes diverging from an initial point, and all evidently entire, as shown in the development of the cellules in *Graptolithus* (*Didymograptus*) *bryonoides* (fig. 3).

In some species of this mode of growth, the bases of the stipes are united in a more or less expanded disc or cup of the same substance as

Fig. 6.

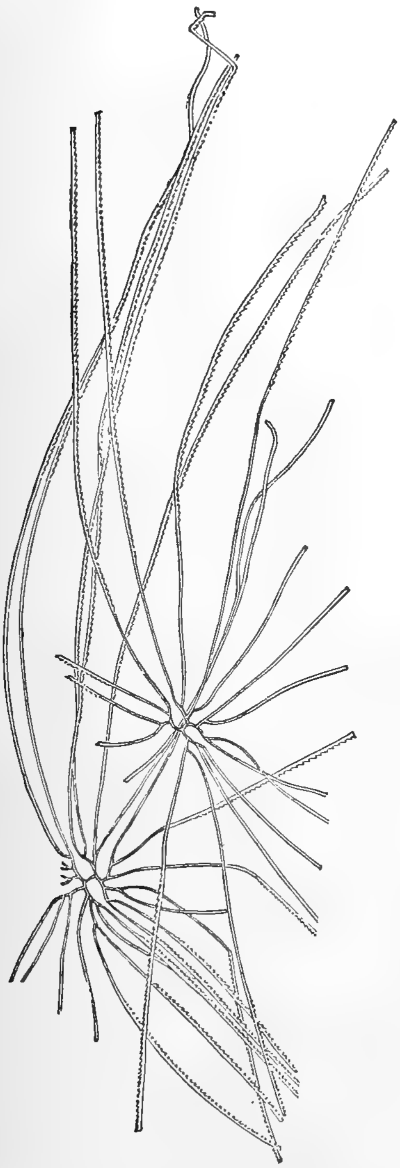


Fig. 6a.

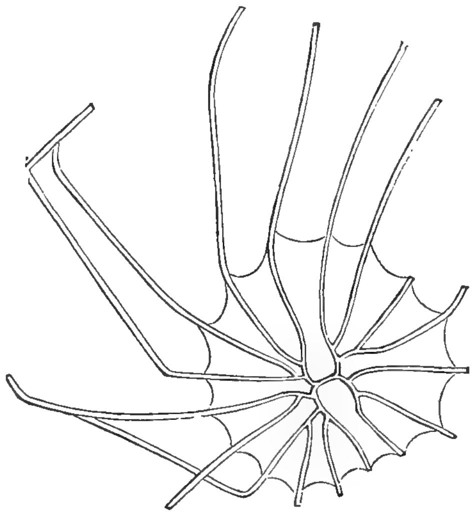
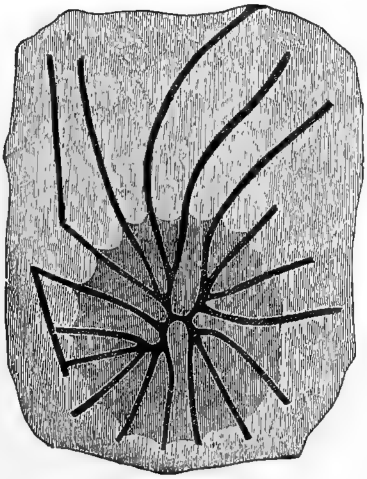


Fig. 7.



the body of the graptolite. The form of this disc is shown in fig. 4 of *Graptolithus* (*Loganograptus*) *headi*.

In a further development in the same direction, we have fronds with eight simple stipes, which may or may not be united in a central disc, as in *G.* (*Loganograptus*) *octobrachiatus* (fig. 5).

In *Graptolithus* (*Loganograptus*) *logani* (Figs. 6, 6*a* and 7), we have numerous simple stipes united in a central disc or cup; while in some specimens otherwise precisely similar, we have no remains of the disc. In all these species the parts are disposed in a symmetrical and bilateral arrangement.

The stipes of this species do not bifurcate beyond the disc, and there are no cellules below the last bifurcation. The number of stipes in different individuals varies from sixteen to twenty-five, so that this character cannot be made of specific importance. In another similar species without a central disc, *G. multifasciatus* (Fig 8) from the Hudson river formation, we have above forty stipes, which do not bifurcate, so far as known, beyond the commencement of the cellules.

Fig. 8.

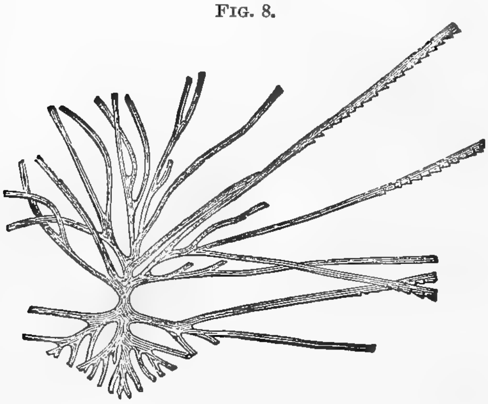
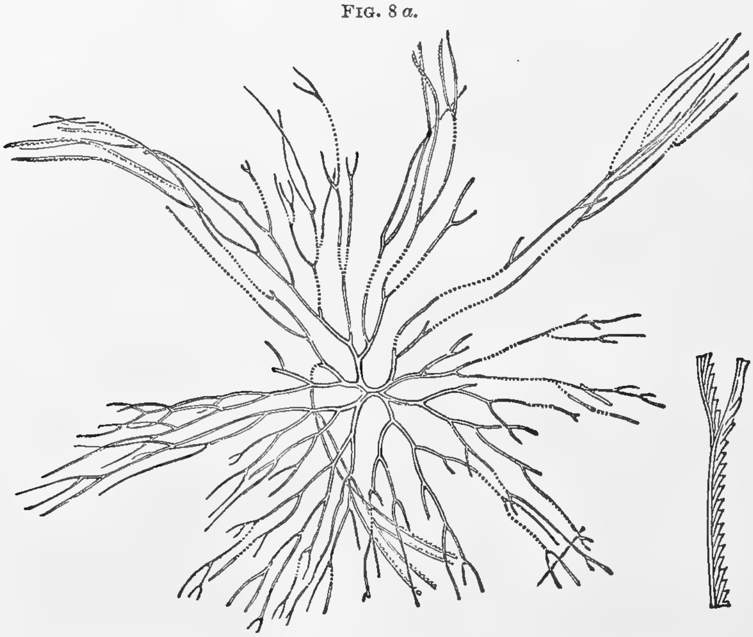


Fig. 8 *a*.



The separated and broken stipes referred by me to *Graptolithus sagittarius** of Hisinger are probably of the same species, occurring as they do in great numbers in the same beds in which this one was found.

* *Palæontology of New York*, Vol. i, page 272, Pl. 74, fig. 1.

In other species with a similar general arrangement of parts, the main stipes are frequently bifurcated; the bifurcations beginning near the base, and continuing as far as the parts can be traced in the stone as in (fig. 8*a* of *Graptolithus* (*Dichograptus*) *flexilis*, with branchlet enlarged). In some of the species of this character the cellules begin near the base of the stipes, while in one species they are not known to exist except on the outer branchlets.

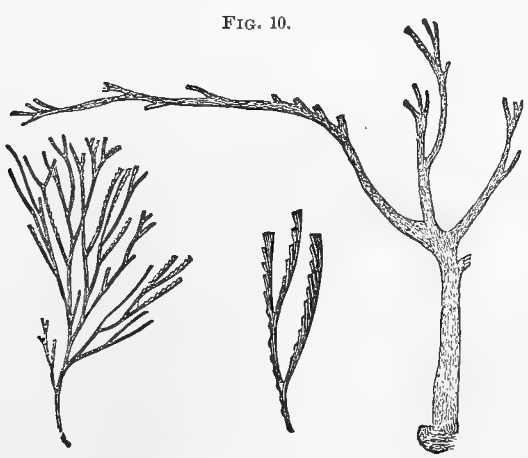
Thus far we trace these forms through what appear to be very natural stages in the progress of development of the parts, which are all constructed upon the same plan, presenting only natural and we may almost say consequent modifications.

The character of stipes and cellules in all these is such that the separated fragments would afford no means of indicating whether the part belonged to two, four, or eight-stiped species, or to those with numerous simple stipes, or with branching stipes, unless the fragment retained a bifurcation. It is on this account that I have not adopted several proposed designations for the graptolites with a single series of cells, since our collections are mostly in a fragmentary condition, which must render it impracticable with our present knowledge, to make the proper reference.

A variety of form is exhibited in the division termed Dendrograptus, in which we may conceive of the numerous stipes near the base becoming conjoined into one strong stem, with the bifurcating branchlets spreading above, and this stem probably fixed in the soil. We then have a representation of the typical forms of this genus, as in the accompany-

Fig. 9.

Fig. 10.



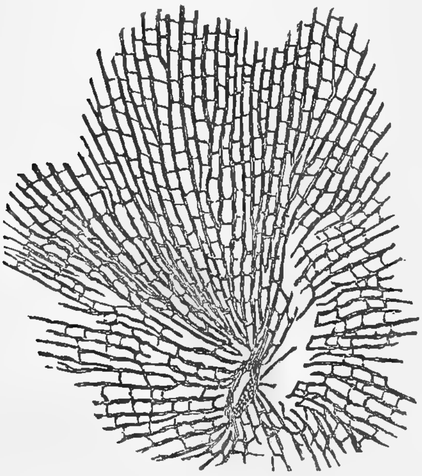
ing figure of *Dendrograptus flexuosus* (fig. 9, branchlets enlarged) and as illustrated on Plate iv of this memoir.

In the species *Dendrograptus hallianus* (figure 10), as shown in the enlargements of the branchlets, we have a form of cellule similar to that in observed fragments of the ordinary species of Graptolites. The cellules are very minute, and from the frequent ramifications, this would probably always be recognized as a branching species.

Some of the forms of Dendrograptus have slender spreading branches, and less rigid stems than the typical species, but still retain the angular cellules. From these we pass almost imperceptibly to the slender spreading forms which I have termed Callograptus (Pl. iv, figs. 13–15) in which there is, apparently, some slight modification in the form of the cellule, and the branches are sometimes united at regular intervals by slender lateral processes. Except for the dark corneous or chitinous textures, these, in their general aspect, might be regarded as slender Bryozoans.

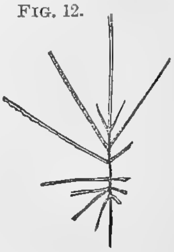
From these forms there is an almost insensible gradation to the Dictyonema, in which the branches are connected by lateral bars, at nearly regular intervals, and the whole is developed in a funnel-shaped or flabelliform frond,* with angular cellules on the inner margins of the branches, as in *D. retiformis*, figure 11.

Fig. 11.



There are certain other forms of Graptolites, which, though possessing linear, straight or slightly curving stipes and angular cellules, like the typical species, have yet a different aspect, and do not so naturally fall into the series. Among these we find *Graptolithus* (*Cœnograptus*) *divergens*, figure 12, where the bilateral relation of the parts is still shown, but the celluliferous stipes or branches are arranged on the two sides of a slender rachis, and diverge on each side from what appears to be the centre or initial point.

Fig. 12.



Among numerous specimens there are some slight variations of these characters, but not any essential differences.

Another form, which we know only in small individuals, is illustrated in figures 13–16, enlarged to twice their natural size, which remind one of some forms of the recent Genus Crisia.†

* The typical species of the genus are clearly funnel-shaped, and all the others may be so likewise; but we know some of them only in fragments, of such form as to render it impossible to determine whether the entire frond may have been flabelliform or infundibuliform.

† Should this form prove not to be the young of *G. gracilis*, it will require a new designation

FIG. 13.

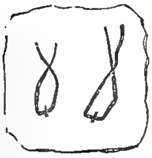


FIG. 14.

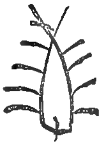


FIG. 15.

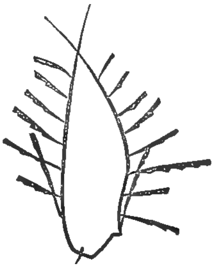


FIG. 16.

In another form with similar angular cellules, *Graptolithus* (*Cœnograptus*) *gracilis*, figs. 17, 18 and 19,* we have the following illustrations of the mode of occurrence of the species:

FIG. 17.

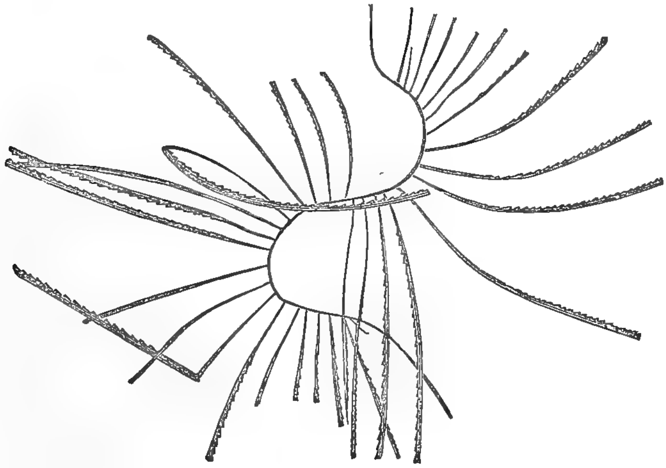


FIG. 18.

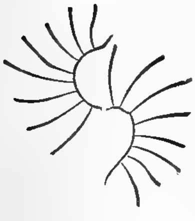
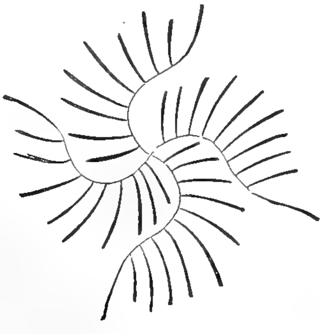


FIG. 19.

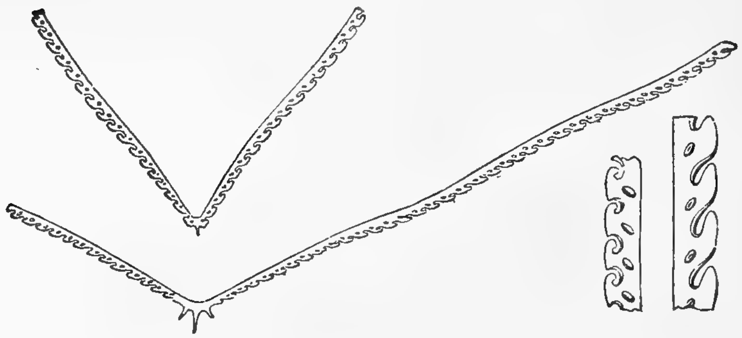


We have still another group, presenting some differences, more particularly in the development and form of cellules, than in their general features or mode of growth; and seeming in some species to unite the characters of those having a single range, with those having a double

for which the specific name of *surcularis* will be appropriate, while the entire group will require to be separated under a distinct generic or sub-generic head, for which I propose the name CŒNOGRAPTUS.

* The fig. 19 was theoretically constructed, but has since been verified by the discovery of a specimen having the same form and arrangement of parts.

Fig. 20.



range of cellules. The simpler forms of this type are similar to the two-stiped forms of the first series; but in all those, whether of two, four, or more stipes, the cellules are developed on the upper side, or that side opposite to the initial point. In species like *G. sextans*, *G. divaricatus*, and others of this type, the cellules are on the lower, or same side with the initial point or radicle. For these forms I have proposed the name Dicranograptus.

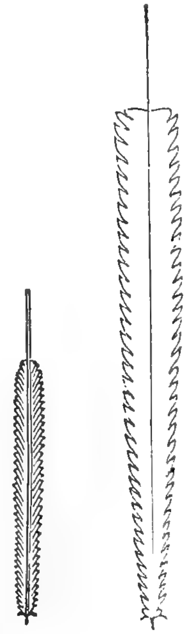
Fig. 21.

In *Graptolithus* (*Dicranograptus*) *divaricatus* (Fig. 20), the frond consists of two simple uniserrate stipes; and the same is true of *G. sextans*, except that it is united at the base for the length of a single cellule. In *G. furcatus*, the stipes are conjoined for a distance of two or three cellules above the base.

In *Graptolithus* (*Dicranograptus*) *ramosus*, as shown in fig. 21, and also in fig. 18 of Plate ii, the lower part of the stipe, for a considerable distance, has a range of cellules on each side, parallel with the axis; and becoming bifurcate above, it presents two stipes or branches, each with a single range of cellules. All the species of this group have a peculiarity in the form of the cellules, which will be noticed hereafter.

These species, in their mode of growth alone, present forms which might be regarded as intermediate between the monoprionidian and diprionidian groups; though the typical forms, *Graptolithus* (*Diplograptus*) *pristis* (fig. 22) and allied species, never show any tendency to a division of the parts of the stipe; and we shall observe, as we progress, that these forms are connected with other differences of structure.

FIG. 22.



The types of this specie (DIPRION or DIPLOGRAPTUS) are simple linear or sub-linear stipes, bearing a range of cellules on each side, often showing an initial point or radicle at the base, and an extension of the slender axis above and beyond the celluliferous portion. This axis is sometimes divided, showing it to be composed of two distinct laminæ, but this condition is extremely rare among American specimens.

From these forms with a double series of cellules, we pass to the broad filiform stipes, which are apparently composed of four semi-elliptical parts conjoined along their straight sides, and thus present four ranges of cellules. These cforms (PHYLLOGRAPTUS) are, in some species, broad and short, while others are elongate, with sub-parallel sides, as shown in figures 23 and 24 of *Phyllograptus angustifolius* and *P. typus*, and it may not always be possible to distinguish them from DIPLOGRAPTUS.

FIG. 23.

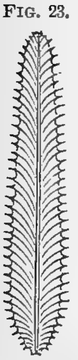
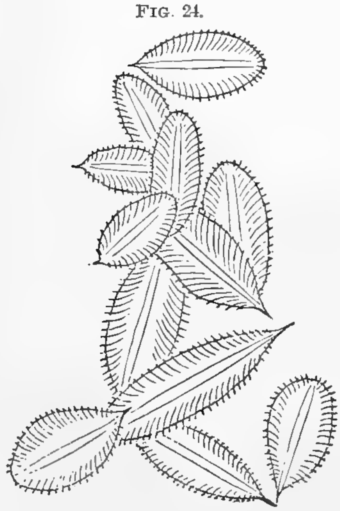


FIG. 24.



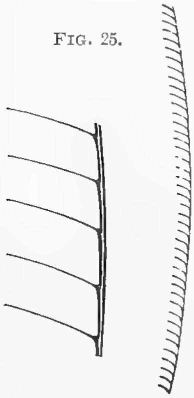
From the occurrence of a large number of these leaf-like stipes, sometimes crowded together in a small space, I have inferred that they may have grown in the same manner as RETIOGRAPTUS (Plate iv).

Following the forms with a double series of cellules, are those of similar general form, the RETIOLITES, which are known only as simple stipes (Plate i, figs. 20 and 21).

In RETIOGRAPTUS, the separate parts consist of simple elongate stipes with the axis projecting at either extremity; and in one form (Plate iv, fig. 9), we have the stipes connected by slender basal extensions of the axis, and the whole united in a spreading frond, in a manner not unlike some of the Graptolites (MONOGRAPTUS) proper, with the parts in bilateral arrangement.

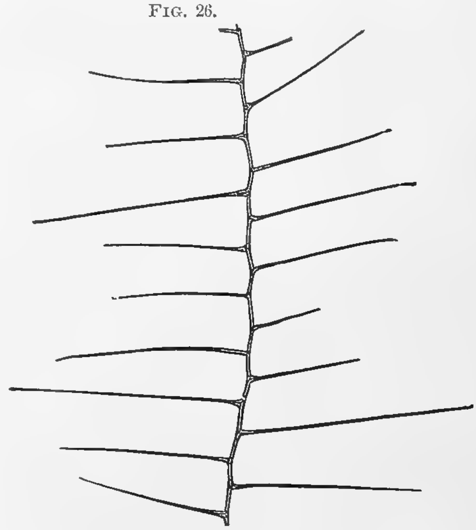
In the Genus RASTRITES of BARRANDE, we find a departure from all of the preceding forms, in the slender stipes with delicate slender tubular cellules. The species of this genus, so far as known, have the cellules developed on one side only of the stipes or branches; though there seems no reason why we should not have species with cellules upon the two sides of the axis (fig. 25, *Rastrites barrandi*).

FIG. 25.



The species for which I have proposed the name THAMNOGRAPTUS, consist of slender cylindrical stipes and branches, some of them very similar in general aspect to RASTRITES; but the alternating branches are long and slender, and we have found no appearance of cellules on any part of the specimens known.

FIG. 26.



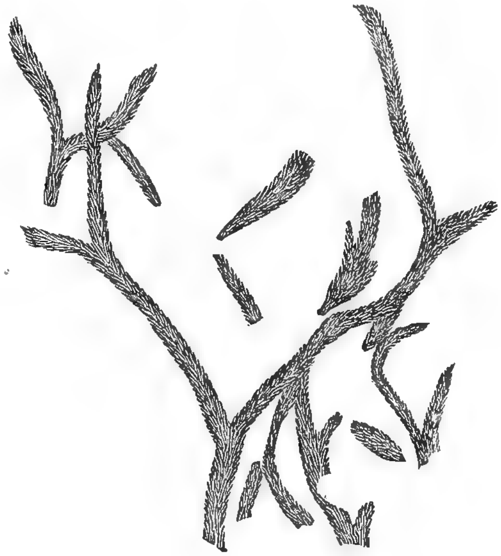
In *Thamnograptus typus* (fig. 26), the branchlets are given off alternately on the opposite sides of a stipe or rachis, and the slender solid axis can be traced from the main stipe into and along the centre of the branchlets. The analogy between these forms and the celluliferous Graptolites of the preceding illustrations does not appear to be very intimate, but they occur in the same beds, and the fossil has the same texture and substance.

FIG. 27.

In the Genus PTILOGRAPTUS (Plate iv), we have a somewhat analogous mode of growth, but there is always an aspect or expression of the fossil which distinguishes it from THAMNOGRAPTUS. In one species of PTILOGRAPTUS, moreover, cell-apertures have been detected on one side of the branches or pinnulæ.

In the BUTHOGRAPTUS (fig. 27, *B. laxus*, enlarged), we have a form bearing some analogies with the preceding; but the rachis is flexible, and is not known to be branched, while the slender alternating pinnulæ are flat and simple, as they have been observed in numerous individuals. The specimen represented is even less curved than the usual condition of this species in the slaty Trenton limestone of Wisconsin.

FIG. 28.



Still more obscure, and perhaps remote in its analogies with Graptolites, is the Genus INOCAULIS, consisting of flattened scabrous stems, associated with DICTYONEMA in the shale of the Niagara formation, which, from their carbonaceous substance and apparent graptolite texture, I have referred to the Graptolitidæ (fig. 28, *Inocaulis plumulosa**).

II. Structure of the Graptolite.

In the study of the HYDROZOA, some terms have been applied to these bodies and their several parts which are equally applicable to the Graptolite family, as one of the same order of animal structures. The word "POLYPARY," a term long in use among the Zoöphytes, embraces the entire animal body whether simple or compound, and is perhaps preferable to the simple "*frond*" or "*stipe*," which are properly botanical terms. In the nomenclature adopted for the HYDROZOA, the parts developed by the nutrient and generative functions have given origin to the term "*trophosome*" for the one and "*gonosome*" for the other; and the term "*cænosarc*" not only applies to the common body or common fleshy basis of the colony, but to the individual polypites occupying the cells or "*hydrotheca*." The initial point or radicle is termed the "*hydrorhiza;*" the non-celluliferous portions, or the part intervening between the initial point and the commencement of the cellules, is termed the "*hydrocaulus;*" and the reproductive or generative buds are termed "*gonophores*."

There may be many advantages in the use of these terms, though they do not cover all the ground required by the Graptolites, which pre-

* The specimens of this fossil are extremely obscure, and the figure does not properly represent its characters. It is not however, a solid stem; and though, as has been asserted, it may not belong to the Graptolitidæ, no other relation has yet been proved.

sent a certain development of form and parts not met with in the ordinary forms of Hydrozoa. The central disc of the compound forms requires a special designation: and the little bar or funicle connecting the two halves of the frond or polypary should be distinguished from the barren portions of the stipes or branches which rise from it, and we must still use the distinctive term "*solid axis.*"

In the present paper, I shall have less hesitation in the use of the simple and more easily understood terms, because the larger proportion of copies will fall into the hands of those who will more readily comprehend and apply them. Following the preceding discussion of the general character and forms among the Graptolitidæ, we proceed to consider the different parts, beginning with the initial point.

III. Central or Basal Portions of the Graptolite.

1. The radicle, or initial point (*hydrorhiza*): 2. The funicle, or non-celluliferous connecting portions of the compound fronds, and the barren portions of the stipe (*hydrocaulus*): 3. The central disc.

1. THE RADICLE, OR INITIAL POINT.

In the most simple forms, or those with two stipes, as shown in the figures on Plate iii, there is a slender initial process, which I have termed the radicle. This presents a greater or less development in the different species; in some being reduced to a mere pustule, or scarcely perceptible point, while in others it attains a quarter of an inch or more in length. Although in none of the species with a single range of cellules does this part show absolute evidence of having been attached to any other substance at the maturity of the fronds, yet it is possible that in the earlier period of its growth, the body may have been temporarily attached at this point to the sea-bottom or to some other object; though all the evidence is opposed to this view.

In some of the bi-celluliferous forms, and probably in all of them, there is a somewhat similar extension below the base of the celluliferous portion of the stipe, though it is usually more slender; but whether this is always the true initial point of the whole body, or whether it is only the broken point of attachment to a frond, may sometimes admit of doubt. It is conspicuous in *Phyllograptus typus;* and we observe this feature also in *Retiograptus;* but in one species of this we learn that it is only a broken process of attachment of the individual stipe by its solid axis, which existed as one of the members of the entire frond, the true initial point of which would be in the centre of the whole (Plate iv, fig. 9).

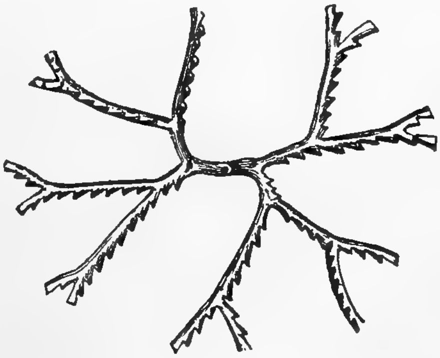
In all the forms of Graptolitidæ which appear to have been free, the initial point or radicle is in fact the commencement of the *solid axis*, which will be noticed farther on. In those Graptolites with two simple stipes, the little radicle-like process enlarges above, and the stipes, diverging in opposite directions, are closely united at their bases, and the cellules often begin almost in the axil between the two (Plate iii, and figs. 1 and 2, page 173).

2. THE FUNICLE.

In the Graptolites with four stipes, the condition appears like that of two individuals of the two-stiped forms, conjoined by a straight connecting process of greater or less extent, with the initial point in the centre, though often obscurely marked. This connecting process is *always destitute of cellules;* and this, with its divisions, I have termed the funicle.

In those forms with eight stipes, the funicle is twice divided at its two extremities; and where there is a greater number of simple stipes, it is correspondingly subdivided. Neither the central portion, nor any of its subdivisions, become celluliferous; and there is usually more or less of the stipe above these subdivisions, both in the simple as well as the compound forms, which is barren or non-celluliferous (the *hydrocaulus*). It is only beyond the last subdivisions of this part of the body, in such forms as *Graptolithus logani*, that the celluliferous parts of the true stipes commence.

FIG. 29.



In one of the proper branching forms, however, the cellules begin immediately beyond the first subdivisions of the funicle, as in the four-stiped species (*Graptolithus milesi*, fig. 29).

These barren or non-celluliferous portions of the graptolitic body, are not otherwise essentially different from other parts of the stipe. In the absence of cellules, they are consequently more cylindrical, and apparently more solid, as if the test were thicker and the interior canal less developed than in the other parts of its extent.

3. THE CENTRAL DISC.

In several of the species having four simple stipes, in one species with eight, and in another with a larger number of simple stipes proceeding from a common centre, we find their bases united by a thickened corneous expansion of the same substance as the body of the Graptolite. This appears to be composed of two laminæ, which, at least, in the central portions are not conjoined, and the space is probably occupied by some softer portion of the animal body (Plate iii, and figures 3, 4 and 6, pages 173, 174 and 175).

The substance of the disc sometimes extends along the margins of the stipes, producing an alation, which may be observed in a slight degree in the figures referred to; while in one species (*G. alatus*), the extension is twice as great as the width of the disc, extending an inch beyond the axil.

This arrangement of the parts of the body seems obviously adapted to give strength and support to the bases of the stipes; but beyond this it probably serves other purposes of the animal economy. In several specimens of *G. bicornis* there is a disc or bulb at the base of the stipe, which, spreading between the two oblique curving processes, envelopes, in the compressed condition of the specimens, some of the celluliferous part near its base. In other specimens we have a crescent-shaped extension, as if the disc were in process of development, or perhaps of absorption. Much the larger proportion of the specimens of this species, however, are destitute of disc or bulb, and have every appearance of being complete without this appendage.

These aspects of the species are shown on Plate ii, figs. 13, 15, 16 and 17.

Many of the young individuals, or those in which the earliest development of cells is perceptible, are enveloped in a sac or sheath, which may perhaps perform some nutritive office in the devolopment of the germs.

How far the bulb-like appearance at the base of some of the species of *Dendrograptus* may correspond to the disc or sac of *G. bicornis* and others, I have not at this time the means of satisfactory determination.

IV. Nature and Parts of the Stipe Proper.

1. The solid axis: 2. The common canal—common body, or *cœnosarc:* 3. The calycles or cellules (*hydrotheca*): 4. Nature and ornaments of the test.

1. THE SOLID AXIS.

All the Graptolites proper are provided with a slender solid axis,* while this feature has not been satisfactorily proved in regard to *Dictyonema*, and some other forms.

In those species having a single series of cellules, this axis is upon the back of the stipe, or on the side opposite to the celluliferous margin; and in the branching forms it is subdivided, following all the ramifications and holding the same relation to the cellules. In all the specimens where it has been observed, it is a slender cylindrical or flattened filiform solid body. In some extremely compressed specimens this axis appears as a slender elevated ridge along the back of the stipe; and where the substance of the body has been removed, it leaves a narrow groove along the margin of the impression.

In the examination of large numbers of specimens of the monoprionidian species, of America, we have never found the axis prolonged beyond, or denuded of, the cellules; as shown in *G. colonus*, by Barrande, in his *Graptolites of Bohemia* (Plate ii, fig. 5 of that memoir). In all the specimens where the extremities of the stipes are entire, there is never any extension of the axis beyond the last partially developed cellule; and the number of specimens in this condition is considerable.

In the Graptolites with two series of cellules, the solid axis is very frequently seen extending beyond the celluliferous portion of the stipe at its distal extremity, while the radicle is the continuation of the same below the base of the cellules. The axis thus appears to be the foundation on which the other parts are erected, being in these forms a condition of their growth, and existing from the first appearance of the germs as shown in several figures upon Plate i. In those older specimens, however, which present so great an extension of the solid axis beyond the common body, the cellules may perhaps have been removed by subsequent causes; or, in such cases, the absence of this extension of the axis may be due to its having been broken off. It should be remarked, however, that none of our specimens having this character show any evidence of the breaking or tearing away of the cells, nor do the cells on one side extend beyond those on the other; a condition we should expect to find, had they been partially removed by maceration.

* In those species with a single series of cellules, M. Barrande has ascertained that this axis is solid and cylindrical, its diameter not exceeding ¼ millimetre, and its structure apparently fibrous (*Graptolites de Boheme,* page 4).

I am able to corroborate, to some extent, the observations of M. Barrande in regard to the apparent double character of this axis. In some extremely compressed specimens, it is marked by a longitudinal groove or line of division;* while in others, a double impression has been left by the removal of the substance.

In some specimens, particularly the younger ones, the solid axis has been seen extending beyond the base of the stipe, as a duplicate process, exhibiting a character as of a double radicle. In several species there is on each side a lateral process of similar character, extending rectangularly or obliquely downward from the base of the lower cellules, and usually having a greater length than the initial point itself. This feature is shown in the germs and young Graptolites on Plate i, and in figures of *Graptolithus* (*Climacograptus*) *bicornis*, Plate ii. The same feature is shown in a more extreme degree in *G.* (*C.*) *atennarius* of the Quebec group.† In some solid specimens of one species, where the tube has been filled with calcareous mud, I am able to detect only a single round point in the centre of a transverse section; and a longitudinal section of the same species presents a slender filiform axis. It may be, however, that the parts are so minute and so closely united, as to render them undistinguishable.

In another species, with two rows of cellules, and in which the latter are of very different form from the preceding, the solid axis is a thin flat apparently double plate, extending across the entire transverse diameter of the tube, which is more than two-thirds as great as its longer diameter. The place of the axis is marked by a longitudinal groove on each side, not in a direct line, but slightly undulating to correspond with the cellules (Plate ii, fig. 10). M. Barrande conceives that the joining of the two plates of this axis may leave a very flat intermediate tube; and in our specimen, there is apparently an extremely narrow space between the two. He farther supposes that each of these plates, composing the double axis, is separable, by decomposition, into two laminæ, as illustrated in Plate iii, fig. 3, of the work already cited.

The entire appearance of the species (Plate ii, fig. 10), is that of two monoprionidian stipes joined together at the back, the line of junction being indicated by the groove.

In one species of Retiolites, there is a strong eccentric or sub-exterior axis, which is nearly direct; and in the same individual there is another

* The aspect presented by the axis, when marked by a longitudinal groove, is precisely that which a hollow cylindrical body would have if extremely compressed.

† *Graptolites of the Quebec Group*, Decade ii. *Geol. Survey of Canada*, Pl. 13, figs. 12 and 13.

undulating axis, to which the cell-divisions of one side are attached. In the RETIOLITES of the Quebec group, one side of the stipe shows a very distinct axis, while upon the other side it is very obscure.*

In RETIOGRAPTUS, we have a very distinct central axis projecting below the celluliferous portion of the stipe, and in one species, uniting in a funicle, and forming part of a compond form. In another species, the simple stipes present similar features, showing at one extremity the duplicate character of the axis.

In PHYLLOGRAPTUS, the central axis is apparently composed of four slender flat laminæ; but we have had no means of examining this part of the body in a satisfactory manner.

2. THE COMMON CANAL,--COMMON BODY OR CŒNOSARC.

In all graptolites with a single series of cellules, there is, between the bases of these cellules proper and the solid axis on the back of the stipe, a continuous sub-cylindrical space or canal, which, in the living condition, has been occupied by the common body of the polyp, from which the buds, with their calycles forming the cellules, take their origin, and are given off at regular intervals.

All the specimens examined confirm this view; and in some of the species where the extremities are apparently entire, we observe the incipient development of the young cell from the common body. In those specimens filled or partially filled with the substance of the surrounding rock, this canal is easily distinguished; while in compressed specimens there is always a flattened space between the bases of the cell-partitions and the solid axis.

In those graptolites with two ranges of cellules, we have apparently a duplication of those with the single series, the two solid axes being joined together, leaving a common canal or body on each side at the base of each series of cellules. If, however, the common body were always thus divided, it would be by the sold axis becoming a flattened plate. This appears to be true of some species (as for example, fig. 10, Plate ii); while in others there is only a simple filiform axis visible, as in CLIMACOGRAPTUS. In this case, of course, there is not an entire division in the common canal or body, after the manner of some other species. This

* The assertion made by some late writers that RETIOLITES has no solid axis, is not sustained by any specimens we have seen. The original description of BARRANDE, that it has no solid axis as in DIPRION = DIPLOGRAPTUS, I suppose may be understood as meaning no dividing axis, which probably exists in all that group proper; while CLIMACOGRAPTUS has a filiform axis, not very unlike the axis of RETIOLITES.

feature is shown under the illustrations of the structure of these bodies on Plate ii.

In Retiolites, the common body occupies the central portion of the stipe, giving origin to a series of buds or polypites on each side, while the central axis is filiform and does not divide the interior canal.

In some species, the common body seems also to have more extensive functions; for in such forms as *G. divergens* and *G. gracilis*, there is a long slender rachis, or tubular body, destitute of cellules except at its two extremities, and apparently consisting of a solid axis and a common body, from which originate, at regular intervals, simple small stipes with solid axis, common canal, and cellules.

This appears to be one step farther in our knowledge of the origin or mode of devolopment; but it shows that a common body or main axis may produce in one part celluliferous stipes, and its extremities develope only cellules, as we see in the continuation of the main axis of *G. gracilis*, and G. *divergens*, where the continuation of this common rachis is marked by marginal cellules of the same character as those of the lateral stipes.

The common body (*Cœnosarc*) appears to perform in this case the double function of developing the buds—polypites, which elongate into stipes with cellules, and also of simple cellules at its two extremities; or we may consider the celluliferous extremities of the rachis, or main axis, as analogous to one of the lateral celluliferous stipes. These individual stipes, if separated from the main axis, would have the appearance of entire graptolites with the attenuate lower extremities; and it seems to me not improbable that some of the simple monoprionidian species, which have been regarded as entire bodies, may in fact be only the separated portions of fronds like that of G. *gracilis* and similar forms.* In the Sertularians we have something analogous to this mode of development. Some of the species have cellules along the common or main trunk, and produce at intervals branches or branchlets in place of cellules; others have a common body, or main stem, entirely destitute of cellules, but producing branches on each side (opposite or alternate, as the case may be), which branches bear cellules only.

So long as this rachis gives off only celluliferous stipes, it is analogous to those parts of the simple Graptolites which I have termed the funicle, having within itself the sources of this development of the several parts. The mode of development differs from that of the branching forms, inasmuch as the branches proper arise from a division of a cell-bearing

* [See also Cyrtograptus; Carruthers, *Geological Magazine*, 1868.]

stipe or branch, and of course a division of the solid axis and common body.

In RETIOGRAPTUS, some specimens show the cell-divisions reaching nearly to the axis, leaving room on each side for a narrow common body or canal; while in a species from the Utica slate, which presents one side of an entire frond, the cell-divisions of the exterior side all reach to the axis, leaving the common body on the other side.* In a species from Norman's Kill, near Albany, there are three parallel ranges of reticulations, with apparently two filiform solid axes, forming the divisions between the three meshes. This structure probably occupies one side of the stipe, while the common body may occupy the other side.

In PHYLLOGRAPTUS, the cell-partitions reach very far towards the centre, and the space left for the common canal is very small. We infer from the better preserved specimens, that there is a slender common canal at the base of each range of cellules. These several canals may or may not communicate with each other.†

3. THE CALYCLES OR CELLULES.

Since a large proportion of the specimens of Graptolites which come under our observation for the purposes of study or otherwise, are fragmentary, it becomes of much importance to know the general characters of form and mode of development of the cellules.

In the preceding section it has been shown that the cellules, or the inhabitants of these cellules, are not independent, but all have their origin in a common body which fills the longitudinal canal, and that they remain in constant connection with the same throughout their existence.

The calycle or cellule is formed by budding from one side of the common body, not unlike many of the Sertularians, except that the cellules are generally close together at their origin. They are usually more or less oblique to the direction of the axis, as is clearly indicated by the cell-partitions; and the degree of obliquity often indicates specific distinction. The cellules are for the most part contiguous at their origin,

* The expression here used is from an idea that the original form of the frond is funnel-shaped; and the inner side, upon which the common canal would be visible, now lies against the stone.

† Mr. CARRUTHERS, in his recent paper on Graptolites, assumes that PHYLLOGRAPTUS has no common canal or common body; but I do not know on what evidence this view is based. There seems to me a narrow semicircular space at the base of each cellule; and these, communicating longitudinally, form the common canal which is occupied by a continuous body or *cœnosarc*.

and they sometimes remain in contact throughout their entire length; but in the greater number of species, there is a small portion of each one free on one side towards the aperture. This character is shown in numerous examples (Plates i, ii and iii).*

In some forms the cellules are contiguous in their lower portions, while the entire upper or outer part becomes free, as seen in G. *clitonensis* (Plate i, figs. 1, 2 and 3); while in one of the bi-celluliferous species from Iowa, the cellules are distinct from each other at their origin, and the upper extremity of one scarcely reaches to the base of the next in advance (Plate ii, fig. 10), and they are therefore not properly in contact in any part of their length. The same is more emphatically true of RASTRITES where there is a large interval between the bases of the cellules, which are often nearly rectangular to the axis.

The earlier or first developed cellules are always smaller than those following, and they reach their full development at different distances from the base or axil, in different species. Towards the distal extremities the cellules usually become gradually smaller, to the last one, while sometimes they become abruptly less and less; the latter feature probably occurring in young and vigorous growing individuals, while the gradual diminution is apparently characteristic of an approach to maturity.

Although we regard the cellule as limited by the cell-partitions, yet in well-preserved specimens there is sometimes a swelling of the test of the common body below the cellule, indicating an enlargement of the parts at the bases of the polypites. In one species there is an evident

* The mode of budding and the form and arrangement of the cellules in the Sertularians are shown in the accompanying figures of two species of SERTULARIA (figs 1 and 2) from our own coast. Fig. 3, with a range of cellules on one side only, is a PLUMULARIA.

FIG. 1.

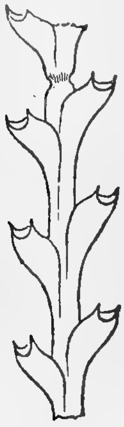


FIG. 3.

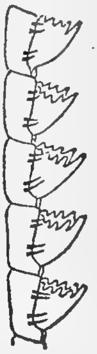
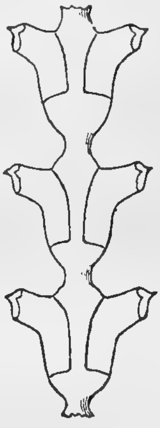


FIG. 2.



undulation of the axis, corresponding to this enlargement of the parts in the common body (Plate ii, figs. 10 and 11).

In the diprionidian species, the cellules on the two sides of the stipe are alternating, so that the bases or the apertures are opposite the space between two others. This is more especially shown in figures 10 and 12 of Plate ii.

In much the larger proportion of species, the body of the Graptolite and the cellules are so extremely compressed, that they appear only as serratures along the margin, with distinct impressed lines marking the cell-divisions. The exterior margin of these serratures indicates in an approximate degree the outline of the aperture; and the frequently occurring mucronate extension at the extremity of the cellule is produced by the continuation of the cell-partitions, or sometimes by an outgrowth from the margin of the stipe above or below the aperture.

Were the cellules isolated, their prevailing form would be that of an elliptical tube or sac, the length of which is greater than either of the two diameters. When they are in juxtaposition, however, the contiguous sides are flattened, while the lateral or external surfaces are usually more or less curved, particularly near the aperture. In a larger proportion of the species, the calycle becomes slightly expanded towards the aperture; but in a few examples there is a distinct contraction above the middle, and the aperture is smaller than the base. Generally, however, the smaller diameter is just at the junction with the common body, or at the junction of the cell-walls with the walls of the common canal.

In a single diprionidian species, where the specimens are not distorted by pressure, a longitudinal section of the stipe in the direction of its greatest diameter (Plate ii, fig. 12), shows the cellules scarcely narrowed at their origin with the common body; while in a lateral view of the specimen, the base of the cellule is seen to be much wider than the orifice (Plate ii, fig. 10).

In many of the species a transverse section of the cellule near the base is quadrangular, becoming more rounded towards the aperture; and when the upper part of the cellule is free, the aperture is round or elliptical, and in some specimens the calycle is elliptical or cylindrical throughout its entire length. We have examples of the quadrangular cellules in *G. extensus* (Plate iii, fig. 12) and *G. octobrachiatus* (Plate iii, figs. 25 and 27); as well as in one species of *Phyllograptus* (Plate iv, figs. 1, 2, 4 and 5). Where the cellules are more nearly isolated, they approach more and more to the cylindrical form, as in *Rastrites.* As examples of cellules contracted towards the aperture, we have *Graptolithus priodon*, BARRANDE, and *G. clintonensis*, HALL (Plate i, figs. 1, 2 and 3).

M. BARRANDE has remarked that from the circumstance of the partial or complete isolation of the successive alveoles of the same series, we may easily conceive that the walls of contact in contiguous cellules should be double. This fact he has ascertained from decomposing specimens of *G. priodon;* and we have the same evidence in some of our species. In the cellules of the ordinary mode of development, each one is an independent part of the organization, and is provided with its individual body and cell-walls, as if each cellule were isolated. Whenever two of these are in contact, the cell-walls coalesce as far as the contact continues; but when becoming free, the cellule assumes its normal condition. In some specimens of PHYLLOGRAPTUS we find this evidence of double walls in the cell-partitions.

In *G. putillus*, illustrated on Plate ii, figs. 10, 11 and 12, the cell-walls, although contiguous to and adjoining the walls of the body (and not free), do not coalesce, but are readily separable without fracturing their substance, and the same is true of *G. clintonensis.*

There are cellules, however, where the production of the calycle by budding from the common body is not so obvious. These forms are like *G. bicornis* and *G. anttennarius*, where the orifice is a simple transversely-oval aperture in the side of the stipe; and in the flattened specimen, it appears like a rectangular or slightly oblique semi-oval notch in the margin. Its true form is perceived only when the cavities of the polyp have been filled with mineral matter, or when the stipes are flattened vertically against the apertures: they then give the form which has been described as *G. scalaris.* This form of cellule is shown on Plate ii, figs. 1 and 2, which are enlarged from a specimen retaining nearly its original proportions. Just within the limits of the cellules, and extending the entire length of the stipe, there is a longitudinal depressed line; and along this line, and running thence almost rectangularly to the outer limits of the stipe just above the aperture, the cell-partitions join the exterior test, and project in an extended border or flange.

In specimens stripped of the test, where the interior has been filled with stony matter, the cell-partitions present the appearance shown in Plate ii, fig. 3; while there is a large central space apparently occupied by the common body, but without the appearance of a central axis on the exterior surface. When the surface is ground down to a plane intermediate between the exterior and the centre, it presents the aspect of fig. 4; and when the cutting is carried to the centre, it gives the characters of fig. 5, the cell-divisions apparently reaching to the axis.

The general form of this stipe in section (fig. 6), approaches that of RETIOLITES, as shown by BARRANDE and GEINITZ; and in the arrangement of the common body and axis, there is a departure from the typical diprionidian forms of GRAPTOLITHUS. In this transverse section we have a somewhat concavo-convex form, which is narrower on the concave side. There is a central or sub-central point indicating the filiform solid axis; and on each side of this are the divisional cell-walls, which produce a slight contraction of the exterior walls of the stipe at the inner limit of their attachment. Another section (fig. 7), shows the same features, together with the remains of two other cell-divisions, neither of which reach to the exterior walls of the Graptolite; and the one on the right hand shows the narrow extremity just before joining the axis.

These sections, together with numerous other longitudinal, transverse and oblique sections, compel us to conclude that this Graptolite possesses a filiform central or sub-central apparently solid axis; and that the cell-partitions originate from, or are joined to this axis. These cell-partitions appear to consist of triangular plates, which have an unequally arching or convex upper surface, and a concave lower surface. This form of cell-partitions would leave the alveoles to communicate at their bases with the common body on each side.*

In some forms having cellules of this character, as in *G. bicornis* proper, there is, in the flattened stipes, an external ridge, as if indicating the junction of the axis with the external walls. But in examples where this axis extends beyond the celluliferous portion of the stipe, it is compressed, having the aspect of a flattened cylindrical filiform body. It has no appearance of having been flat, or laterally extended within the body of the stipe.

In the ordinary forms of Graptolites, the orifice of communication between the cellules and the common body is usually round, oval or quadrangular; and this appears to be true of all the species with a single range of cellules, and also of the ordinary forms of those two ranges of cellules where the common body is divided by a longitudinal axis.

* The cell-partitions in this form of Graptolites are represented as they appear to exist in the solid specimens examined, on Plate ii, fig. 9, where, curving gently downwards on their exterior margins from the upper edge of the orifice, they turn more abruptly towards the axis, while the central portion extends obliquely to the axis, leaving a broad arch above, which gradually becomes angular as it approaches the axis.

In Retiolites, where there is no well-marked division limiting the common body, the union of the cellules with it is not so well defined; nor does there appear to be, in these forms, a continuous cell-partition: the cellules open in a quadrangular aperture, which is a little oblique to the transverse diameter.

In those Graptolites with the simple transversely-oval orifices in the test, as *G. bicornis*, the arrangement of the common body and the communication of the cellules differ from all the other forms. There is an apparent double communication with the common body, giving not only the usual bilateral arrangement of the parts generally, but a bilateral arrangement of the parts in the individual alveoles.

The external orifice of the cellule in Graptolites is extremely variable in form, and in its relative direction to the body of the cellule and to that of the general axis. In a large proportion of the species, the aperture is oblique to the axis of the cellule, a little expanded, and thickened at the margin. The lower or posterior edge is often prolonged into a mucronate point or expansion. This feature, combined with the various degrees of curvature at or near the aperture, produces a great diversity of external expression in the orifice.

In *G. nitidus* and *G. extensus*, Plate iii, the plane of the orifice is nearly rectangular to the axis of the cellule; while in *G. bifidus* and *G. pennatulus* and others, the margin is produced into a strong mucronate extension. In *G. octobrachiatus*, the line of the cell-margin makes an angle of more than 90° with the axis of the cellule.

In mature individuals of *G. clintonensis* the upper part of the cellule is recurved, and the orifice opens downward nearly at right angles to the general axis, having a slight spreading and thickening of the border. In less mature individuals the orifice is apparently angular, and opens upward, while the plane of the aperture makes less than a right angle with the direction of the general axis. It would appear that in the progress of growth the cell-walls are continued, gradually contracting above, and, after becoming free from the adjacent cellule, form a slender gradually curving tube, which, in mature individuals has its orifice directed backward.

In Dendrograptus, the form of the orifice and outline of the aperture present variations similar to those of the simple uniserrate Graptolites; but some species show modifications in the form of the cellule which do not accord with the more simple species of the genus. In Dictyonema, the cellules are not fully known; the orifices are marked by a prominent mucronate extension, and apparently simulate the more common forms of Graptolites (Plate i, fig. 5).

In the bicelluliferous species the compressed specimens present the plane of the orifice, sometimes rectangular to the general axis, sometimes with the outer margin a little advanced, making an acute angle with the axis of the cellule; while sometimes the plane of the margin of the aperture is rectangular to the axis of the cellule, or rarely makes with it an obtuse angle. The cellules of Retiograptus, which have not yet afforded means of satisfactory examination, apparently have their orifices nearly rectangular to the general axis of the stipe.

In one of the forms of the bicelluliferous Graptolites, the cellules are sub-elliptical tubes, with an orifice of corresponding form, without extension beyond a slight thickening or callosity at the margin of the orifice. The plane of the cell-aperture in this one makes an obtuse angle with the direction of the general axis.

In forms like *G. bicornis*, the external orifice is transversely oval, with or without a projection and thickening of the test from the cell-partition above the orifice, or extension of the test.

4. ORNAMENTS OF THE TEST.

The compressed condition in which the Graptolites usually occur, is unfavorable to the preservation of any minute surface-markings, or ornaments of the test.

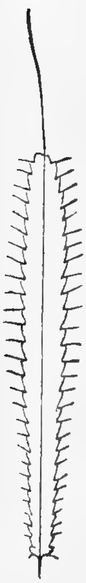
In many of the species, fine striæ, parallel to the margins of the cell-apertures, are perceptible, and in the larger number of species this marking is all that is preserved. There is sometimes a granular appearance of the surface; but I have not been able to satisfy myself that this is the actual surface-texture, and it may be a condition induced by mineralization. In a few examples, there is a row of minute pustules at the base of, and corresponding to the cellules.

The stems and branches of Dendrograptus, Callograptus and Dictyonema, are irregularly striated. In typical species of Retiolites the test is finely reticulate; while in the species from the Quebec group, this texture, if existing, is so fine as not to be readily resolved by an ordinary lens. The surface, however, has not the appearance of entire smoothness, as in most of the ordinary Graptolites.

The chief ornaments of these bodies are the mucronate extensions of the test, usually from the lower margins of the cellules, but sometimes from the upper margins. In ordinary forms of the species, with single, and with double ranges of cellules, the mucronate or setiform extensions are usually from the lower extremity of the cell-aperture, as illustrated in fig. 30.

In all those forms of which *G. bicornis* may be regarded as the type, these processes, when existing, are extensions of the test above the aperture, so far as observed (Plate ii, figs. 1 and 9); or as in species of the character of fig. 20, Plate ii.

FIG. 30.



In some species of *Diplograptus* there is a single mucronate extension from the lower side of the cell aperture, as in the accompanying illustration, fig. 30, of *Graptolithus* (*Diplograptus*) *whitfieldi*, twice enlarged.

In others, as *G. quadrimucronatus* (Plate iii, figs. 1 and 2), there is a mucronate point extending from each of the lower lateral angles of the cellules; as also in *G. testis* of BARRANDE; except that in the Canadian species these appendages are more rigid.

In *Phyllograptus typus* and *P. ilicifolius*, these processes are apparently the extension of the angles of the cell-partition.

The cellules of DENDROGRAPTUS, CALLOGRAPTUS and DICTYONEMA sometimes show mucronate extensions from their outer margins. In RETIOLITES the cellules sometimes terminate in a plain margin, and in one species the divisions are extended in short strong mucronate points (Plate i, figs. 5 and 21, and Plate iv, fig. 11).

All the species of RETIOGRAPTUS have the margins of the stipes garnished with slender mucronate points, corresponding to the cellules, and extending almost rectangularly to the axis (Plate iv, figs. 8 and 9).

These ornaments are not always uniformly developed in the same species or even in the same individual. In the larger proportion of specimens of *G. ramosus*, the margin of the cellules are apparently plain; but in the cellules of the simple part of the stipe we sometimes find a rigid mucronate point, prolonged from the upper margin or limit of the cell-aperture (Plate ii, fig. 20). In *G. sextans*, the mucronate point is half way between the two cell-apertures.

In specimens of *G. sextans*, and in some allied forms from the Hudson River formation at Marsouin, Canada East, the stipes and cellules are less fully developed than in those of the same species from Norman's Kill, near Albany, while the mucronate extensions from the cell apertures are more conspicuous.

Besides these ornaments, there is on each side of the radicle or initial point at the base of most of the diprionidian species of Graptolites, a small process, varying in length, and usually directed downwards. These processes are usually short, but often considerably extended; in some species they are very slender, while in others they are strong and rigid. In *G. pristis* they are frequently seen as short slender processes; while in *G. bicornis* they are rigid, strong, and slightly curving. In *G. antennarius*, a congener of the latter, they are slender setiform processes, directed downwards.

In no species of PHYLLOGRAPTUS have such appendages been observed; nor have they been seen at the bases of the stipes of RETIOLITES.

V. Mode of Reproduction and Development in the Graptolitidæ.

As already remarked, the Graptolites proper are now generally referred by authors to the RADIATA—*Hydrozoa;* while some forms, which I include in the family, have been heretofore regarded as reticulate bryozoans, or as gorgonians.

In nearly all the true bryozoan forms among fossils, we have the means of tracing the relations and analogies, both in manner of growth and reproduction, throughout all the successive geological periods, and in the present fauna. It becomes therefore more difficult to discover such analogies for the Graptolitidæ, since the Graptolites proper disappear from existence in the Silurian period; and the latest form of Graptolitidæ (*Dictyonema*) is not found, so far as now known to me, in American strata, at a later period than the Hamilton formation or Middle Devonian. From this cause the mode of growth and development are not so readily understood as in those families which can be traced throughout the geological series, and still find their analogues in the present seas.

In 1858, I laid before the American Association for the Advancement of Science, a notice, with some illustrations of Graptolite stipes, bearing what I then regarded, and do still regard, as the reproductive cells (*Gonophores*). These cells first appear as small ovate buds upon the margins, projecting but little beyond the regular cellules, and, becoming enlarged, form elongated sacs with swollen extremities, which become finally dehiscent; and then, as I suppose, discharging the ovules or germs, are gradually absorbed or dissipated.

Although these sacs are distinctly defined, they have scarcely any apparent substance, except along the lateral margins, which are limited by a filiform extension resembling the solid axis of a Graptolite. There are likewise numerous fibres of this kind traversing the sacs; and these sometimes remain attached to the original stipe after the other parts are separated. In one example, we have conclusive evidence that they are connected with the solid axis of the parent stipe. The gradations of development in these sacs may be studied in figures 6–9, Plate i.

In the specimen fig. 10 of the same Plate, the ordinary cellules are removed, and the fibres are still seen joined to the axis, showing the origin of the reproductive sacs. In most specimens bearing these sacs, the cellules of the stipe are so obscure that the species cannot be determined; but in fig. 9 we find them attached to a well-marked stipe of *G. whitfieldi.*

This mode of reproduction in the Graptolites shows much analogy with the hydroidea, and would indicate the sertularians as their nearest analogues.*

Upon the surface of the slate where these bodies occur, there are numerous graptolitic germs, or young Graptolites of extremely minute proportions, ranging from those where the first indications of their form can be discovered, through successive stages of development till they have assumed the determinate characters of the species.

In several examples, these minute germs have been detected near to and in contact with the reproductive sac; and in one case, there is but a hair's breadth between one of the fibres of the sac and one of the oblique processes at the base of the germ. It cannot be said that we have detected the germ actually within the sac; but the numerous young individuals lying near them, and upon the surfaces of the same laminæ, offer very good arguments for supposing that they have been thus derived.

The earliest defined form which we observe in the young Graptolites consists of the initial point or radicle; a diverging process of similar character on each side, but not quite opposite; a longitudinal axis of greater or less extent; and a sac-like covering, or a thin pellicle of graptolitic test, which has scarcely assumed the form of cellules, but which

* In the recent SERTULARIA and CAMPANULARIA we find ovarian vesicles, in which a number of ovules may be enclosed in a common envelope. These vessicles are developed along the side of a stipe or branch, and the ovules are often arranged along a central axis, each one communicating with the common axis of the zoöphyte. (JAS. J. LISTER, *Philosophical Transactions*, 1834, pp. 365–388, pl. ix. Cited also by DANA, "*Structure and Classification of Zoophytes.*"

Prof. M'COY has stated (*British Palæozoic Fossils*, p. 4) that he has found near the base of the cellules of Graptolites, a transverse partition or diaphragm, similar to what may be observed in some sertularians, and which he regards as proving similar relations; but I have not discovered in any American specimens, evidence of such cell-diaphragms.

is most extended in the direction of the common body along the solid axis. This little sac contains the germ of the zoöphyte, which, extending itself as the common body in its canal along the axis, gives origin to the budding which developes the successive cellules and the gradual building up of the polypary.

The earliest condition of development is illustrated in fig. 12 of Plate i.* At a farther stage of development we have the form better defined, as in fig. 13, where the germ has assumed the general aspect of *G. pristis*, the slender lateral processes being rectangular to the axis.

On the left hand of fig. 8, and at the third reproductive sac below the top, there are two germs visible, close to the sac, where the connection between one of these and the fibre is nearly complete. The same is shown in the enlarged fig. 11.

In fig. 14, we have the germ of another form, which is unequally developed on two sides. Figure 15 (represented of the natural size) appears to be of the same species, having reached a more definite form. Figure 16 is an oval disc, of which several more or less defined specimens have been found among the young Graptolites, but I have not been able to trace it to any known mature form.

The specimens figs. 17 and 18 appear to be the young of *G. bicornis*, or of a similar form. In one the body is narrow, without marks of cellules, and the solid axis is not extended above the common body, having probably been broken off. In the other there is a greater expansion of the common body, but no cellules are visible, and the central portion of the substance is more dense, while towards the margin it is extremely thin; the solid axis is extended beyond the stipe, and the lateral oblique processes are quite perfect. This germ, with its axis and common body, had not begun to develop the cell-apertures on its margins, which may be seen at a later period.

In nearly all the young Graptolites, there is an extension of the common body along the axis above the incipient cellules. This is observed in the figures referred to and in the young of *G. ramosus*, shown six times enlarged on Plate ii, fig. 21.

Although I have found none of the monoprionidian forms with reproductive sacs attached, I have nevertheless observed what appear to be the young of some of these species, having an aspect similar to the others, except in carrying the development of the cœnosarc upon one side only of

* All the specimens of germs or young Graptolites are six times enlarged, except figs. 11 and 17.

the solid axis. An illustration of one of these forms is given in Plate i, fig. 19, showing the base irregularly divided. These forms cannot be referred to any known mature species.

This mode of development, illustrated in numerous specimens, can be readily understood in the simple stipes, whether of the monoprionidian or diprionidian character. Admitting that the examples given furnish evidence of the mode of reproduction of the diprionidian forms, or those of the sub-genus Diplograptus, where we have a range of cellules on each side of a solid axis, it is easy to perceive how the germ of an analogous form may develop, from its initial point, two series of cellules upon a stipe, where the parts diverge in opposite directions from the common origin. One step farther in this direction will give us the four-stiped forms, where the germ of the common body, with its additional elements of subdivision, produces the quadripartite frond; and so onwards, until we have the numerously branched fronds, and the branching stipes.

In all these the germ in its incipient development will differ very little. It may consist of the radicle or initial point, with the solid axis and the common body separated into two, four, eight, or an indefinite number of divisions, each one bearing its solid axis and common canal. These subdivisions sometimes all take place near the origin, which is always central; and the divisions continue simple throughout, or do not bifurcate after they commence to develop cellules. In others the stipes are again divided, and this subdivision is only limited by the extent of the frond. In all these fronds the parts are always arranged symmetrically or bilaterally on the two sides of the initial point, as has been illustrated in the preceding pages.

In the greater part of the monoprionidian forms, we have only modifications or extensions of the simplest form of development shown in figs. 8 and 9 of Plate iii. Where the divisions at the base become more numerous, as in figs. 15, 16, 20 and 22, it is simply a farther subdivision of the stipes, but all taking place near the initial point. In a further development, the subdivision takes place at any point along the branches, either near to or distant from the initial point. Where the divisions at the base become more numerous (and indeed in some of the four-stiped species), we often find a thick, corneous test, of the same substance as the other parts of the Graptolite, uniting the bases of the stipes and continuing along their margins. This disc has a greater or less development, not always corresponding to the size or extent of the stipes. It is sometimes absent, apparently from accident, and some of the four-stiped species are not known to possess it; while it has never been observed in any of the species where the stipes are properly branched, or divided in the celluliferous parts of their length.*

The interior of this corneous disc, previously described as apparently composed of two plates of the test, has probably been occupied by some softer substance, which may have been an extension of the common body, or have possessed in some degree the character of the common body of the stipe.

The development of the diprionidian forms, as deduced from the young Graptolites which we find associated with the reproductive cell-bearing stipes, would show that these forms of Graptolites exist as single and simple independent stipes from the commencement of their growth. Nevertheless, I conceive that both RETIOLITES and RETIOGRAPTUS may have existed in compound fronds, having their origin from a central point not unlike in the commencement to *Graptolithus logani*, but without the central disc. These fronds were probably concavo-convex, as were the individual stipes. The solid axis, instead of being central, is placed externally along the centre of the convex or outer side; and the cell-divisions on that side proceed from it; while on the upper or concave side the cell-divisions do not reach the centre, leaving a space for the common body, which has been shown by BARRANDE and GEINITZ to produce a central longitudinal prominence.

In these forms the mode of development has been similar to that already explained, the modification being chiefly in the external position of the axis and the joining of cell-divisions with the axis on one side; leaving the common body in a somewhat triangular form, from which the alveoles are developed on either side.

Whether the PHYLLOGRAPTUS existed as simple stipes with four ranges of cellules, or in a compound arrangement as in RETIOGRAPTUS, the mode development has been similar: either the germ with its initial point developed a single stipe with four ranges of cellules, or the same elements first subdivided, and each division gave origin to its stipe through the common body.

In regard to the development of the cellules in the different parts of the graptolite, we observe, as a uniform feature, their smaller size towards the base of the stipe. In all the monoprionidian forms, this

* See remarks upon the Genus DICHOGRAPTUS under Generic descriptions in this paper.

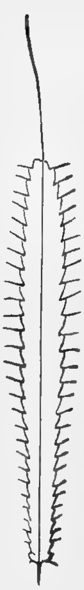
character is particularly observable; and in a few species, the earlier cellules are raised in a scarcely perceptible elevation above the general surface of the common envelope. Indeed, in a few instances, it is impossible to ascertain satisfactorily whether these earlier prominences are expanded into open cellules. As the stipe is extended they become gradually more and more prominent, until towards the middle, or oftener perhaps nearer the distal extremity, their greatest degree of development is reached. In some species this takes place near the base, and in the more elongated stipes there is no sensible increase throughout a great part of their length, and the two margins of the stipe are essentially parallel. Towards the distal extremity there is a gradual, or often a more abrupt, diminution in the size of the cellules; and a few of the last ones are much smaller, until the terminal cellule is sometimes seen in a partially developed condition between the common body and the partition of the preceding cellule.

The same condition of development in the cellules is true of the diprionidian forms, as is shown in some degree in G. *pristiniformis*, Plate xiii (*Canadian Decade* ii), but more especially in the accompanying enlarged figures of *G. pristis* and *G. whitfieldi*, the last of which also shows the higher cellules diminished, so as to contract the width of the stipe above (figs. 31 and 32).

In Retiolites and Retiograptus, the full development of the cellules takes place below the middle of the length of the stipes, while they are less developed towards either extremity. In some species of Retiolites, including one from the Clinton formation, the cellules acquire their full development near the base, and the margins are essentially parallel for the greater part of their length.

Fig. 31.

Fig. 32.



In Phyllograptus, the lesser development of the cellules at the base of the stipe is a marked feature. They increase rapidly towards the middle; and their greatest development is sometimes above and sometimes below the middle, but in all cases they suddenly decrease towards the apex.

In Dendrograptus, where we have a stout stem without cellules, the branches usually begin at some distance above the base, and in their lower part they have scarcely the appearance of being celluliferous: in the middle of their extent the cellules become more distinct, and, so far as can be observed, they are less developed towards the extremities.

VI. Mode of Existence.

The numerous individuals of entire or nearly entire fronds illustrated in the "*Figures and Descriptions of Canadian Organic Remains*," some of which are reproduced in this memoir, as well as large numbers of others examined, serve to give a pretty clear idea of the general form of the true Graptolites, as well as of their congeners of the same family. Notwithstanding the presence of the radicle or initial point observable in so many species, it does not afford evidence of attachment to the sea-bottom or to any other substance, at least in the mature condition. In all the monoprionidian forms, however much or little extended the radicle may be, it is always smooth, and tapering to a point. In many of these, and more especially in those with a central disc, this radicle is reduced to a minute protuberance, and is often scarcely or not at all perceptible.*

The same is essentially true of the greater number of diprionidian forms examined. In these the solid axis is sometimes extended beyond the base of the stipe, and terminated as if broken off abruptly; while there is often a slender oblique process on each side of the base.

In Retiograptus and Phyllograptus, there is not the same evidence of completeness at the base of the radicle. The lower termination, when it can be fully examined, is broken, as if there had been a further continuation of this part, though it exhibits no enlargement. I have inferred that all these, like the examples of *Retiograptus eucharis* (Plate iv, fig. 9), have constituted parts of a similar compound body, and are but the separated stipes of the frond. If this be true, their mode of existence is not unlike the other species with compound fronds and a central disc.

In *G. bicornis*, the extension of the solid axis below the base of the stipe is not always preserved; but when it is entire, we find two strong, diverging and slightly curving processes or spines from the base, having smooth terminations. Sometimes a disc or bulb, of the same substance as the stipe, extends between these spines, and, in the compressed condition, envelopes a few of the lower cellules, as shown in Plate ii, fig. 17. Some of the phases presented by the basal extremities of this species are shown in figs. 13, 15, 16 and 17 of the same plate.

* The minute initial point of some of these extended fronds with a central disc appears to me to be quite insufficient to have afforded means of attachment in the mature condition of the individual, whatever it may have done in the earlier stages of its growth.

The expansion at the base of this species has the same general appearance as the central disc of *G. logani*, *G. headi*, and others; showing that this sort of development of the substance is not alone characteristic of those forms having several stipes united at the base. In other examples this basal expansion is contracted in such a manner as to give a crescent form to the lower extremity; but in all these gradations the margins of this part are entire and unbroken.

We have seen that the youngest forms of the diprionidian Graptolites, those which we may suppose had but recently escaped from the reproductive sac, are furnished with the minute radicle-like appendage or extension of the solid axis, as well as the oblique lateral setiform processes; and the condition of these parts does not seem to have been essentially changed during any subsequent period of their growth. While the extension of this slender solid axis does not seem of sufficient strength to have formed the base of attachment to the sea-bottom, it may have been sufficient to maintain connection with other parts of a compound polypary; but this condition has never been proved true of any of the species of Diplograptus proper.

For all those species with a single range of cellules, where the stipes are combined in a compound form, as well as for some with a double range, including Retiolites, Retiograptus, and Phyllograptus, I conceive that we have already shown a similar plan of development and a uniform mode of existence; and we are constrained to believe that all these forms, in their mature condition, were free floating bodies in Silurian seas.

In regard to another group including Dendrograptus, Callograptus and Dictyonema, as well as one or two other forms, we have some evidence indicative of a different mode of existence. The stems of Dendrograptus are enlarged towards their base, and sometimes present a sudden expansion or bulb, which I have inferred may be the base or root, once attached to another substance, or imbedded in the mud or sand of the sea-bottom. The general form of the species conduces to the belief that they were fixed to the sea-bottom, though possibly this basal expansion may have resembled that of *Graptolithus bircornis*. In most of the species described there is a gradual enlargement towards the lower extremity, which is imperfect, and its termination unknown.

In those which I have termed Callograptus, the bases of the fronds are imperfect, but indicate, according to analogy, a radicle or point of attachment like Dendrograptus. In the more nearly entire forms of Dictyonema known, we have not been able to observe the base; but from their similarity in form and mode of growth to FENESTELLA and RETEPORA, we have inferred their attachment either to the sea-bottom or to foreign bodies.

Nearly all these forms occur in rocks where there are few of the larger fossils, and indeed few fossils of any kind except the graptolites; so that there is little chance of finding their bases attached to shells and corals, as we do those of the bryozoans, even had they thus existed. The DICTYONEMA of the Niagara, Upper Helderberg and Hamilton groups do occur in strata which contain other fossils; but we have no evidence of their having been attached to any of these. It is only from their general form, therefore, and from their analogy with other bodies, that we infer that these genera may have been attached to the sea-bottom or to other objects during their growth.

We admit, therefore, that the family of Graptolitidæ, as now extended, may include both free and fixed forms.

VII. General Characters of the Family Graptolitidæ; With Reference to the Distinctive Features of the Genera, as Known in the Geological Formations of Canada and the United States.

In the first section of this memoir I have remarked upon the nature and general form of the Graptolites proper, and the allied genera which I regard as belonging to the same family. The large accession to the number of species, and the great variety of new forms added to those formerly known, require an extension of the characters heretofore given.

The numerous Graptolites described by NILSSON, HISINGER, BRONN, MURCHISON, EICHWALD, PORTLOCK, GEINITZ, BARRANDE, SUESS, McCOY, SALTER, HARKNESS, NICOL, MENEGHINI, NICHOLSON,* CARRUTHERS,* myself, and others, are for the most part in a fragmentary condition, affording knowledge only of the simple stipe, the structure of its parts, and the arrangement of the cellules. From these fragments, however, we have derived the generic characters; while the modifications in form, and the order and relations of cellules, have furnished means of specific distinctions in the greater proportion of those described.

In maintaining the generic term GRAPTOLITHUS for the forms which have the nearest relations with those to which the term was originally applied by LINNÆUS, M. BARRANDE has proposed two sub-genera, characterized by the presence of a single series, or of two parallel series of cellules, under the name of MONOPRION and DIPRION. The latter term

* Since the original publication of this memoir.

having been applied to a genus of insects, the name DIPLOGRAPTUS* of McCOY has generally been adopted.

The distinction indicated would at one time have expressed a character perfectly trenchant; but the discovery of such forms as *G. ramosus* † and *G. furcatus* shows the occurrence of both a single and a double series of cellules upon the same stipe, or, more properly, shows the basal portion consisting of a simple stipe, with two parallel ranges of cellules; which dividing at some distance above its origin is continued as two simple stipes, each with a single range of cellules. These cellules are on the outer margins, and are a continuation, without interruption from those of the lower part of the stipe. Including these, therefore, in the same group with *G. pristis*, the subdivisions indicated would have less value for the purposes of study; but I believe these latter forms may be separated on other grounds, as will be shown farther on; so that with our present knowledge we may still recognize DIPRION, = DIPLOGRAPTUS, as a well-marked and clearly-defined sub-generic group of GRAPTOLITHUS proper, having such forms as *G. pristis* among the typical species.

M. GEINITZ has more recently proposed the name MONOGRAPTUS to include MONOPRION and RASTRITES of BARRANDE; placing under this genus, as his typical species, *G. sigittarius* of HISINGER, which has usually been regarded as the typical form of *Graptolithus* of LINNÆUS.

The genus CLADOGRAPTUS ‡ is also proposed by M. GEINITZ, to include the species *G. ramosus* and *G. furcatus* (HALL), *G. murchisoni* (BECK), *G. serra* (BRONGNIART), G. *forchhammeri* (GEINITZ), *G. sextans* and *G. serratulus* (HALL). At the same time the British palæontologists, adopting the name DIDYMOGRAPTUS (McCOY), place under that genus *G. murchisoni* (BECK), *G. caduceus* (SALTER), *G. sextans* (HALL), *G. geminus*, (HISINGER), *G. hirundo* (SALTER), and other similar forms. Those which are made the typical forms of the genus by GEINITZ are the "species *gemellæ*" of BRONN, who included under that term the *G. geminus* (HISINGER), and *G. murchisoni* (BECK), which are by no means nearly related to *G. ramosus* or *G. furcatus*. The first named two species, which were the earliest

* In the genera proposed by myself, I have chosen the termination *graptus* instead of *grapsus*, since the latter is in use in the nomenclature of Crustacea.

† The subdivision of this species beyond the first bifurcation, represented in the *Palæontology of New York*, Vol. i, pl. lxxiii, fig. 3, is erroneous; the specimen consists of two individuals, the base of one being placed directly in the axil of the other.

‡ *Cladograpsus* (GEINITZ). Syn. *Graptolithus auctorum;* species *gemellæ*, Bronn (*Die Verstienerungen der Grauwacken formation in Sachsen*, etc., Heft i, Graptolithen, p. 29). *Monograpsus*, id. ibid. p. 42. Syn. *Monoprion* et *Rastrites* (BARRANDE); *Gruptolithus*, SUESS. Not *Cladograptus*, CARRUTHERS. See supplementary note.

known of that character, and regarded as the typical forms of DIDYMOGRAPTUS, are similar to *G. bifidus* and *G. extenuatus* of the Canadian Decade, represented in Plate iii, fig. 13, of this memoir, and differing from figs. 8 and 9 of the same plate only in the lesser divergence of the stipes.

At a later period, Mr. SALTER proposed a further subdivision of the graptolites under the name TETRAGRAPTUS, "a kind of double DIDYMOGRAPTUS," of which *G. byronoides* is made the typical species; and *G. quadribrachiatus* is referred to the same genus. He also proposes DICHOGRAPTUS for those having the "fronds repeatedly dichotomous from a short basal stipe into eight, sixteen, twenty-four, or more branches, each with a single row of cells." "But the main character which distinguishes DICHOGRAPTUS is the presence of a corneous plate* which envelopes all the lower part of the branches, and which is not known in any other genus of the group; it has not indeed been seen in more than two or three species of DICHOGRAPTUS, but it may not in many cases have been preserved."†

These subdivisions may be of some value when the entire frond and all its appendages are preserved, but unfortunately this is a rare condition; and when we have but fragments of the stipes or branches, there is no force or value in the application of these terms: we are thus reduced to the necessity of adopting the old term GRAPTOLITHUS. Again, the value of DIDYMOGRAPTUS I conceive to be pretty well illustrated in the case of *G. caduceus*, the original of which is cited from Lauzon, Canada.‡ After studying the large collection of graptolites made by the Canadian Geological Survey, I am compelled to believe that the *G. caduceus* was founded upon such forms as I have represented on Plate iii, figs. 18–21; for we have no two-stiped species or forms of "DIDYMOGRAPTUS" with a pedicle or radicle so long as that represented in the figures of Mr. SALTER, nor any one so abruptly recurved; and I regard the apparent radicle in the two examples figured as simply one of the four stipes imbedded in the shale, and exhibiting its non-celluliferous margin and a small portion of its width, as I have shown in the figures cited.

Other varieties of this form show only the two simple stipes, with a slight process in the centre. We have therefore a "TETRAGRAPTUS" in a condition undistinguishable from a "DIDYMOGRAPTUS;" and the same may happen in *G. bryonoides*, whenever the quadripartite stipe is separated

* First discovered in the Graptolites of the Quebec group at Point Levis.

† *Quarterly Journal of the Geological Society*, Vol. xix, p. 136.

‡ *Graptolithus caduceus* (SALTER), *Quarterly Journal of the Geological Society*, Vol. ix.

into two; and in the separated stipes it is impossible to know if there have been two, four or eight in the entire individual. With regard to those fronds which are repeatedly dichotomous, forming the genus DICHOGRAPTUS, of which the distinguishing character is the central "corneous plate which envelopes all the lower part of the branches," we may remark, that we have three or four species of the four-stiped form, or "TETRAGRAPTUS" with the central corneous plate; while we have four species which are not known to possess it. Of the two eight-stiped species known, one has the central corneous plate or disc, and the other was probably destitute of such an appendage. In *G. logani*, with its numerous simple stipes, the central corneous plate is usually present, though not in all examples; while *G. multifasciatus*, with more numerous simple stipes than *G. logani*, is not known to have a central corneous disc, and from its mode of growth, probably never possessed such an appendage. From the irregularity of growth in the *G. abnormis*, I infer that there was no central plate.

In all the properly-branching species where the initial point is known, as in *G. flexilis*, *G. rigidus*, and *G. milesi*, no such central plate has ever been seen; nor has it been shown in any European species, so far as I know. Those with the "fronds repeatedly dichotomous," similar to the one originally proposed by Mr. SALTER* as the type of DICHOGRAPTUS, are not known to possess the central corneous disc.

Although entirely willing to accept and adopt such subdivisions of the graptolites as will aid in determining their zoölogical character and relations, their geological value, or indications of differences in mode of development, I do not appreciate the force and value of these proposed generic subdivisions for the two, four and eight-stiped species, or the presence or absence of a central corneous disc as indicating generic distinctions; since it is impossible to obtain any aid from such designations for the references of the numerous fragments which are the ordinary form and condition in which we find the graptolites, and in which they must generally be studied.

The form, mode of growth, and arrangement of cellules in all these several proposed genera, are so identical in plan as to afford no means for generic separation; and although the same is true of the properly ramose forms, yet I conceive it might have been convenient to adopt a term (DICHOGRAPTUS or CLADOGRAPTUS) indicating the ramose character of the

* *Geologist*, Vol. 4, p. 74, 1861.

stipes, regarding as true branches only the subdivisions which take place after the commencement of the cellules.

The Genus NEREOGRAPTUS* of GEINITZ, proposed by that author to include such forms as NEREITES, MYRIANITES, and NEMERTITES of MURCHISON, and NEMAPODIA of EMMONS, etc., can scarcely be admitted into the family of Graptolitidæ, since all the American species referred to the first three named genera have no texture or structure like graptolites, and (as I have elsewhere shown) appear to be referable to the tracks or trails of some marine worms or other animals upon the sea-bottom; while NEMAPODIA is simply the trail of an existing slug or worm upon the slightly lichen-covered surfaces of the slates.†

The Genus GLOSSOGRAPTUS of EMMONS is founded upon a species of DIPLOGRAPTUS with ciliate appendages on the cell-margins; and no characters are given to show its generic distinction. The typical species of NEMAGRAPTUS (*N. elegans*) is apparently a part of an individual of *Graptolithus gracilis*, or of some similar form; while the relations of the second species of the genus (*N. capillaris*), an elongate, flexuous, filiform body with a few branches at irregular intervals, can scarcely be determined from the figure given.

The typical and only species of STAUROGRAPTUS‡ of the same author is a very remarkable form of extremely minute proportions. Its mode of growth and subdivision of stipes, if accurately represented in the figure, are unlike anything known among this family of fossils, and it merits generic distinction.

The term DIPLOGRAPTUS is properly applied to such forms as *Graptolithus pristis*, of HISINGER, *G. palmeus*, of BARRANDE (excepting figs. 5 and 6); *G. foliaceus*, of MURCHISON, and *G. amplexicaulis* of this memoir; where the cellules are disposed in parallel ranges on the two sides of the central axis, and are of the same or similar form and arrangement with those of the monoprionidian form *G. sagittarius*, and with others of that type; the reason for the proposed separation being in the double range of cellules only.

In the ordinary forms of DIPLOGRAPTUS (Plate iii, figs. 1–7), as in the ordinary monoprionidian types, the cellules are usually closely arranged, and overlapping each other for a part of their length. In a single

* *Nereograpsus: Die Verstein. Grauwacken formation*, etc., Graptolithen, p. 27.

† These markings can be easily removed from the surface of the laminæ by washing with water; and they can be traced over the exposed surface of the edges of the successive laminæ.

‡ GLOSSOGRAPSUS, STAUROGRAPSUS, NEMAGRAPSUS (EMMONS): *American Geology*, Part ii, pages 108 and 109.

species (*G. putillus*, from the Hudson-river formation in Iowa), which has come under my observation in some well-preserved fragments, we have so far a modification of the general arrangement of the cellules that the apex of one barely reaches the base of the next succeding. The stipe is a strong elliptical tube with a flattened central solid axis. the line of which is marked on the exterior by a longitudinal undulating groove (Plate ii, fig. 10). The surface is strongly striated transversely, and the sides studded with tubular cellules, which are alternately arranged. These cellules are sub-oval, flattened on the side adjoining the body of the graptolite, curving on the exterior free portion, and obliquely flattened at the base just above the aperture of the cellule next below, as shown in the profile view (Plate ii, fig. 11). The exterior test of the common body is swollen in oblique undulations in the direction of the base of the cellules, or where the individual buds take their origin; and the axis is curved towards the opposite side as shown in fig. 10.

The transverse diameter of the stipe is about two-thirds as great as the longer diameter. The celluliferous face of the stipe shows broad elliptical depressions; the lower side, for little more than half the height, being the sub-oval cell-aperture; while the upper part is the semi-oval flattened area at the base of the next succeeding cellule, as shown in (Plate ii, fig. 11). In this case the cellules are shown to be separate and distinct tubes, closely pressed against the lateral walls of the stipe on one side, and communicating with the common body by a slightly narrowed passage, as shown in Plate ii, fig. 12, which represents a longitudinal section of the body. In a transverse direction, the base of the cellule is wider than the aperture (Plate iii, fig. 11).

Specimens of this character, on becoming flattened, would present a form where the cellules, though inclined against the common body, would not overlap each other, and where the margin of the cellule is directed backward instead of forward. Were these cellules to be prolonged, they would overlap the next in advance, presenting in this condition but a slight modification of the usual forms of DIPLOGRAPTUS. These deviations from typical forms are so slight as to offer no sufficient ground for generic separation.

There are, however, a few examples, where the stipe is marked by a range of cellules upon each side of the central axis, which appear to be properly separated from DIPLOGRAPTUS, on account of the form and structure of the cellules. These are apparently quite unlike those of *G. pristis*, and others of that sub-genus. The *Graptolithus bicornis*, and two or three allied forms, when flattened in the shale, show, as already described, a simple semi-elliptical notch in the margin of the stipe, nearly rectangular to the axis. This is well shown in fig. 3, Plate vi, of M. BARRANDE'S memoir, and also in Mr. SALTER'S illustrations of *Graptolithus teretiusculus* of HISINGER.* It is represented, lest perfectly, in the figures of Prof. HARKNESS,† and in most of my own figures on Plate lxxiii of the first volumes of the Palæontology of New York. When compressed rectangularly to the cellules, the apertures are transversely oblong-oval; and the same form is shown when looking upon the celluliferous margin of an uncompressed stipe.

The structure of these stipes and their cellules has already been described in a preceding section, with reference to the figures illustrating the same. The *G. bicornis*, known in New-York and Canada, may be considered the type of a group of species of which we have two in the shales of Norman's Kill near Albany, one in Ohio, and a similar or identical form in the Utica slate at Collingwood in Canada West. I would include in the same group figs. 5 and 6 of Plate iii, as well as figs. 7, 8 and 15, Plate ii, of M. BARRANDE'S Memoir, *Graptolithus teretiusculus* of HISINGER, and those referred to the same species by SALTER.‡ The *Diplograptus rectangularis* of M'COY § is of the same type, as also figs. 1, 5, 10, 11, 12, etc., Tab. ii of GEINITZ (*Graptolithen*); and I conceive that many of the scalariform specimens belong to species of this character.

The *Graptolithus ramosus* has usually been arranged by authors under DIPLOGRAPTUS; the lower part of the stipe being simple and having a double range of cellules, while above the bifurcation it has a single range on the outer margin of each division, as already described; and a simple explanation of this condition has been offered by supposing that the solid axis has been divided after the death of the zoöphyte. This, however, will scarcely afford a satisfactory argument when we find that all the specimens are in the same condition; that usually the division begins at a uniform distance from the base; and that when entire, the divided portion much exceeds the simple undivided part of the stipe. Moreover, the species is recognized in this condition in the Hudson-river formation in Canada, and has likewise been recognized in Great Britain;

* *Quarterly Journal of the Geological Society of London*, Vol. viii, Pl. xxi, figs. 3 and 4.

† *Quarterly Journal of the Geological Society*, Vol. vii, Pl. i, fig. 11.

‡ Ib. ibid., Vol. viii, Pl. xxi.

§ *British Palæozoic Fossils*, page 8, Pl. xiii, figs. 8, 9 and 10.

while a similar or identical form has been shown by Prof. M'Coy to occur in Australia. We must, therefore, seek some other than an accidental cause for the explanation of this uniform bifurcation of the stipes of that species. In the meantime, it appears to me highly proper to suggest its separation from Diplograptus.

On farther comparison, we shall find that *G. ramosus* is not quite alone in its peculiar characters. In *G. furcatus* there are a few cellules at the base of a simple stipe below its bifurcation; and in *G. sextans*, the lower part of the stipe is simple, the division taking place above the first cellule; but in entire individuals the division is never from the initial point, as we see it in *G. bifidus* and *G. nitidus.*

Now these first named species, as well as *G. ramosus*, have cellules of a peculiar form; and looking still farther, we find a similar form of cellule in *G. forchhammeri*, Geinitz, and *G. divaricatus*, Hall, two species which are divided from the base, having a single range of cellules upon the outer sides of the stipe. I believe it will be found, moreover, that all the graptolites with cellules on the lower side of the stipes (in reference to the initial point or radicle) have these parts of the same form as in *G. ramosus*, and very unlike the *G. pristis* and allied species. Nor are the cellules on the simple or divided portions of the same stipe, or on those which are entirely divided, and upon the lower side, at all like the cellules of *G. priodon*, *G. geminus*, *G. murchisoni*, or any of the allied forms illustrated in this memoir to which the term Didymograptus has been applied; nor can they be properly united with them. The form of the cellules is always sufficiently distinctive, even in fragments of the stipes; and this feature, together with the mode of development or growth, seems to me sufficient to sustain a generic distinction.

The Genus Retiolites is described by M. Barrande as having no central solid axis, but with a single internal canal occupying the median portion of the polyp. The prevailing form of the stipe is somewhat concavo-convex, with the centre of the concave side prominent; the entire surface is covered by a net-work of corneous substance, and the cell-apertures are quadrangular.

Prof. Geinitz has given some further illustrations, showing more distinctly a longitudinal axis on the convex side, to which are joined the cell-partitions; while he regards the common body as occupying the prominent central portion of the concave face of the stipe, and showing the cell-partitions terminating before reaching the centre, leaving a space occupied by the width of the common body. This he represents as covered by a net-work of slightly different texture from that of the other portions of the substance.

The Canadian specimens which I have referred to this genus are so extremely attenuated that it is impossible to determine the details of structure, and the surface-characters are obscure. Thus far we have no American specimens in a condition to afford the means of elucidating some obscurities, which seem to me still to exist, in regard to the intimate structure of this genus. The species of the Clinton formation is extremely compressed; and while some specimens show the cell-divisions terminating at a distance from the centre, yet, after protracted and repeated examinations, my most critical observations result in showing only the structure which is illustrated on Plate i, figs. 20 and 21.

On one side we have an external, cylindrical, solid axis, to which the cell-divisions are joined; but these latter show only a filiform cylindroid process, extending from the axis to the cell-margin, and projecting a little beyond the margin of the stipe. The only other aspect which we observe in this species is that of an undulating or zigzag filiform axis on *the opposite side*, to which the cell-partitions are joined, as in Plate i, fig. 21. We know this to be on the opposite side or within the stipe, as it is sometimes seen overlying the straight axis and cell-partitions.

At the junction of the cell-divisions with the zigzag axis there are other processes of similar character, projecting upward and outward from the axis, all of nearly equal length, but apparently broken at their extremities. I have not been able to determine any connection between these and other parts of the skeleton, but we have the two structures very clearly represented in the figures referred to. I have supposed that similar processes may have extended to the opposite side, from the junction of the cell-partitions with this undulating axis, either joining the cell divisions or the straight axis; but after long investigation, I have been unable to find satisfactory evidence of such connection. The cell-apertures are surrounded by thickened margins, and the only appearances of cell-partitions are the sub-external cylindrical extensions from the aperture to the axis. Neither the species of the Quebec group nor that of the Clinton formation, in any of the specimens seen, are in a condition to show evidence of the concavo-convex character of the stipe represented by M. Barrande and Prof. Geinitz.

The species of Retiograptus, while having some characters in common with Retiolites, do not possess the reticulated structure of the test in either of the described species. There yet remains some obscurity in regard to the internal structure of this genus, which can only be satisfactorily explained by the examination of better preserved specimens. Nevertheless, in its general form, structure and mode of growth, it is shown to be quite distinct from other graptolitic genera. The three species referred to this genus present differences which can only be reconciled by supposing that the two sides of the stipe are very unlike each other in form and external characters, as in RETIOLITES.

The species for which I have proposed the generic name PHYLLOGRAPTUS, present close analogies with the typical form of DIPLOGRAPTUS in the character of test and form of cellules. These, in their aperture and form, are nearly quadrangular; and the cell-partitions are apparently continuous between the two sides of the cellules, and reach nearly to the central axis; characters which we find in DIPLOGRAPTUS. These forms, in their great lateral extension, depart widely from their analogues; but they differ more essentially in their cruciform mode of growth, presenting an arrangement of parts, as if four simple stipes (like those of *G. bryonoides* or *G. bigsbyi*) were joined together by the coalescing of the solid axes. In this latter respect, and in their greater development in width, they differ most essentially from all the other genera of this family of fossils. These forms are illustrated on Plate iv of this memoir.

In the typical species of DENDROGRAPTUS, as illustrated under the generic description, and in some other species, we have a wide departure from the typical forms of GRAPTOLITHUS, as developed in the characteristic species of the genus. The strong stem or trunk, which is free from cellules, and which has apparently been fixed at the base; the irregular branching, which has no bilateral, and apparently no definite arrangement, such as observed in all the forms of true GRAPTOLITHUS, are strong points of dissimilarity, and furnish characters for generic distinction. The stem and branches are unequally striated longitudinally, but the form of the celluliferous branches and of the cellules offers no important difference (except in the smaller dimensions) from those of the stipes or branches of the usual form of graptolites with a single series of cellules. In one species referred to this genus (the *D. gracilis*) there is some departure from the typical form of cellules, and the body of the stipe is contracted at intervals, while the form of cellule and cell-aperture is not unlike some of the sertularians.

The Genus CALLOGRAPTUS offers forms which are intermediate between true DENDROGRAPTUS and DICTYONEMA. In these species, the form of the cellules has not been fully determined. They are marked in one species by slight oval pustules, or oval depressions, upon the extremely compressed surface of the stipe; but it cannot be satisfactorily shown that this appearance indicates the normal condition of the cellule or the aperture. If the true form be in reality so far different from the usual character of the Graptolitidæ as these appearances indicate, it may be found necessary to separate them from this family.

The Genus Dictyonema is restricted to such forms as have the numerous stipes and branches connected by transverse processes, and the whole united in a flabelliform or funnel-shaped frond, without elongate stem or trunk. The stipes and branches are irregularly striated externally, consisting of a corneous envelope, as in ordinary graptolites; but I have not been able to determine clearly the existence of a solid axis. The cellules are indicated by angular processes or cell-denticles on the inner side of the branches, as shown in fig. 5 of Plate i.

In the Genus Rastrites of Barrande, the distinguishing features are the slender cylindrical stipes or branches, with slender tubular cellules which are free throughout their entire extent.

The few species of Thamnograptus known, consist of cylindrical or subcylindrical stipes, with slender elongate alternating pinnulæ or branchlets. No evidence of cellules has been observed in any of the specimens.*

The peculiar forms for which I have proposed the name Ptilograptus, consist of branching stems, which, in all their divisions, are studded on each side, in alternating order, with narrow pinnulæ. These are sometimes extremely slender, or even capillary in their dimensions. In one species I have detected elliptical spots upon one face of the pinnulæ which are slightly flattened, and I infer that these are the cell-apertures. The substance of the test is corneous, and there is an internal solid axis. Although I have placed these forms under the Graptolitidæ with some hesitation, the form of cellules may perhaps render a separation desirable; but with our present information, such a separation cannot at this time be made.

The Genus Inocaulis was proposed for some flattened stipes with a scabrous surface, which have the appearance of denticles upon the margins. These stipes grow in close groups or tufts, and are bifurcating or branched in their upper portions. No positive evidence of cellules has been observed. The presence of denticles, together with a corneous or

* It is possible that this genus may have more intimate relations with Rastrites than would appear from the species now known.

carbonaceous substance, have induced me to place this fossil among the Graptolitidæ.

There is still another form known, which may be doubtfully classed among the Graptolitidæ. It consists of a slender flexible median rachis, on each side of which are placed, in alternating order, slender flattened pinnulæ, which are of nearly equal width throughout, and are themselves flexuous. Upon one side of the rachis are minute points or dots, which have apparently been the cell-apertures. The test is a black corneous or carbonaceous substance, but there is no evidence of a solid central axis. These bodies are numerous in some shaly beds of the age of the Trenton limestone, at Plattville, Wisconsin. For these forms I have proposed the name of BUTHOGRAPTUS.*

Associated with the preceding forms there are some stipes of corneous or carbonaceous texture, frequently branched, the branches again dividing, and sometimes, if not always arranged in whorls; in one of which six divisions were counted. The general form of the body is not unlike that of DENDROGRAPTUS, but the branches are more slender, and ramify in a different manner, while there are no visible cellules. In the absence of farther knowledge, I refer these fossils, with hesitation, to the Genus OLDHAMIA (*O. fruticosa*, HALL).

The variety of form and mode of development among the Graptolites is shown by the collections from the Quebec and Hudson river groups to be much greater than had ever before been supposed. The number of species which have been traced to their origin or initial point, and whose mode of growth has been verified, is probably larger than in all collections heretofore made; and, together with those before known, enables us to give a very good exposition of the characters of this family of fossils.

SYNOPSIS OF THE GENERA OF GRAPTOLITIDÆ.

I.

Polypary, with a single series of cells, consisting of simple or divided stipes, or of branching fronds with a bilateral arrangment of the parts; a solid axis and common body.

1. The successive buds developed in tubular cellules (*hydrotheca*), which are in contact for a greater or less portion of their length, and inclined towards the axis.†

* *Report of Progress of the Geological Survey of Wisconsin for* 1860, communicated January 1st, 1861.

† This section as here presented is simply a revision of section 1 *a* of Report, p. 217, recognizing the genera which have been proposed for those forms heretofore placed under the genus GRAPTOLITHUS of LINNÆUS.

a. Polypary simple from the initial point [?]; cells triangular.
GRAPTOLITHUS, (*Linnœus*) *McCoy*.

b. Polypary growing bilateraly and consisting of two simple stipes, or of two stipes which dichotomise at their base.
DIDYMOGRAPTUS, *McCoy*,* [including TETRAGRAPTUS, *Salter*].

c. Polypary compound, growing bilaterally from the initial point, and repeatedly branching in a dichomotous manner.
DICHOGRAPTUS, *Salter*.

d. Polypary compound, growing bilaterally from the initial point, and consisting of four, eight or more simple stipes numerously divided near their base, and below the commencement of the cells; furnished with a corneous central disc. LOGANOGRAPTUS, *Hall*.

e. "Polypary compound, growing in one direction from the primary point;" the subdivisions taking place (by budding) from the celluliferous margin. CYRTOGRAPTUS, *Carruthers*.

f. Polypary compound, developed bilaterally from the initial point; cellules on one side of slender branches, which are developed on one or two sides of a long slender axis or rachis, the free extremities of which are likewise celluliferous. Not branching dichotomously. CŒNOGRAPTUS, *Hall*.

g. "Polypary growing bilaterally, irregularly and repeatedly branching and rebranching, and without a central disc."
CLADOGRAPTUS†, *Carruthers*.

2. Slender cylindrical stipes or branches, with tubular cellules arranged in single series. Cellules free throughout their entire length.
RASTRITES, *Barrande*.

II.

Polypary with two series of cells, a solid axis, which is slender and filiform or flattened.

a. Polypary simple, cellules developed in parallel arrangement on two sides of a common solid axis. Stipes narrow elongate. Sub-genus *Diprion*. DIPLOGRAPTUS, *McCoy*.

b. Polypary simple, with a double series of cells which are excavated in the margins of the stipe. CLIMACOGRAPTUS, *Hall*.

c. Polypary simple with a double series of cells which are in contact throughout their entire extent; solid axis excentric; substance reticulate. RETIOLITES, *Barrande*.

d. Polypary simple? or compound, with a double series of cells and a bilateral arrangement of the parts in the compound forms.
RETIOGRAPTUS, *Hall*.

* See supplementary notes.
† Of CARRUTHERS, not GEINITZ.

III.

Polypary with a double and single series of cells; the stipes simple below with a series of cells on each margin, and becoming dichotomous above with a single series of cells on the outer margin. Other forms having the polypary divided from the initial point with a single series of cells on each division. DICRANOGRAPTUS,* *Hall.*

IV.

Polypary with four series of cells, the laminæ united rectangularly by their axes, giving a cruciform arrangement to the parts. PHYLLOGRAPTUS, *Hall.*

V.

Species having a common trunk or stem, or growing in sessile groups of stipes from a common origin, without distinct bilateral arrangement of the parts. Cellules in single series on one side of the stipes or branches, and arranged along a common canal or axis.

1. Branches free, developed in a dichotomizing manner from a common trunk. Cellules in contact or closely arranged. DENDROGRAPTUS, *Hall.*
2. Branches unfrequently and irregularly connected by transverse processes. CALLOGRAPTUS, *Hall.*
3. Stipes and branches more or less regularly united in a reticulate frond. DICTYONEMA, *Hall.*
4. Stipes round or flattened, growing in groups, and bifurcating above; margins denticulate; surface rough or scaly. [*The relations of this genus are not fully determined.*] INOCAULIS, *Hall.*

VI.

Species having a common axis or rachis, with slender lateral alternating branchlets. Cellules unknown. THAMNOGRAPTUS, *Hall.*

VII.

Species having a common axis, more or less frequently bifurcating, with pinnulæ closely and alternately arranged on the opposite sides; cell-apertures on one face of the pinnulæ. PTILOGRAPTUS, *Hall.*

VIII.

A simple flexuous rachis, with slender flexuous flattened pinnulæ, arranged in alternating order, at close and regular intervals, on the two sides. Cell-apertures unknown or circular?. BUTHOGRAPTUS, *Hall.*

IX.

Strong stems, which are numerously branched. Branches and branchlets slender, arranged in whorls. Cellules undetermined. OLDHAMIA? *Forbes.*

* See supplementary notes.

VIII. *Geological and Geographical Distribution of the Graptolites in the Rocks of Canada and the United States.*

Until the remarkable discovery of the graptolites of Point Lévis, in 1854, the chief repository of these fossils known in American rocks was in the shales of the Hudson River valley. The position assigned to the rocks of this valley was the superior part of the lower division of the Silurian system. In this respect, the horizon of the Graptolite beds corresponded with those of Ireland, from which these fossils had been described by General PORTLOCK; * and with the position assigned to those in Sweden, as well as with those of the Llandeilo and Caradoc formations of Great Britain. The Graptolites of Bohemia are from strata referred by M. BARRANDE to the base of the superior division of the Silurian system; and those of Saxony were regarded as from the same horizon.

In 1850, M. BARRANDE expressed the opinion that the epoch of the graptolites was posterior to that of the "Faune Primordiale" in Bohemia and Scandinavia; while their association with primordial fossils in the Malvern Hills and at Snowdon, indicated the earlier appearance of these zoophytes in Great Britain. A comparison of all the published information on the subject at that time induced M. BARRANDE to conclude, as a general fact, that the graptolites had made their earliest appearance in the regions of the northwest; and that their highest development in central Europe had only been reached at a later period, or at the base of the upper division of the Silurian system.

The investigations during the Geological Survey of New York had proved in a pretty satisfactory manner that no graptolites proper occurred above the horizon of the Clinton group, though DICTYONEMA had been found in the Niagara formation. The species, at that time known ranged, from the higher strata of the Lower Silurian, to the lower beds of the Upper Silurian division; and both in Europe and America, these fossils were regarded as of eminently silurian character, and unknown in any later geological periods.

The discovery of a graptolitic species in the Potsdam sandstone of the St. Croix River valley, by Dr. H. A. PROUT, in 1850, was the first indication of the occurrence of this family of fossils at a lower horizon than that of the Hudson river and Trenton formations.

Before the discovery of graptolites in the shales of Point Lévis, these rocks were supposed to belong to the age of the Hudson river formation;

* *Geological Report on Londonderry*, etc., page 317–322.

and although it was shown that the graptolites were all of different species from those previously described, yet they appeared to offer only corroborative evidence in support of the previously entertained opinion regarding the age of the strata. It was only at a later period, and from the discovery of numerous other fossils in the same formation, some of them having a primordial aspect, that its higher antiquity was suspected.

The shales of Point Lévis, with their associated limestones and sandstones, since termed the Quebec group, are now regarded as embracing the period from the Calciferous sandstone to the Chazy limestone, inclusive. This epoch, therefore, is entirely anterior to that of the Hudson river formation, and a careful comparison of all the species of graptolites has shown that no identical species occur in the two series of rocks.

In the present state of our knowledge, we recognize the Graptolitidæ as beginning their existence at the period of the Potsdam sandstone. The greatest development of the family, both in genera and species, is found to be at the epoch of the Quebec group. Several genera and a few species are known in the Trenton formation; and a greater development, embracing most of the genera and many species, occur at the period of the Hudson river formation in Canada and the United States. In the Clinton strata we have a single species of GRAPTOLITHUS and a RETIOLITES; while DICTYONEMA and INOCAULIS occur in the Niagara beds. In all the subsequent geological formations we have found no true graptolites, and the only representatives of the family consist of fragments of DICTYONEMA, belonging to a few species. These occur in the Upper Helderberg and Hamilton formations, above which we do not yet know a species of any genus referable to this family of fossils. The GRAPTOLITES proper, therefore, have their upper limit in the shales of the Clinton formation, and all other genera of the family, except DICTYONEMA, are restricted to the Silurian system.

The geographical distribution of the graptolites is not in all respects coincident with the extent of the geological formation. DENDROGRAPTUS occurs in the Potsdam sandstone of the St. Croix valley; but neither this nor any other graptolite is known in other localities of the sandstone, so far as I am aware. The species of the Quebec group, numbering more than all the other formations together, have been identified for a longitudinal extent of about 900 miles; Point Lévis, Orleans Island, St. Anne's River (Gaspé), and the western part of Newfoundland, being the principal localities. But although the Quebec group is known to extend into Vermont and along the eastern counties of New York, I am not aware that graptolites have been found in any authentic localities of that formation, unless the *Diplograptus secalinus* of the Hoosic slates be referred to that group.* With these exceptions, therefore, these fossils of the group are known only in Canada and Newfoundland.

The Trenton limestone, while furnishing two species of GRAPTOLITHUS in New York, gives at the west no specimens of the genus proper; but we have one DICTYONEMA, a BUTHOGRAPTUS, and an OLDHAMIA? in the same formation in Wisconsin, though not elsewhere known to me at this time.

The Utica slate at Utica abounds in the remains of graptolites, and these fossils are of frequent occurrence at Oxtungo Creek, in the Valley of the Mohawk. It is probable that some of the localities referred to the Hudson river formation may be in the Utica slate, which, owing to the disturbed condition of the strata, is not separable from the succeeding slates of the group.

In the Hudson river formation the characteristic graptolites, of numerous species, have been found, in greater numbers than elsewhere, at Norman's Kill, near Albany; but they occur at Stuyvesant's Landing, and at the city of Hudson; while some species have been found near Baker's Falls on the Hudson river, and at Ballston and Saratoga, New York. Graptolites, of species identical with, and similar to those of the Hudson river formation, have been found by Dr. EMMONS in the shales of Augusta county, Virginia, and also in Tennessee.

The more characteristic species of the formation, *G. pristis*, *G. bicornis*, *G. ramosus*, *G. sextans*, *G. divaricatus*, and *G. gracilis*, have been recognized among the collections of the Canada Geological Survey, from the Hudson river formation in the Valley of the St. Lawrence: and a species of DIPLOGRAPTUS occurs in the Utica slate at Lake St. John. In the extension of this formation westward, a few species only have been found in Central and Western New York; among these, *G. pristis* is the most common, while *G. bicornis* is more rarely seen. In Ohio, we have no more than two species from rocks of this formation; while extensive collections from the same formation in Wisconsin and Iowa have afforded only three species (all unlike those from Cincinnati), and one of these has been found in beds of the same age in Illinois. In the catalogue of fossils appended to the Geological Report of Missouri, no mention is made of the occurrence of Graptolitidæ in any of the formations.

The greatest accumulation of materials at the epoch of the Hudson river formation has been in the direction from northeast to southwest;

* A single branching form, the *G. milesi*, has been published in the *Geological Report of Vermont*. The specimen was found in a boulder of slate, but it is probably of the Quebec group.

and along this line the black and dark colored graptolite schists, alternating with coarser beds, have collected in much greater mass than in any other part of its extent. In the northwestern counties of New York, Jefferson and Oswego, where the formation has a thickness of more than a thousand feet, the graptolites are comparatively few in species, and not of common occurrence. The gradual attenuation of the rocks of this formation towards the west is marked by the extreme paucity of graptolitic forms.

The graptolites of the Clinton strata have not, to my knowledge, been found beyond the limits of Western New York; and both their horizontal and vertical range is very restricted. The graptolitic forms of the Niagara formation (Dictyonema and Inocaulis) are very limited in their geographical extent.

The Dictyonema of the Upper Helderberg and Hamilton formations are known to occur in New York and in Ohio; and in the northwest a species has been found in the Upper Helderberg limestone on Mackinac Island.

This distribution of the Graptolitidæ, as well as their general association with other fossils, together with the nature of the sediments, would indicate the existence of quiet water and proximity of the coast-line as their habitat, and as the zone of their greatest development.

VERTICAL DISTRIBUTION OF THE GENERA OF THE FAMILY OF GRAPTOLITIDÆ.

GENERA.	Potsdam.	Calciferous, Chazy, Quebec.	Trenton.	Hudson.	Medina.	Clinton.	Niagara.	Onondaga.	Lower Helderberg.	Upper Helderberg.	Hamilton.	Chemung.	Carboniferous.
Graptolithus—†													
Sub-genera *Monoprion*, etc.	..	*	*	*	..	*	..	..	..	..	..	..	..
Sub-genus *Diplograptus*	..	*	*	*	..	..	..	..	..	..	..	..	..
Climacograptus	..	*	..	*	..	..	..	..	..	..	..	..	..
Dicranograptus	..	..	..	*	..	..	..	..	..	..	..	..	..
Phyllograptus	..	*	..	..	..	..	..	..	..	..	..	..	..
Retiolites	..	*	..	..	..	*	..	..	..	..	..	..	..
Retiograptus	..	*	..	*	..	..	..	..	..	..	..	..	..
Dendrograptus	*	*	..	..	..	..	..	..	..	..	..	..	..
Callograptus	..	*	..	..	..	..	..	..	..	..	..	..	..
Dictyonema	..	*	*	..	..	..	*	..	..	*	*	..	..
Ptilograptus	..	*	..	..	..	..	..	..	..	..	..	..	..
Thamnograptus	..	*	..	*	..	..	..	..	..	..	..	..	..
Rastrites	..	..	..	*	..	..	..	..	..	..	..	..	..
Inocaulis	..	..	..	..	..	..	*	..	..	..	..	..	..
Buthograptus	..	..	*	..	..	..	..	..	..	..	..	..	..
Oldhamia?	..	..	*	..	..	..	..	..	..	..	..	..	..

† For subdivisions under this head, see pages 251 and 260

The preëminence of the Quebec group, as the period of the greatest development in the Graptolitidæ, is shown in the above table. Of the seventeen genera and sub-genera here enumerated, eleven are known in this period; while four genera, viz: PHYLLOGRAPTUS, DENDROGRAPTUS, CALLOGRAPTUS, and PTILOGRAPTUS, are not at present known in any higher position than the Quebec group, though one of them occurs in the Potsdam sandstone. All those genera having the nearest relations with *Graptolithus* proper in the structure of their parts occur in this group, and the species monoprionidion found in it are more numerous than in all the subsequent formations, so far as at present known.

In addition to circumstances originally favorable to their development and growth, the subsequent condition presented during the period of the accumulation of the materials of the Quebec group, in Canada, seem to have been equally favorable to the preservation of graptolites, and in no other formation have they been found with all their parts so entire.

GEOLOGICAL DISTRIBUTION OF THE SPECIES OF GRAPTOLITIDÆ IN CANADA AND THE UNITED STATES.

GENERA AND SPECIES.	Potsdam.	Quebec. Calciferous, Chazy,	Trenton.	Hudson River.	Medina.	Clinton.	Niagara.	Onondaga.	Lower Helderberg.	Upper Helderberg.	Hamilton.	Chemung.	Carboniferous.
Genus GRAPTOLITHUS*													
(Sub-genus *Monoprion*),													
G. abnormis, HALL†	..	*	..	..	..	..	..	..	..	..	..	..	..
alatus	..	*	..	..	..	..	..	..	..	..	..	..	..
arcuatus	..	*	..	..	..	..	..	..	..	..	..	..	..
bifidus	..	*	..	..	..	..	..	..	..	..	..	..	..
bigsbyi	..	*	..	..	..	..	..	..	..	..	..	..	..
bryonoides	..	*	..	..	..	..	..	..	..	..	..	..	..
clintonensis	..	..	..	..	..	*	..	..	..	..	..	..	..
constrictus	..	*	..	..	..	..	..	..	..	..	..	..	..
crucifer	..	*	..	..	..	..	..	..	..	..	..	..	..
denticulatus	..	*	..	..	..	..	..	..	..	..	..	..	..
divergens	..	..	..	*	..	..	..	..	..	..	..	..	..
extensus	..	*	..	..	..	..	..	..	..	..	..	..	..
extenuatus	..	*	..	..	..	..	..	..	..	..	..	..	..
flaccidus‡	..	..	..	*	..	..	..	..	..	..	..	..	..
flexilis	..	*	..	..	..	..	..	..	..	..	..	..	..
fructicosus	..	*	..	..	..	..	..	..	..	..	..	..	..
gracilis	..	..	..	*	..	..	..	..	..	..	..	..	..
headi	..	*	..	..	..	..	..	..	..	..	..	..	..

* For subdivisions under this head see pp. 251 and 260.

† All the species in this Table same author, unless otherwise indicated.

‡ Utica slate.

GEOLOGICAL DISTRIBUTION OF GRAPTOLITDÆ.—CONTINUED.

GENERA AND SPECIES.	Potsdam.	Calciferous, Chazy, Quebec.	Trenton.	Hudson River.	Medina.	Clinton.	Niagara.	Onondaga.	Lower Helderberg.	Upper Helderberg.	Hamilton.	Chemung.	Carboniferous.
Genus GRAPTOLITHUS (Sub-genus *Monoprion*),													
G. indentus	..	*	..	..	..	..	..	..	..	..	..	..	..
logani	..	*	..	..	..	..	..	..	..	..	..	..	..
logani, var.	..	*	..	..	..	..	..	..	..	..	..	..	..
milesi *	..	*?	..	..	..	..	..	..	..	..	..	..	..
multifasciatus	..	..	..	*	..	..	..	..	..	..	..	..	..
nitidus	..	*	..	..	..	..	..	..	..	..	..	..	..
octobrachiatus	..	*	..	..	..	..	..	..	..	..	..	..	..
octonarius	..	*	..	..	..	..	..	..	..	..	..	..	..
patulus	..	*	..	..	..	..	..	..	..	..	..	..	..
pennatulus	..	*	..	..	..	..	..	..	..	..	..	..	..
quadribrachiatus	..	*	..	..	..	..	..	..	..	..	..	..	..
ramulus	..	*	..	..	..	..	..	..	..	..	..	..	..
richardsoni	..	*	..	..	..	..	..	..	..	..	..	..	..
rigidus	..	*	..	..	..	..	..	..	..	..	..	..	..
saggittarius†	..	..	..	*	..	..	..	..	..	..	..	..	..
serratulus	..	..	..	*	..	..	..	..	..	..	..	..	..
similis	..	*	..	..	..	..	..	..	..	..	..	..	..
surcularis	..	..	..	*	..	..	..	..	..	..	..	..	..
tenuis [?] (PORTLOCK).	..	..	..	*	..	..	..	..	..	..	..	..	..
Genus DIPLOGRAPTUS.													
D. amplexicaulis	..	..	*	..	..	..	..	..	..	..	..	..	..
angustifolius	..	..	..	*	..	..	..	..	..	..	..	..	..
ciliatus	..	..	..	*	..	..	..	..	..	..	..	..	..
inutilis	..	*	..	..	..	..	..	..	..	..	..	..	..
marcidus	..	..	..	*	..	..	..	..	..	..	..	..	..
mucronatus	..	..	..	*	..	..	..	..	..	..	..	..	..
peosta	..	..	..	*	..	..	..	..	..	..	..	..	..
pristis (HISINGER?)	..	..	..	*	..	..	..	..	..	..	..	..	..
pristiniformis	..	*	..	..	..	..	..	..	..	..	..	..	..
putillus, n. s.	..	..	..	*	..	..	..	..	..	..	..	..	..
quadrimucronatus ‡	..	..	..	*	..	..	..	..	..	..	..	..	..
secalinus, EATON	..	*	..	..	..	..	..	..	..	..	..	..	..
spinulosus	..	..	..	*	..	..	..	..	..	..	..	..	..
whitfieldi	..	..	..	*	..	..	..	..	..	..	..	..	..
(unnamed) n. s.	..	..	..	*	..	..	..	..	..	..	..	..	..
Genus CLIMACOGRAPTUS.													
C. attennarius	..	*	..	..	..	..	..	..	..	..	..	..	..
bicornis	..	..	..	*	..	..	..	..	..	..	..	..	..
parvus, n. s.	..	..	..	*	..	..	..	..	..	..	..	..	..
typicalis, n. s.	..	..	..	*	..	..	..	..	..	..	..	..	..
Genus DICRANOGRAPTUS.													
D. divaricatus	..	..	..	*	..	..	..	..	..	..	..	..	..
furcatus	..	..	..	*	..	..	..	..	..	..	..	..	..
ramosus	..	..	..	*	..	..	..	..	..	..	..	..	..
sextans	..	..	..	*	..	..	..	..	..	..	..	..	..
Genus PHYLLOGRAPTUS.													
P. angustifolius	..	*	..	..	..	..	..	..	..	..	..	..	..
anna	..	*	..	..	..	..	..	..	..	..	..	..	..
ilicifolius	..	*	..	..	..	..	..	..	..	..	..	..	..
typus	..	*	..	..	..	..	..	..	..	..	..	..	..

* From a boulder. † Probably identical with *G. multifasciatus*. ‡ Utica slate.

GEOLOGICAL DISTRIBUTION OF GRAPTOLITIDÆ.—Continued.

GENERA AND SPECIES.	Potsdam.	Calciferous, Chazy, Quebec.	Trenton.	Hudson River.	Medina.	Clinton.	Niagara.	Onondaga.	Lower Helderberg.	Upper Helderberg.	Hamilton.	Chemung.	Carboniferous.
Genus Retiolites.													
R. ensiformis	..	*	..	..	..	..	..	..	..	..	..	..	..
venosus	..	..	..	..	..	*	..	..	..	..	..	..	..
Genus Retiograptus.													
R. eucharis *	..	..	..	*	..	..	..	..	..	..	..	..	..
geinitzianus	..	..	..	*	..	..	..	..	..	..	..	..	..
tentaculatus	..	*	..	..	..	..	..	..	..	..	..	..	..
Genus Dendrograptus.													
D. diffusus	..	*	..	..	..	..	..	..	..	..	..	..	..
divergens	..	*	..	..	..	..	..	..	..	..	..	..	..
erectus	..	*	..	..	..	..	..	..	..	..	..	..	..
flexuosus	..	*	..	..	..	..	..	..	..	..	..	..	..
fructicosus	..	*	..	..	..	..	..	..	..	..	..	..	..
gracilis	..	*	..	..	..	..	..	..	..	..	..	..	..
hallianus, Prout	*	..	..	..	..	..	..	..	..	..	..	..	..
striatus	..	*	..	..	..	..	..	..	..	..	..	..	..
Genus Callograptus.													
C. elegans	..	*	..	..	..	..	..	..	..	..	..	..	..
salteri	..	*	..	..	..	..	..	..	..	..	..	..	..
Genus Dictyonema.													
D. cadens, n. s.	..	..	..	..	..	..	..	..	..	..	*	..	..
fenestrata	..	..	..	..	..	..	..	..	..	*	..	..	..
gracilis	..	..	..	..	..	..	*	..	..	..	..	..	..
hamiltoniæ, n. s.	..	..	..	..	..	..	..	..	..	..	*	..	..
irregularis	..	*	..	..	..	..	..	..	..	..	..	..	..
murrayi	..	*	..	..	..	..	..	..	..	..	..	..	..
neenah	..	..	*	..	..	..	..	..	..	..	..	..	..
quadrangularis	..	*	..	..	..	..	..	..	..	..	..	..	..
retiformis	..	..	..	..	..	..	*	..	..	..	..	..	..
websteri†	..	..	..	..	..	..	*	..	..	..	..	..	..
Genus Ptilograptus.													
P. geinitzianus	..	*	..	..	..	..	..	..	..	..	..	..	..
plumosus	..	*	..	..	..	..	..	..	..	..	..	..	..
Genus Thamnograptus.													
T. anna	..	*	..	..	..	..	..	..	..	..	..	..	..
capillaris	..	..	..	*	..	..	..	..	..	..	..	..	..
typus	..	..	..	*	..	..	..	..	..	..	..	..	..
Genus Rastrites.													
R. barrandi	..	..	..	*	..	..	..	..	..	..	..	..	..
Genus Buthograptus.													
B. laxus	..	..	*	..	..	..	..	..	..	..	..	..	..
Genus Inocaulis.													
I. plumulosa	..	..	..	..	..	..	*	..	..	..	..	..	..
Genus Oldhamia [?].													
O. fructicosa	..	..	*	..	..	..	..	..	..	..	..	..	..

* Nova Scotia. † Utica slate, Lake St. John, Canada.

The following is a list of the species of American Graptolites which have a single series of cellules on one side of the stipes or branches, indicating their relation to the point of origin or initial point, so far as known, following the arrangement of the synoptical table, page 251.

Genus Graptolithus, Linnæus.

A. Species known only as simple and single stipes from their origin. (*Monoprion Monograptus, etc.*)

G. clintoni.

B. Species having a bilateral arrangement of parts; often numerously sub-divided. (Sub-genus Monoprion, Barrande; Monograptus, Geinitz; Didymograptus, M'Coy.)

a. Polypary consisting of two stipes from a single initial point, with the cellules on the upper or inner side. (Didymograptus, M'Coy, in part; Cladograptus, Geinitz, in part.)

G. (D.) arcuatus,	*G. extenuatus,*	*G. pennatulus,*
bifidus,	*flaccidus,*	*serratulus,*
constrictus,	*indentus,*	*similis,*
divaricatus,	*nitidus,*	*tenuis.*
extensus,		

b. Polypary consisting of four simple stipes from a single axis, with or without a central disc. (Tetragraptus, Salter; Dichograptus, Salter, in part.)

G. alatus (disc),	*G. crucifer* (disc),	*G. headi* (disc),
bigsbyi,	*denticulatus,*	*quadribrachiatus.*
bryonoides,	*fruticosus,*	

c. Polypary consisting of eight simple stipes proceeding from a single axis, with or without a central disc. (Dichograptus, Salter, in part.)

G. octobrachiatus (disc), *G. octonarius.*

d. Polypary consisting of more than eight simple stipes (stipes not divided after becoming celluliferous), proceeding from a single axis, with a distinct broad, corneous disc. (Dichograptus, Salter, in part; Loganograptus, Hall.)

G. logani, *G. logani,* var.

It may be found desirable to include under the latter term *G. octobrachiatus*, *G. alatus*, *G. crucifer* and *G. headi*, on account of the presence of a central disc.

e. Polypary with the stipes proceeding from a single axis, and more or less frequently branched during their entire length; not known to have a central disc. (DICHOGRAPTUS, Salter, typical forms).

G. abnormis,	*G. multifasciatus,*	*G. richardsoni,*
flexilis,	*ramulus,*	*rigidus.*
milesi,		

f. Polypary developed from an initial point in two or more directions; these divisions developing celluliferous branches, and themselves becoming celluliferous towards their extremities. (CLADOGRAPTUS [?] Carruthers; CŒNOGRAPTUS, Hall.)

G. gracilis,	*G. divergens,*	*G. surcularis.*

g. Polypary consisting of two simple stipes from an initial point, with a single range of cellules on the outer margin of each; or, with the stipes simple for a short distance above their origin with a double range of cellules, and bifuracting above with a single range on each division. (DIDYMOGRAPTUS, M'Coy, in part; CLADOGRAPTUS, Geinitz, in part=DICRANOGRAPTUS, Hall.)

G. arundinaceus,	*G. furcatus,*	*G. sextans.*
divaricatus,	*ramosus,*	

It will be seen that the *G. clintoni* of the Clinton group is the only known American species of Graptolite of the monoprionidian type in which we have not demonstrated a more or less compound structure. It is possible that this species may grow in simple linear stipes as represented in some of the European species; but if this should be proved regarding it, such a character, taken in connection with the peculiar form of cellules, would entitle it to rank as a sub-genus at least, for which I would suggest the name, LAGENOGRAPTUS.

IX. *Historical Notice* of the Genus Graptolithus.*

Folia graminium	Bromel.
Graptolithus .... / Graptolites	Linnæus, Wahlenberg, Beck, Quenstedt, Murchison, Portlock, De Verneuil, Keyserling, Mather, Vanuxem, Emmons, Barrande, D'Orbigny, Geinitz, Suess, Meneghini, M'Coy, Richter, Salter, Nicol, Harkness, Hall, etc.
Priodon	Nilsson.
Orthoceratites.........	Wahlenberg, Schlotheim, Quenstedt, Geinitz.
Lomatoceras............	Bronn, Eichwald.
Prionotus	Nilsson, Hisinger.
Fucoides	Brongniart, Eaton, Emmons, Conrad, Vanuxem.
Petalolithus	Suess.
Diprion (sub-genus)	Barrande.
Didymograptus	M'Coy, Salter, and others.
Diplograptus............	M'Coy, Salter, Harkness, Hall, etc.
Monoprion (sub-genus)..	Barrande.
Monograptus .... / Cladograptus	Geinitz, Emmons.
Cladograptus	Carruthers, *non* Geinitz.
Glossogaptus........... / Nemagraptus	Emmons.
Tetragraptus .... / Dichograptus	Salter.
Cyrtograptus	Carruthers.
Climacograptus .... / Dicranograptus .... / Phyllograptus .... / Retiograptus........... / Cœnograptus .... / Loganograptus	Hall.

A. D. 1727. The graptolites of Sweden were observed by Bromel, who regarded them as leaves of grasses (*Act. Upsal*).

1736. Linnæus established the Genus Graptolithus in the first edition of his *Systema Naturæ;* and some years later, in the twelfth edition, introduced specific names, *G. scalaris* being the type of the genus. This form has been regarded by Wahlenberg, Geinitz and Barrande as the *G. sagittarius*, compressed in a direction rectangular to the cellules. The *G. sagittarius*, Linnæus, is therefore regarded by the latter author as the veritable historical prototype of the Genus Graptolithus and of the family of graptolites. For my own part, I consider the *G. scalaris*, so far as illustrations of that form have come under my observation, as a distinct type of the graptolite family.

1821. Wahlenberg considered the graptolites of Sweden as very slender orthoceratites (*Nova Acta. Soc. Scien. Upsal*, Vol. viii, pp. 92, 93.

* From the earliest notice of the Genus Graptolithus to the year 1850, I have added but little to that which has already been published by M. Barrande, in his *Graptolites of Bohemia*.

1822. SCHLOTHEIM, participating in the opinion of WAHLENBERG, described and figured a species under the name *Orthoceratites serratus* (*Petrefaktenkunde*, p. 56, Plate viii, fig. 3).

1828. AD. BRONGNIART described two species of graptolites from the Transition formation at "Pointe Lévi près Québec dans le Canada," as *Fucoides dentatus* and *F. serra** (*Histoire des Végétaux Fossiles*, pp. 70 and 71, Plate vi, figs. 7–12).

1829 [1831?]. F. HOLL re-published the description of *Orthoceratites serratus* of SCHLOTHEIM (*Handbuch die Petrefact.*, Vol. ii, p. 234).

18—? Prof. NILSSON recognized the graptolites as polyps belonging to the ceratophydians. He proposed to substitute the preöccupied name of PRIODON for that of GRAPTOLITHUS (See Dr. BECK, in *Murchison's Silurian System*, p. 696.)

1835. Prof. BRONN, adopting the opinion of Prof. NILSSON regarding the nature of graptolites, gave the name *Lomatoceras* (*Lethea Geognostica*, Vol. i, p. 55, Plate i, fig. 13, *L. priodon*), at the same time arranging the species with the orthoceratites, etc.

1837. HISINGER described five species of graptolites from the rocks of Sweden, adopting the generic name PRIONOTUS, proposed by Prof. NILSSON. Among these are two species of LINNÆUS, *P. sagittarius* and *P. scalaris;* to which he added the new species *P. pristis*, *P. folium* and *P. convolutus* (*Leth. Suecica*, p. 113, Plate 35.) In the second supplement to that work, published in 1840, two other species are added, under the names *P. geminus* and *P. teretiusculus;* the latter being of the type of *G. scalaris* (Supp. ii, p. 5, Plate 38).

1839. Sir RODERICK MURCHISON described and figured in the Silurian System three species of graptolites, *G. ludensis*, *G. murchisoni*, and *G. foliaceus* (*Sil. System*, p. 695).

1840. Prof. EICHWALD published a description of *Lomatoceras distichus*, a graptolite from the Silurian formation of Esthonia (*Sil. Syst. in Esthland*, p. 101).

1840. Prof. QUENSTEDT sought to reëstablish the opinion that the graptolites are true orthoceratites (*N. Jahrb. f. Min.*, p. 275).

1842. Prof. GEINITZ described and figured five species of graptolites under the names *G. foliaceus*, MURCHISON, *G. priodon*, BRONN, *G. ludensis*, MURCHISON, *G. serratus*, SCHLOTHEIM, *G. scalaris*, LINNÆUS, and *G. spiralis*, GEINITZ; regarding them as belonging to the Cephalopoda (*N. Jahrb. f. Min.*, p. 697).

* These species are probably identical with those which I have heretofore described as *G. pristiniformis* and *G. bryonoides*.

1842. VANUXEM identified a graptolite of the Utica slate with the *Fucoides dentatus* of BRONGNIART. *Graptolithus dentatus*, VANUXEM; *G. pristis*, HALL, HISINGER? (*Geol. Rep. 3d Dist., N. Y.*, p. 57, fig. 2).

1843. Gen. PORTLOCK, in his Geological Report, discussed the nature of the graptolites, recognizing them as true zoophytes, and indicating their analogy with *Sertularia* and *Plumularia.* He suggested that the species may form several genera, belonging perhaps to different orders. The species described and enumerated by this author are indicated under the names *G. sedgwicki*, *G. distans*, *G. tenuis*, PORTLOCK; *G. convolutus*, *G. sagittarius*, *G. pristis* and *G. folium*, HISINGER; *G. scalaris*, LINNÆUS, *G. foliaceus*, LONSDALE (*Geol. Rep. on Londonderry, Tyrone and Fermanagh*, pp. 317–321, Plates xix and xx). The species described by this author as GORGÒNIA, probably belong to DICTYONEMA.

1843. W. W. MATHER and E. EMMONS recognized *Graptolites dentatus* as characterizing the Utica slate (*Geol. Rep. 1st Dist. N. Y.*, p. 390, *and Geol. 2d Dist. N. Y.*, p. 279).

1843. J. HALL described *Graptolithus clintonensis* from the shales of the Clinton group in the Upper Silurian formation (*Geol. Rep. 4th Dist. N. Y.*, p. 72, fig. 12).

1845. Sir R. I. MURCHISON, DE VERNEUIL, and Count KEYSERLING enumerated *G. sagittarius*, HISINGER, and *G. distichus*, EICHWALD, as characterizing the Silurian formation of Russia (*Geol. of Russia and the Ural Mts.*, Vol. ii, p. 382).

1846. Prof. GEINITZ repeats the opinion expressed by himself in 1842, regarding the nature of the graptolites; and divides them into two sections, the straight and the spiral forms. In the first section he describes four species: 1. *G. foliaceus*, MURCHISON (with which he identifies *G. pristis* and *G. folium*, HISINGER, and *G. dentatus*, VANUXEM); 2. *G. priodon*, BRONN (under which he includes *G. ludensis*, MURCHISON, and *G. teretiusculus*, HISINGER); 3. *G. sagittarius* and *G. scalaris*, LINNÆUS (which he regards as varieties of the same species), *Fucoides serra*, BRONGNIART, and *G. murchisoni*, BECK; 4. *G. serratus*, SCHLOTHEIM (*Grundriss der Versteinerungen*, p. 310, Plate x).

1846. E. EMMONS published *Fucoides simplex* [= *Graptolithus secalinus*], from the roofing-slates of Hoosic (*Natural History of New York, Agriculture*, Vol. i, Plate xvii, fig. 1).

1847. J. HALL described and figured fifteen species of graptolites, mostly new, from the Lower Silurian strata, placing them among zoophytes (*Pal. N. York*, Vol. i, p. 265, Plates lxxiii and lxxiv).

1848. Rev. Prof. SEDGWICK announced the occurrence of *Graptolithus sagittarius*, HISINGER, and *G. latus*, M'COY in the Skiddaw slates. (*Quarterly Jour. Geol. Soc.*, Vol. iv, p. 223).

1848. J. W. SALTER, described *G. folium*, *G. pristis*, HISINGER, *G. pristis*, var. *foliaceus*, PORTLOCK, *G. ramosus*, HALL, *G. tænia*, SOWERBY and SALTER, *G. tenuis*, PORTLOCK, and *G. sextans*, HALL, from the slates of Loch Ryan, etc. (*Quart. Jour. Geol. Soc.*, Vol. v, pp. 15–17).

1848. Prof. PHILLIPS enumerated the *G. ludensis*, *G. murchisoni*, and three other species in the Builth, Llandeilo, and Harverford-west districts (*Memoirs of Geol. Survey*, Vol. ii, part 1, p. 308).

1849. JAMES NICOL enumerated and described *Graptolithus griestonensis*, *G. convolutus*, *G. ludensis*, and *G. laxus* (*Quarterly Jour. Geol. Soc.*, Vol. vi, pp. 63 and 64).

1849. J. HALL stated the occurrence of twenty species of graptolites in the Lower Silurian rocks; two other species having been found in the Clinton formation* (*Proceedings of the Amer. Assoc. for the Advancement of Science*, 1849, p. 351).

1850. J. BARRANDE published a memoir upon the graptolites of Bohemia, describing seventeen species of GRAPTOLITHUS, of which fifteen were new; a new genus, RASTRITES, with four species; and the genus RETIOLITES, with one species. These are all placed among the Polypi. All of these species, except one, are found in the Upper Silurian; four of them occur in the colonies of the inferior division, and pass upward to the superior beds; while one species is restricted to the lower division. M. BARRANDE has given in this memoir a resume of the geographical and geological distribution of the graptolites in the different countries of the globe.

1850. Prof. M'COY described three species of graptolites, proposing the name DIPLOGRAPSUS for those with a double series of cellules. He proposed also the generic name PROTOVIRGULARIA for a zoophyte which he refers to the Gorgoniadæ, but which may perhaps belong to the Graptolitidæ (*Annals and Magazine of Nat. Hist.*, Vol. vi, 2d series, pp. 270–272).

1850. Prof. HARKNESS described the graptolites found in the black shales of Dumfriesshire, recognizing two species of RASTRITES, and ten species of GRAPTOLITES (*Quar. Jour. Geol. Soc.*, Vol. vii, pp. 59–65, Plate i).

1851. Prof. M'COY published descriptions and figures of graptolites from British palæozoic rocks, adopting the name DIPLOGRAPTUS for the

* This number of twenty species included some forms known, but not at that time described.

species with two ranges of cellules; and proposing the name DIDYMOGRAPTUS for the bifurcating or two stiped forms with a single range of cellules. Of fifteen species which he described, eleven are identified as those of preceding authors, and three of these are recognized as American species (*British Palæozoic Fossils*, pp. 3–9, Pl. 3 B).

1851. Dr. H. A. PROUT described a graptolite, *G. hallinus* [= DENDROGRAPTUS], from the Potsdam sandstone of the St. Croix river (*Am. Journal Science* [2], Vol. ix, p. 187).

1851. EDWARD SUESS published descriptions of Bohemian graptolites, reproducing nearly all of those described by BARRANDE, recognizing several other known species, and describing nine new species. He proposed the name PETALOLITHUS as a substitute for DIPRION = DIPLOGRAPTUS (*Naturwissenschaftliche Abhandlungen*, Vierter band, pp. 88–134, Plates vii, viii and ix).

1851. J. W. SALTER described *G. tenuis*, PORTLOCK, and *G. bullatus* = *G. pristis ?*, from the Silurian rocks of Scotland (*Murchison, Silurian Rocks of Scotland, Quar. Jour. Geol. Soc.*, Vol. vii, pp. 173 and 174).

1851. CHRISTIAN BOECK: *Bemærkinger angaaende Graptolitherne;* with two lithographic plates (*Ledsager Forslærnings-Catalogen for* 1*st Halvaar*, 1851). CHRISTIANIA, 1851.

1851. SCHARENBERG, *Ueber Graptolithen* (cited by GEINITZ; work not seen by the writer).

1852. Prof. GEINITZ described the graptolites of Saxony, placing them among zoophytes, and proposing the genera MONOGRAPSUS and CLADOGRAPSUS for certain forms of graptolites, and the genus NEREOGRAPSUS to include MYRIANITES, NEREITES, etc. He enumerates and describes fifty species of graptolites of his own or of preceding authors; and one species of RETIOLITES, *R. geinitzianus* (*Die Versteinerungen der Grauwacken-formatien*, Heft i, *Die Graptolithen*).

1852. J. W. SALTER described some graptolites from the south of Scotland, recognizing three species *Quar. Jour. Geol. Soc.*, Vol. viii, pp. 388–391, Plate xxi).

1852. J. HALL reproduced the description of *Graptolithus clintonensis*, and described *G. venosus* = *Retiolites venosus.* He also described the genus DICTYONEMA, suggesting its relations with GRAPTOLITHUS, and likewise the genus INOCAULIS (*Palæontology of New York*, Vol. ii, pp. 39 and 40, Plate xvii, and pp. 174–176, Plates xl F and xl G).

1853. J. W. SALTER. A new species of graptolite (*Didymograptus caduceus*, SALTER), "from the Lauzon Precipice, Hudson river group" (*Quarterly Jour. Geol. Soc.*, Vol. ix, p. 87).

1855. Dr. EMMONS described several new species of graptolites, and proposed the generic names of NEMAGRAPSUS, GLOSSOGRAPSUS, and STAUROGRAPSUS (*American Geology*, Vol. 1).

1857. Prof. MENEGHINI, from collections made by General DE LA MARMORA, described ten species of graptolites from the Silurian rocks of the Island of Sardinia, of which eight species were new (*Palæontologie de l'Ile de Sardaigne*).

1857. J. HALL communicated to Sir WILLIAM E. LOGAN descriptions of twenty-one new species of graptolites from the Lower Silurian rocks of Point Lévis (Lauzon seigniory) near Quebec, (many of the species having compound forms not before known among this family of fossils), proposing several new genera (*Report of Progress*, *Geol. Survey of Canada*, 1857. See also the *Canadian Naturalist and Geologist*, Vol. iii).

1858. WILLIAM CARRUTHERS gave a list of twenty-four species of graptolites found in the shales of Dumfriesshire, and described the Genus CLADOGRAPTUS; *C. linearis*, *Diplograpsus tricornis* and *Didymograptus moffatensis* (*Annals & Magazine of Natural History*, Vol. iii,* 1859).

1859. J. HALL published *Notes upon the Genus Graptolithus*, with an enumeration of the Canadian species; a notice of graptolite-stipes with reproductive cells, together with descriptions of two new species (*Twelfth Report on the State Cabinet*, Albany, pp. 45 and 58, 1859).

1859. The preceding notes were reproduced, with descriptions of five additional species of GRAPTOLITHUS, one RETIOGRAPTUS, the genus THAMNOGRAPTUS, with two species, and one species of RASTRITES (*Palæontology N. Y.*, Vol. iii, Supp. pp. 495 and 522).

1860. J. HALL, in continuation of the paper from the Twelfth Report on the State Cabinet (from *Palæontology of New York*, Vol. iii, Supp.), described additional species of GRAPTOLITHUS, RETIOGRAPTUS, THAMNOGRAPTUS and RASTRITES as above (*Thirteenth Report of the State Cabinet*, pp. 55-64, 1860).

1861. J. W. SALTER, in "New Fossils from the Skiddaw Slates," noticed the occurrence of several species of GRAPTOLITHUS, and the discovery of a branching form similar to those which Sir WILLIAM E. LOGAN first brought to light in Canada, which he proposed to term DICHOGRAPTUS (*Geologist*, Vol. i, p. 74).

* It is with much regret that I am compelled to say that at the time of preparing the Canadian Decade, this volume was not within my reach, nor did I know of the publication of Mr. CARRUTHERS' paper, which otherwise I should have cited with pleasure.

1861. Prof. M'Coy sent to the writer a proof of a plate of graptolites from the "*Palæontology of Victoria.*" Among the figures are species closely resembling or identical with *G. ramosus*, *G. furcatus*, *and G. gracilis;* while others resemble *G. pristis*, *G. sagittarius*, &c. The descriptions or farther illustrations have not come under our notice.

1861. E. Billings "*On the Occurrence of Graptolites in the Base of the Lower Silurian.*" The paper contained a review of the work of Friedrich Schmidt, and a comparison of the graptolitic zones in Europe and America, with a view to show that the graptolite-schists of Norman's Kill, near Albany, are not in the upper part of the Lower Silurian division, or Hudson-river group (*Canadian Naturalist and Geologist*, Vol. vi, pp. 344 and 348).

1863. Sir William E. Logan recognized the occurrence of *Graptolithus bicornis*, *G. ramosus*, *G. mucronatus*, and *G. pristis*, characteristic species of the shales of Norman's Kill, in the Utica and Hudson river formations of Canada (*Geology of Canada*, p. 200, and *Catalogue of Fossils*, p. 942; Idem, *Graptolites of the Quebec group*. pp. 226 and 228).

1863. J. W. Salter (Note on Skiddaw-slate Fossils) noticed some new species of graptolites, proposing the new genus Tetragraptus, and describing the genus Dichograptus previously proposed, as cited above, including other characters (*Quarterly Journal of the Geological Society*, Vol. xix, pp. 135–140, with illustrations).

1866. Henry Alleyne Nicholson, "*On some Fossils from the Graptolitic Shales of Dumfriesshire.*" This paper announces the discovery of numerous minute bodies in the graptolitic shales, and associated with the *G. sedgwickii* in such a manner as to sustain the belief that they are *ovarian vesicles*, or graptolitic *gonophores* similar to those found in the shales of Norman's Kill, near Albany (*Proceedings of the British Association, Thirty-sixth meeting*, 1866, p. 63).

1867. William Carruthers, "*Graptolites; their Structure and Systematic position,*" with illustrations (*Intellectual Observer*, Nos. lxiv and lxv).

1868. William Carruthers. A revision of the British Graptolites, with descriptions of the new species and notes on their affinities (*Geological Magazine*, Vol. v, Nos. 2 and 3, *March*, 1868.

⁂ The Graptolithus from the Hoosic slate-quarries was named by Prof. Eaton *Fucoides secalinus*, and the specimens were thus labeled in the Cabinet of the Rensselaer School at Troy, as known to the writer from 1832 to 1836; but we have been unable to find any published descriptions.

SUPPLEMENTARY NOTES.

REMARKS UPON THE GENERA DIDYMOGRAPTUS M'COY, CLADOGRAPTUS GEINITZ, CLADOGRAPTUS CARRUTHERS, DICRANOGRAPTUS AND CŒNOGRAPTUS HALL.

In 1851, Prof. M'COY (*British Palæozoic Fossils*, page 9) suggested the name DIDYMOGRAPTUS in the following manner, after describing *Diplograptus? sextans* HALL, sp.:

"From the strong affinity between this and the *D. furcatus* HALL, sp. I provisionally leave it in the present genus, though it differs much from the normally formed species. Those species, bifid from the base as this, the *serratulus* HALL, *murchisoni* BECK, etc., form a little group, having one row of cells on each branch, sometimes on the inner, and sometimes on the outer edge: if necessary, these might be called DIDYMOGRAPTUS—the twin graptolites."

The term DIDYMOGRAPTUS as adopted in Great Britain, has usually been applied to such forms as *G. murchisoni* and *G. serratulus;* but Prof. M'COY clearly included species of two very distinct types, since *G. sextans* and *G. furcatus* have a different mode of growth, the cellules being on the outer margin of the polypary, and of a different form from those of the first named species and others usually referred to DIDYMOGRAPTUS.

In 1852, Prof. GEINITZ* proposed the name CLADOGRAPTUS, which, in its definition, included also the two groups of species here noticed, viz: those with the cellules angular and on the inner margin of the stipe, and those with curving indentations upon the outer margin of the stipe. He cites *C. ramosus* and *C. furcatus* HALL sp., in his first group, and *C. murchisoni* BECK, *C. serra* GEINITZ, *C. forschammeri* GEINITZ, *C. sextans* and *C. serratulus* HALL sp., in his second group. We have in fact precisely the same grouping under CLADOGRAPTUS that M'COY has given under DIDYMOGRAPTUS. If the latter term be employed to designate such forms as *G. murchisoni* BECK, *G. serratulus* and *G. bifidis* HALL, and similar forms, then CLADOGRAPTUS may be used in the restricted sense to designate such forms as *G. furcatus*, *G. sextans* and *G. divaricatus* HALL. In this case the term DICRANOGRAPTUS might be dropped; since it may not be proper to separate those with the stipe partially divided from those entirely divided,

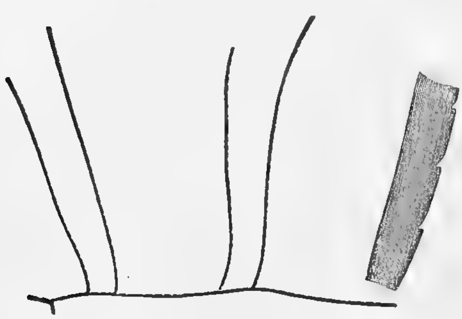
* *Die Versteinerungen der Grauwacken formation in Sachsen*, etc. Heft 1, *Die Graptolithen*, pp. 29–32.

where the cellules are similar in form. Such a disposition of the generic terms will satisfy the claims of Profs. M'Coy and Geinitz, each one having in his proposed genus included the two groups of species.*

In 1858, Mr. Carruthers, without knowledge of Prof. Geinitz's Genus Cladograptus, proposed the same name for a form of graptolite found in the shales of Dumfriesshire. In the typical species, the zoophyte is described as dividing, from a short and slender base, "into two stems, each supporting the cells on their upper sides." "Branches are given off at irregular intervals from these principal stems." In the *Intellectual Observer* (No. lxv, 1867), Mr. Carruthers has given the following description of the genus:

"Cladograpsus, *Car.* Polypary compound; growing bilaterally from the primary point; irregularly and repeatedly branching and rebranching, and without a central disc."

The original figure illustrating Cladograptus linearis (*Annals & Mag. of Nat. History*), shows it to be a fossil belonging to the group of *G. gracilis.* Hall, and the figure of the same in the *Intellectual Observer* shows less distinctly the same characters. The form is *not branching* and *rebranching* in the ordinary acceptation of that term (or by dichotomizing), as is clearly enough shown in the figures of Mr. Carruthers. In the figure first cited, the two main parts diverge on two sides from an initial point, and the divisions on one of these parts or branches rise at regular intervals from one side of the common rachis. In the specimen figured, the stipes or offshoots are in two pairs and at equal distances from each other, the intervening space being about three times as great as between the individuals of each pair, and probably indicating the place where two others have been broken off. In the American species of this type, there are no cellules on the principal rachis, except towards the distal extremeties of the two parts, and beyond all the subdivisions, which are usually from one side only.



Cladograptus linearis, Carruthers.

* I have heretofore used the term *Didymograptus* in its application to such forms as *G. murchisoni,* forgetting the original extent of its application by Prof. M'Coy; and it is only since the preceding pages have been in type, that on re-reading the remarks of the latter in the paragraph cited, I have become more fully impressed with the necessity for some revision of the terms in their application to species.

In the figure of *C. linearis* given in the *Intellectual Observer*, the divisions are shown as originating from one side only, while the main axis is continued, but not to our view branching and rebranching as described; not at least in the sense in which we apply that term to such forms as *G. flexilis* of this paper, or to such forms as DENDROGRAPTUS. There is no division of the celluliferous parts of the stipe, if we may judge from analogy with similar forms in the American rocks.

Should the term CLADOGRAPTUS of GEINITZ be retained for certain forms, as suggested above, then the Genus CLADOGRAPTUS of CARRUTHERS must be abandoned; and in any event it can scarcely be continued, since the same generic term had been previously applied to other forms of graptolites, and, as now appears, with as much reason for its adoption as the term DIDYMOGRAPTUS, which cannot properly be so extended as to include all the species originally named under it.

I have little doubt that the forms to which Mr. CARRUTHERS has applied the name CLADOGRAPTUS are similar to our *G. gracilis* and *G. divergens*, to to which I have applied the name CŒNOGRAPTUS; and it may be a question whether the NEMAGRAPTUS of EMMONS, proposed in 1855, is not of the same character; though the remarks of that author concerning the cellules would, if verified, exclude the typical species from that group.

The discussion in regard to nomenclature is at this time of small consequence, compared with that of the structure; and, on this account, these forms require to be separated from GRAPTOLITHUS proper.

The question as to the limitation of the term GRAPTOLITHUS still remains a matter for discussion. I have, on page 170, repeated what I had previously written upon this subject, and I still find little reason for a modification of those views. Mr. CARRUTHERS, speaking of the compound forms so common in our rocks, remarks: "Whether or not all the American graptolites are fragments of this more complex form, I cannot say; but it is certain that few if any of the European species could belong to it. In many species the termination of both the extremities of the polypary is known, and that end which should be united to the compound group is certainly free." This might have been said of our own species in past time; but experience has proved it otherwise, and at this time we have but one form of the *monoprionidian* type which we suspect to have grown in single stipes. But if this be true of European species, they have been erroneously represented. Even taking Mr. CARRUTHERS' own figures of "two perfect specimens of *G. clingani*," we are scarcely willing to accept the assertion. If we examine all the figures of PORTLOCK, we shall find that no one of them gives evidence of completeness at the base; and including the figures of SALTER, HARKNESS and M'COY, we shall find no better evidence of it. Consider also Mr. CARRUTHERS' description of CLADOGRAPTUS, where he says "the polypidom, at its origin near the base, is very narrow, being little more than a fine line: as it increases in breadth," etc. Now had this been broken off, when filled with the common body, where it had the width of a fine line, would it not have become less from consequent contraction, and have appeared as if complete at its lower extremity? When we look at such forms as *G. gracilis* in the slender attachment of the stipes to the common rachis, could we decide, in their separated condition, whether they were entire bodies, or stolons from a common body? I do not mean, however, to assert that there are no single *monoprionidian* stipes which are complete in themselves.

I am willing to reassert here what I have before said, that in the separated portions of the Graptolites we cannot distinguish between DIDYMOGRAPTUS, TETRAGRAPTUS and DICHOGRAPTUS; and in regard to the latter term, if it is to be brought into use, we have a right to some explation of its meaning and its limits. In the figure first given by Mr. SALTER in the *Geologist* (1861), where the name was proposed we have a properly branching form, not very dissimilar from *G. milesi* of this paper, but without a disc; and no allusion is made to a disc. In 1863,* Mr. SALTER gives a figure of *Dichograpsus aranea* of SALTER, a form with eight simple celluliferous stipes; and also "fig. 10, *Dichograpsis* SALTER with its corneous cup (from LOGAN)." Fig. 11, *Dichograpsus sedgwicki* is another species with eight simple stipes. At that time, it does not appear that Mr. SALTER had seen a British specimen with a central corneous disc. The addition of the disc to DICHOGRAPSUS was a subsequent idea, and the adoption of such forms as *G. aranea* and *G. sedgwicki* as the types of his genus by Mr. SALTER, leaves out the really branching forms, like the diagram in the *Geologist* for which the name was first proposed. If separation is to be made on such grounds as these, a farther one must be adopted; and the Genus DICHOGRAPSUS, which now includes three types, must be restricted to the types *D. aranea* and *D. sedgwicki.* This arrangement will leave those forms with the central corneous discs to form a new genus, for which I propose the name LOGANOGRAPTUS. Those which are repeatedly dichotomous, like *G. flexilis*, will constitute a third genus; for notwithstanding that Mr. SALTER says the DICHOGRAPSUS "is doubly branched

* *Quart. Jour. Geol. Society,* Vol. xix, p. 137.

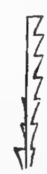
and again dichotomous more than once in most of the species," he does not show that feature in those he has given as the types of the genus; unless indeed he designates the divisions of the polypary below the cellules as the doubly branching and dichotomous condition, which, if in this case sufficient to constitute a generic distinction, is enough to warrant a farther separation where the branches are repeatedly dichotomous after becoming celluliferous.

In speaking of the monoprionidian forms of graptolites, I have neglected to explain the effects of compression in different directions, and the consequent aspect presented by the cellules upon the surfaces of the shaly laminæ. This is to some extent illustrated in Plate iii, fig. 24, and in the enlarged parts, figs. 28, 29 and 30. In the extremely dichotomous forms, like fig. 8 *a*, p. 208, and fig. 29, p. 217, the branches are variously compressed, sometimes presenting the celluliferous face as a narrow indented surface, limited on each side by the margins of the stipe (fig. 1). We rarely observe the more extremely compressed forms which, when the back of the stipe is presented on the upper side, have an appearance of double serratures, but with a different aspect at the indentation of the cellules from true Diplograptus (fig. 2). As these branches become partially turned so as to show the lateral face, we have the aspect presented in fig. 3, where the lower extremity shows some of the cellules marking the two sides, while the upper part shows the true character of the species.

Fig. 1.

Fig. 2.

Fig. 3.

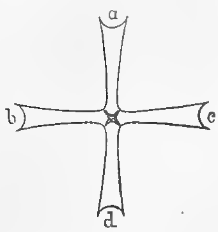


It is but rarely that the cellules of any of the genera or species are preserved in their proper form and proportions: they are however, sometimes found in this condition from being filled with the mineral matter of the surrounding rock; but often with iron pyrites, which preserves them in their original form more completely perhaps than any other substance.

In regard to the Genus Phyllograptus, I may not have sufficiently indicated the probable existence of a common body, the evidence of which is obscure, owing to the fact that the cell-partitions extend downwards nearly to the solid axis, and are apparently connected with it at the exterior margins. I suppose that the narrow bases of the cell-partitions are concave towards the axis, and consequently allow the presence of a continuous slender common body, uniting the bases of all the cellules as in ordinary forms of graptolites, where the common body is of variable width, and sometimes very narrow. The general aspect of this type of Graptolite is illustrated in figs. 23 and 24 on page 213, while the figures on

Plate iv present other phases of two species. It will be observed that in some of these there is a central linear space marked by the bases of cellules, while others present a simple dark line to which the cell-partitions are joined. The graptolites of this type, having the character of four simple graptolitic stipes joined at the back, will present in sections a cruciform figure like fig. 5 of Plate iv. When these bodies were thrown down upon the muddy sea bottom, they would become imbedded mainly in two positions. The most common position appears to be that in which the parts retain a vertical and horizontal position, as in the accompanying fig. 4. The lower division, or *d*, would thus become first imbedded; while the parts *b* and *c* would be in the plane of deposition, and *a* would be the last imbedded. This slaty laminæ will separate along the line *b*, *c*, either above or below the graptolite, leaving on one side the substance of the cellules and on the other the impression. If the separation take place above, then the bases of the cellules often remain: these are directed obliquely downward towards the base of the stipe, as shown in figs. 2 and 7 of Plate iv. If the separation takes place below the substance of the graptolite, in the plane *b*, *c*, the cellules of the division *d* are seen directed upwards towards the apex of the stipe, like fig. 15 of Plate xvi, Canadian Decade.

Fig. 4.



The other direction of imbedding would be where the specimens were so deposited that the divisions rested obliquely to the plane of stratification upon the points *c*, *d*, as in fig. 5. In this position, they would, from the accumulating sediment, become compressed as in fig. 6, until the parts *b*, *d*, and *a*, *c*, would approach each other, or come in contact. Lying thus, the slaty laminæ separating above or below them, they would present the aspects of figs. 4 and 6, Plate iv; giving no evidence of cellules except at the margins; unless where the stipe may be fractured when we have an exhibition of a section of the cellules as in fig. 1 of Plate iv. When the separation takes place in such a manner that the parts *b a* are removed, the parts *d c* remain, showing the bases of two rows of cellules, as in fig. 3 of Plate iv. The various phases presented in large collections of specimens of these forms are all explicable upon this view of their mode of growth and manner of imbedding in the soft mud of the sea bottom.

Fig 5.

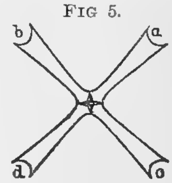
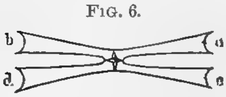


Fig. 6.



NOTE ON THE GENUS PTILOGRAPTUS, HALL.—Since the publication of the Canadian Decade, I have seen the work of GŒPPERT, "*Ueber Die Fossile Flora der Silurischen, der Devonischen und Unteren Kohlen Formation*, 1859." The *Callithamnion*, or *Callithamnites reussianus*, figured on plate xxxvi, from the Upper Silurian of Bohemia, is so similar to the *Ptilograptus genitzianus* of Plate xxi, Canadian Decade (Plate iv of this paper), that I cannot doubt the generic identity. Whatever may be the relations of the European species, the Canadian one is not a plant, if we may judge from its horny carbonaceus texture.

In a paper on "*Fucoides in the Coal Formation*,"* by M. LESQUEREUX, the author has stated his opinion that the "peculiar *Fucoides serra*" described by BRONGNIART in his *Végétaux Fossiles*, page 71, tab. 6, figs. 7 and 8, should be placed under the Genus CAULERPITES of STERNBERG, into which he proposes to admit all the forms described by Prof. HALL under the name of *Spirophyton*, Regarding the latter, I have, in this place, nothing to say; but the *Fucoides serra* of BRONGNIART is no doubt a species of Graptolite, and the locality whence cited, "*Pointe Lévi près Québec*," has afforded many species of GRAPTOLITIDÆ, but no recognizable species of *Fucoides*. In the "*Figures and Descriptions of Canadian Organic Remains*," Decade ii, page 84, I have given my reasons for believing that the *Fucoides serra* of BRONGNIART is identical with *Graptolithus bryonoides* of HALL (Plate iv, figs. 1–11, and Plate iii, figs. 11 and 12 (?) of Decade, and Plate iii, figs. 16 and 17 of this paper), the identity not having been discovered till long after the publication of the last named species. The *Fucoides dentatus* of BRONGNIART, from the same locality, is likewise without doubt a graptolite, and probably identical with that described by me as *G.* (*Diplograptus*) *pristiniformis*. I have no doubt that if M. LESQUEREUX were to examine these and other Lower Silurian fossils of generally similar character, he would arrive at the same conclusions as myself regarding their nature and relations.

* *On Fucoides in the Coal Formation* [with a Plate]. By LEO LESQUEREUX. Read before the American Philosophical Society, May 18th, 1866.

(L.)

CONTRIBUTIONS TO PALÆONTOLOGY.

By JAMES HALL.

I & II. OBSERVATIONS ON THE GENERA STREPTORHYNCHUS AND STROPHODONTA.

The illustrations for these papers not having been completed, the discussions upon the characters of the genera will be deferred to a future report.

The result of a critical examination of the species known in the higher rocks of New York has resulted in referring to *Strophomena chemungensis* CONRAD, the following forms, which are apparently only varieties of this very variable species: *Strophomena bifurcata* HALL, *S. arctostriata* HALL, *S. pectinacea* HALL, *Orthis perversa* HALL, *Streptorhynchus pandora* BILLINGS, *Orthisina arctostriata* and *O. alternata* HALL, *Orthis inequalis* and *O. pravus* Hall.

Among these there are noticed as distinct varieties, the following:

a. *Streptorhynchus pandora* BILLINGS, which differs very little from *S. woolworthana* HALL of the Lower Helderberg group.
b. *S. arctostriata* HALL;
c. *S. perversa* HALL;
d. *S. pectinacea* HALL.

These varieties of form and of surface-markings are illustrated on Plates iv, ix and x of Vol. 4, *Palæontology of New York.*

The study of the hinge structure in some forms referred to the Genus STROPHODONTA has suggested some modifications in the limits of the genus, and indicates in one direction an intimate relation with STREPTORHYNCHUS.

III. GENUS CHONETES FISCHER, 1837.

(From Vol. IV, Palaeontology of New York.)

THE Genus CHONETES, having the general form of STROPHODONTA or STROPHOMENA and LEPTÆNA, is distinguished externally from those genera by the tubular spines on the cardinal margin of the ventral area; and from PRODUCTUS, by the manner in which these spines are disposed. In some species, however, in addition to these, the surface of the shell is studded with small spines as in PRODUCTUS. Internally it has been shown by Mr. DAVIDSON to possess characters which ally it with PRODUCTUS; and it connects more nearly, by form and general features, the families of STROPHOMENIDÆ and PRODUCTIDÆ.

In the ventral valve, the area is narrow but well-defined, with a distinct foramen which is partially closed by a pseudo-deltidium, and the remainder of the space is filled by a cardinal process from the opposite valve. In the bottom of the cavity there is a longitudinal median ridge, and on each side and close to it are the occlusor muscular impressions: the divaricator impressions occupy a wider space, and usually are not very well defined in their limits, though having the same general form and features as those of STROPHODONTA.

In the dorsal valve, the teeth-sockets are well marked. The cardinal process is entirely unlike that of the preceding genera, being simple at its base, and bifid or grooved at the extremity; while the lateral divisions usually reach nearly as far as the central portion of the process, and are separated from that by a groove more or less distinct. Sometimes the lateral or accessory lobes are distant from the extremity, and separated in like manner by a groove.

In one or more of the slender forms of the process, these lateral lobes are situated at some distance from the apex, and appear like minute processes on the sides. At its base, the cardinal process is continued in a slender median ridge. The double occlusor impressions are small, and from between them proceeds an elevated vascular marking which assumes a reniform shape; this being a distinguishing feature of the genus, which allies it with PRODUCTUS.

The interior of the shells are strongly pustulose or papillose: the little granules are arranged in the direction of the striæ and along the grooves of the exterior striæ, which often become defined elevations upon the inner surface of the shell.

So far as we at present know the species in the rocks of this country, the genus begins its existence in the shales of the Clinton group, where a single species has been found. There are two species known in the Lower Helderberg group, and but a single one in the Oriskany sandstone.* Two species are known in the Schoharie grit, and three others are common in the Corniferous limestone; while others are added to the number in the Hamilton and Chemung groups. Several species are known in the Carboniferous limestones and in the Coal measures.

For the most part the species are of small size, and, when well preserved, it is not very difficult to distinguish them; but in their various conditions of preservation, such as partially exfoliated and more or less worn shells, casts of the interior and impressions of the exterior in a matrix varying from pure limestone to calcareous shale, and through the arenaceous shales to a nearly pure sandstone, the specific relations often become difficult of determination.

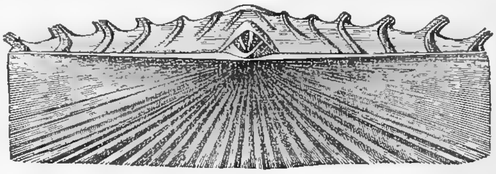
In a very large proportion of the specimens coming before me for investigation, the cardinal spines cannot be seen, or are but imperfectly preserved. Their comparative strength or direction often furnishes means for specific distinction; but I have not been able to satisfy myself that the number of spines on the hinge-line is of specific importance, for these are sometimes unequal on the two sides of the apex, and their development seems often to be promoted or retarded by the irregular growth of the shell; some of the larger species having only three or four spines on each side of the beak, while in the smallest specimens of the group in our rocks (*C. lepida*), I am able to count six spines on each side; and in *C. scitula*, as many as six or seven, the bases only of many of them being preserved, in the substance of the shell, as tubular openings.

In many specimens the spines can be seen to originate near the inner margin of the area, or along the hinge-line, and can be traced in the substance of the shell in an oblique direction inwards, at first nearly parallel with the margins of the foramen; and it is only after becoming free, that they take a vertical or obliquely outward direction.

* The same occurring in the Lower Helderberg group.

The accompanying figure of the hinge-line of *Chonetes scitula*, greatly enlarged, will illustrate the relations of the tubular spines.

The nature of these tubes penetrating the substance of the shell, has been pointed out by Count VON KEYSERLING,* and shown in his illustrations of *Chonetes comoides;* but this function has been doubted by Prof. DE KONINCK, who regards their obliquely inward direction as a contrary indication.† In



many of our specimens, however, I am able to trace these tubes through the substance of the shell fromthe hinge-margin (their opening into the interior being a little within the margin), beginning near the triangular foramen, and penetrating the shell to the upper edge of the area in lines parallel to the sides of the foramen. Those nearest the centre are more closely arranged than those at a greater distance: the former appear on the exterior as minute pustules, sometimes very close to the apex of the shell; and in receding from the centre, they become more prominent, and attain the character of spines. In some examples, the obliquity of the tubes within the substance of the shell is seen to become less and less on receding from the apex, and they are often curved outwards before reaching the surface; but the connexion of these tubes with the spines is unmistakable.

In numerous examples of the casts left by the destruction of the ventral valve, the form of the tubes is well preserved in the infiltrated matter; and in these casts we often find evidence of the tubes near the centre, where no spines are visible on the exterior surface of the shells of the species, as in *Chonetes logani* and *C. scitula.*

The following specie of CHONETES are known in the Upper Helderberg and Hamilton groups of New York:

Chonetes acutiradiata,
C. *arcuata,*
C. *coronata,*‡
C. *deflecta,*
C. *hemispherica,*
C. *lepida,*
C. *lineata,*
Chonetes logani, var. *aurora,*
C. *mucronata,*
C. *pusilla,*
C. *scitula,*
C. *setigera,*
C. *yandellana.*

* *Geognostiche Beobachtungen auf einer Reise in das Petschora-land.* By Count ALEXANDER VON KEYSERLING, 1846.

† "These grooves do not appear to me to be produced by the cardinal tubes, as M. DE KEYSERLING thinks, because in this case they should take an opposite direction: I am led to believe that they depend solely on the successive growth of the shell." *Recherches sur les Animaux Fossiles,* p. 190.

‡ The *Chonetes littoni, C. maclurea, C. tuomeyi* and *C. martini* of NORWOOD and PRATTEN are regarded as varieties of *C. coronata* (CONRAD).

The *Chonetes scitula*, *C. lepida* and *C. setigera* occur likewise in the Chemung group, together with a remarkable species, the *C. muricatus*.

The *Chonetes logani* was originally described from the base of the Burlington limestone of Iowa; and a careful comparison of specimens from that locality, as well as from intermediate points in Ohio, together with casts of the same, has left no doubt of the propriety of referring the Tully limestone species to that one. The criticisms of Prof. WINCHELL regarding the concentric lamellose lines or ridges, I do not regard as of even varietal value, and the varying conditions in this respect are merely accidental. The species is illustrated on Plate xxii of Vol. IV, *Palæontology of New York;* and every care has been taken to give a true representation of the characters of specimens from Iowa, Ohio and New York.

IV. REMARKS ON THE GENERA PRODUCTUS, STROPHALOSIA AULOSTEGES AND PRODUCTELLA.

(From Vol. IV, Palæontology of New York.)

The genera constituting the Family Productidæ, as recognized at the present time, are the following: Chonetes, Productus, Strophalosia, and Aulosteges; the two latter being considered by Mr. Davidson as subgenera of Productus.

The Genus Chonetes has already been noticed in the preceding pages; and from its marked characters there is usually little danger of confounding it with any other of the Productidæ. The Genus Productus, in its typical and varied forms, is characteristic of the Carboniferous period; a few species are known in the Permian, while other similar forms in the Devonian, which were formerly considered as Productus, have lately been referred to the genus or subgenus Strophalosia of Prof. King.

Productus, which is the oldest established genus, includes species described as semicircular or semioval concavo-convex shells, with spiniferous exterior surface, straight hinge-line, without an area on either valve, and without teeth or sockets. The interior characters, though with a general resemblance to Strophodonta, have in addition certain other points by which they are distinguished. Notwithstanding that the species of Productus have usually the shell more or less closely studded with spines, and generally a row of spines just below the hinge-margin of the ventral valve, there are some species referred to this genus which are nearly destitute of spines, and others upon which no spines have been detected except on the ears or near the cardinal margin. Species having this exterior character are usually more extremely gibbous or ventricose in the ventral valve than any species of Leptæna, Strophodonta or Chonetes, and the dorsal valve is more deeply concave.

Strophalosia is described as differing externally from Productus in sometimes having a truncated apex, and by the presence of an area of greater or less extent on each valve, with a foramen which is more or less closed by a deltidium. In the interior it is said to be characterized by teeth in the ventral valve and teeth-sockets in the opposite valve; while the disposition of the reniform vascular impressions of the dorsal valve is a distinctive feature.

In reference to the Genus PRODUCTUS, Mr. DAVIDSON remarks as follows:

"All authenticated species of PRODUCTUS hitherto examined have shown themselves to be edentulous; but whether this character was general and without exception, may remain a question for further consideration; anyhow, the dorsal valve must have turned on its hinge-line with as much precision as CHONETES, which possessed regularly articulating teeth. It has been often asserted and believed that PRODUCTUS might be distinguished from its subgenera by the total absence of an area; and although this is the prevalent character of the genus, still in certain species, such as *P. sinuatus*, a perfectly developed area is generally present in the ventral valve. There exists also an occasional tendency to the formation of hinge-area in several species, as may be seen, for example, in the remarkable example of *P. semireticulatus*, of which a representation is given in Plate xliii, fig. 5." *

These observations of Mr. DAVIDSON are of later date than his "*Introduction to the Natural History of Brachiopoda.*"

One of the important features of distinction between PRODUCTUS and STROPHALOSIA has been stated to be the different disposition of the reniform vascular impressions in the dorsal valve. The accompanying figures represent this character in two species of the latter genus—fig. 1, *Strophalosia goldfussii*; fig. 2, *Strophalosia morrisiana*—as given by Mr. DAVIDSON in his Introduction.

FIG. 1.

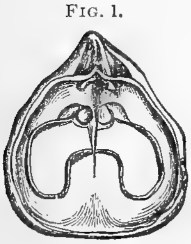
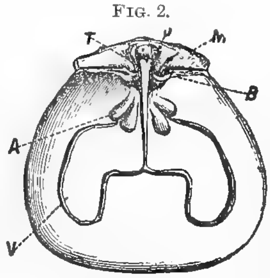


FIG. 2.



In examining the species occurring in the higher formations of the New York rocks, which I had supposed might be referred to the Genus STROPHALOSIA, I find evidence of a narrow area with small teeth and sockets in the greater number of species; although these features do not usually appear, except upon the most critical examination. The disposition of the reniform vascular impression, however, does not correspond with that of STROPHALOSIA; but in all the species where this feature has been observed it is similar to that shown in figs. 3, of *Productella onusta*, and 4, of *Productella striatula*, enlarged to two diameters.†

FIG. 3.

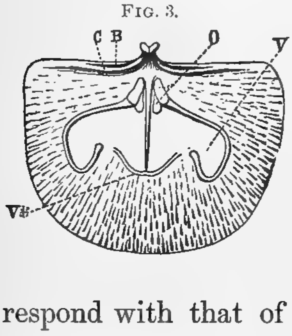
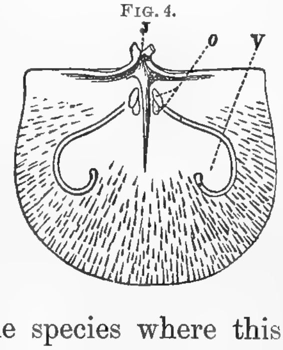


FIG. 4.



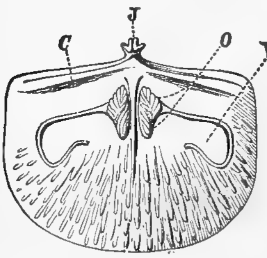
* *Monograph of British Carboniferous Brachiopoda*, p. 136, 1861.

† *B C*, tooth-socket and socket-plate; *J*, cardinal process; *O*, anterior and posterior occlusors; *V*, the reniform vascular impressions; *V**, the faint diverging impression proceeding from the extremity of the mesial septum.

Neither of these species are known to have the apex of the ventral valve truncated. In another species, with extremely gibbous and arcuate ventral valve and deeply concave dorsal valve, the disposition of the reniform impressions is precisely like those illustrated; and in none of the species under investigation have we seen the least evidence of reniform impressions like those of figures 3 and 4, which are illustrations of Permian species of STROPHALOSIA.

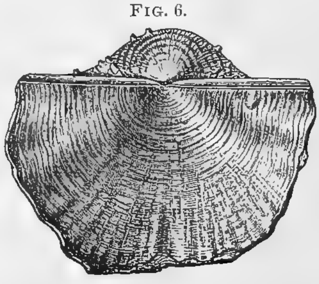
It is clear, therefore, that this character could not be relied on for distinguishing the genus, if we were to include in it our Devonian species; for in the three species referred to, the imprint has the same direction and termination as shown in AUSTOLEGES, except perhaps that the muscular scars may be a little nearer the hinge-line; and in this respect it is not very dissimilar to some species of PRODUCTUS, as shown in *P. costatus* (fig. 5), interior of the dorsal valve showing the reniform vascular impressions, cardinal processes and the oblique callosity *C.**

FIG. 5.



I have, moreover, ascertained that the American forms of *P. costatus* have often a well defined area on the ventral valve, and a narrow area on the dorsal valve, extending nearly the entire length of the hinge-line; and in some specimens, this is as distinct as the area of STROPHODONTA or of CHONETES. There is of course a foramen, which is open in the examples observed; though in Mr. DAVIDSON'S figure of *P. semireticulatus*, cited above, the foramen is closed by a deltidium. The specimens of ventral valves of PRODUCTUS, which I have been able to examine, have no true teeth or extensions from the margins of the foramen; but sometimes a callosity extends obliquely backward and unites with the interior of the shell, being in fact as much a representation of dental laminæ as we have in some species of STROPHODONTA.† The accompanying figure 6 is a dorsal view of *Productus costatus*, showing the hinge area.

FIG. 6.



Thus we see that the species referred to PRODUCTUS may have all the

* *Productus longispinus* and *P. pustulosus* have a similar form of the reniform impressions. See DAVIDSON'S *Monograph of British Carboniferous Brachiopoda.*

† See *Strophodonta demissa, S. reversa, S. nacrea* and others.

characters of Strophalosia except the hinge-teeth and sockets, and the disposition of the reniform impressions; while the New York species, possessing teeth and sockets, have not the disposition of the reniform vascular impressions which are given by European authors as characteristic of Strophalosia.

In glancing at the species of Productidæ illustrated on Plates 23, 24, 25 and 26 of Vol. iv, *Palæontology of New York*, one cannot fail to be impressed with the prevailing greater width on the hinge-line, and consequent modification of form in the American Devonian species, as compared with the Strophalosia of the Permian system in Europe. But while the greater part, and perhaps all of these, have a narrow cardinal area and small hinge-teeth and sockets, I conceive that their exterior character and expression are much more like the true Productus than are the Permian species of Strophalosia; and one of the most marked features consists in the conspicuous ears with rows of spines, as in Carboniferous Producti; while their anterior extension and highly arcuate forms assimilate them much more with Productus than with Strophalosia.

The Productidæ of this character make their first appearance in the American geological series in the Upper Helderberg group, and continue with increasing numbers through the successive formations to the Carboniferous limestone. There are a few individuals of two species in the Corniferous limestone, and more in numbers of individuals and of other species in the Hamilton group; but it is difficult to find specimens in a condition favorable for satisfactory investigation. A few specimens have been obtained entirely separated from the rock; but nearly all are imbedded, with the ventral valve adhering to the matrix so that the hinge and interior structure can rarely be seen; while the dorsal valves almost uniformly adhere by their exterior surface, leaving only their interior for examination.

In the Chemung group, the specimens occur mostly as casts of the interior and impressions of the exterior, and these are frequently much distorted. In some of the softer compact shales of this group, we find the shell partially preserved, but still in such condition that the entire characters cannot be discovered; and it is only in some fresh exposures of the semicalcareous bands that we are able rarely to obtain specimens of more natural appearance and better preserved surface. Under circumstances of so much difficulty, it is with much hesitation that I approach the final disposition of the species of this character in our formations.*

It would appear that the Genus STROPHALOSIA has been founded upon characters derived from Permian species, in which the interior structure has been well preserved. Of the few European Devonian species of this genus which are cited, I have seen no illustrations of the interior; and these have probably been referred to the genus from the generally similar form, the presence of a narrow area, and minute teeth and sockets, which are characters found in identical or similar forms in the American strata. It is probable, therefore, that had the interior of these species been observed, they would not have been placed among the Permian Strophalosiæ, but rather among the Producti, to which they seem more nearly allied.†

It appears to me that we have in the Devonian period the incipient manifestation of the productidian type, which became modified in the later Carboniferous period, where, with conditions favorable to its excessive development, it has assumed extravagant forms and proportions, but here and there indicating the characters of its prototype in the presence of an area and foramen, among species of a genus which is characterized by the absence of these features. In the still later Permian period, with changed conditions, we have an approximate return to the earliest forms of the species, or to the prototype; and in reality the foundation of the genus lies in the Devonian forms which have been referred to STROPHALOSIA.

It would appear that the presence, rather than the absence of characters, should be the foundation of generic description and determination; and in this view PRODUCTUS possesses fewer characters, and, in the absence of hinge-area, teeth and sockets, is less complete than the forms possessing these appendages. Nevertheless, the great development of forms and number constituting the Genus PRODUCTUS during the Carboniferous

* Those who have the best right to criticise the work, from having themselves labored in a similar field, will appreciate the difficulties to be encountered; and they will only need to be assured of my earnest intention to dispose of the species without prejudice or partiality to previously expressed opinions. With larger collections before me than I had when originally describing the species under the preceding genera, I have seen cause to modify in some instances the views formerly maintained, and I believe I have shown no leniency towards species proposed by myself on insufficient materials; but I am quite unable, at the present time, to reduce the species of this type from these formations, to the limits indicated by European authors who have examined American collections.

† Prof. DE KONINCK, in his *Recherches sur les Animaux Fossiles*, has not recognized the Genus STROPHALOSIA; and the Devonian forms similar to those of our rocks are by him placed under PRODUCTUS.

period has acquired for it the importance and distinction which it must retain; and any subdivisions proposed must have reference to the characters of this genus as established.

On a critical examination of the genera of the Family Productidæ, we shall find that CHONETES is distinguished by well-marked and important characters, having an area on each valve and a row of spines upon the margin of the area of the ventral valve, which is one of the distinguishing external features, though it has been ascertained that spines sometimes occur on the body of the shell.

The separation of the genera or subgenera STROPHALOSIA and AULOSTEGES from PRODUCTUS is based upon less important differences. The former has an area on each valve, a foramen in the ventral valve covered by a deltidium, with teeth and sockets, while the reniform vascular imprints have a different direction and termination. The latter has a wide area on the ventral valve, a foramen closed by a pseudo-deltidium, without teeth or teeth-sockets, and with the reniform vascular impressions extended far towards the anterior margin of the valve, and sometimes abruptly recurved.* The typical species of AULOSTEGES is very similar to STROPHALOSIA in external form. Both are from the Permian system, and the differences between them consist in the presence or absence of teeth and sockets, and the different direction of the reniform impressions.

While the typical and fully developed forms of STROPHALOSIA in the Permian system have a large area on the ventral valve, with a narrow area on dorsal valve; all the New York species have a very narrow area on each valve (often so narrow as to be no greater than the thickness of the shell), with the other general differences pointed out. These features alone might not be sufficient to indicate a distinct group; and a little extension of the characters of PRODUCTUS or of STROPHALOSIA might include them; but while STROPHALOSIA and AULOSTEGES remain distinguished by such small differences, these forms, also, I conceive, should be separated from the former, both on account of the external differences and from the reniform vascular impression, which has been regarded as an important feature in the Productidæ. These differences I consider as scarcely less important than those upon which the other subgenera have been separated; and from their external form and internal structure so nearly resembling PRODUCTUS, I would propose for the Devonian species

* The disposition of the reniform impressions is not essentially different from that of some species of PRODUCTUS; and the presence of an area and covered foramen, and the absence of teeth and teeth-sockets are the distinguishing features.

having narrow hinge-areas and small teeth and sockets, with reniform vascular impressions of the form of those illustrated, the name PRODUCTELLA.

SUBGENUS PRODUCTELLA, n.s-g.—Shells having the general form of PRODUCTUS, but uniformly with a narrow area on each valve, a foramen or callosity on the ventral area,* small teeth, and more or less distinct teeth-sockets.

The reniform vascular impression, rising from between the anterior and posterior occlusor muscular impressions, curves gently outwards, and, following a curvature somewhat parallel with the margin of the shell to below the middle of its length, is abruptly recurved, and the extremity, turned a little backwards, terminates about half way between the margin and the anterior extremity of the mesial septum.

The cardinal process, seen from the inner side, is bilobed, and from the exterior side each of these divisions is usually bilobed.

These shells differ from STROPHALOSIA in the extremely narrow linear cardinal area, greater extension of the hinge-line, more extreme arcuation or ventricosity of the ventral valve in many or most of the species, and especially in the direction and termination of the reniform vascular impressions, which resemble those of AULOSTEGES and of some species of PRODUCTUS. They differs from the typical forms of PRODUCTUS in the constant presence of an area, hinge-teeth and sockets.

* In the specimens affording the most satisfactory evidence of area, etc., the foramen is open; but in some specimens the impression only remains, and there is the appearance of a narrow indentation below the beak, so that it is impossible to determine whether the foramen has been open, or closed by a deltidium.

V. ON THE GENERA SPIRIFERA, CYRTINA AND ALLIED GENERA.

THIS paper will be deferred on account of the non-completion of a plate illustrating the hinge-structure of SPIRIFERA and allied genera, which will be finished for a future report. In the mean time I will repeat here the concluding remarks of the chapter on SPIRIFERA from Vol. iv, *Palæontology of New York:*

"Some important considerations are suggested by the study of *Spirifera præmatura*, *Spirifera alta*, and their associates.

"The species which I have here designated as *Spirifera præmatura* exhibits no external markings which enable one to say that it is distinct from *S. hirtus* of the sandstones at Burlington, Iowa; nor does it present differences from *S. pseudolineata* which may not be reconciled with geographical influences, and with a habitat nearer to the shore line and the essential absence of calcareous matter in the sediments deposited. Its associates, however, are of different species from those in the western locality; but still among the more conspicuous of these is *Spirifera alta*, *Productus lachrymosa* var., and *Chonetes muricata*, which have a carboniferous aspect; and were it not for the presence of *Spirifera disjuncta* and one or two others, the general aspect of the fauna might be termed carboniferous.

"If again we look at the characters of *Spirifera alta*, an analogue or representative of *Spirifera cuspidata*, we have many points of similarity with one or more species in the rocks of the West and Southwest which are usually referred to a higher position. The high area and the transverse concave septum, which is not a true pseudo-deltidium, allies it with *Spirifera textus*, in which we find similar features. In the *S. alta* there has probably been an external convex pseudo-deltidium, and between this and the septum closing the fissure has been a narrow space. This septum, which is an extension of the dental lamellæ, has been thickened or expanded on the inner side, as shown by the casts of the ventral valve; and in several specimens there is a narrow semi-cylindrical depression extending nearly to the beak of the valve.

"In comparing this species with *Spirifera textus*, we find similar conditions, or more properly an extension or amplification of the same features. In that species there is a convex arching pseudo-deltidium, though rarely preserved in the specimens. Beneath this there is concave septum, and upon the inner face of this there is a tubular callosity; or, in other words, the inner laminæ of the septum become fistulous, and enclose a cylindrical or sub-cylindrical space, which extends from the base of the septum to near the apex of the valve.* But more usually the laminæ appear to be separated, and, extending inwards, are recurved, their edges sometimes joining to form a tube; but more frequently, perhaps, the margin of each one is recurved upon itself, leaving the tube with a slit along the lower side. In some instances, however, these extensions from the inner face of the septum continue to the bottom of the cavity, and, joining the external shell, leave a quadrangular tube instead of a cylindrical one.

"It is evident from what has been said, as well as from the illustrations given, that there is a near approach to this character of *S. textus*, or an incipient step towards it, in *Spirifera alta;* but the feature has not become fully developed. We have the concave septum with a semi-cylindrical callosity on its inner face, but this ridge has apparently remained solid. The concave septum, however, must not be confounded with the pseudo-deltidium: the latter is apparently an independent growth of shelly (or sometimes perhaps scarcely solid shell) matter, forming an exterior plate from the apex of the fissure, covering to a greater or less extent the opening, but apparently not connected with, nor a part of the dental lamellæ or substance of the area, while the septum is an outgrowth or lateral extension of the dental plates.

"In the case of *Spirifera alta*, the extension of the septum is so great, that when connected with the general form of the shell, its nearest analogue appears to be *Spirifera textus;* which, so far as I can now determine, is identical with the one described by me as *S. subcuspidatus* in the *Geological Report of Iowa.* The latter is a carboniferous species from the Keokuk limestone, and closely allied to the *Spirifera cuspidatus* of Europe; and the Chemung species thus reminds us of the Carboniferous one, or has a carboniferous aspect.

"If, in its full development, the presence of a septum and internal tube be regarded as of generic value, then we have in *Spirifera alta* the same appendages in part, or in a partially developed condition; the distinct tube only being wanting. But had we the means of examining the internal characters of the ventral valves of all the species of Spirifers, we should probably find gradations from the solid filling of the rostral cavity, with a greater or less extension of shelly matter in the form of a septum in the fissure occupying a narrow space in its apex, till we reach the development observed in *S. alta* and *S. textus.*

"To a considerable extent, we are able to prove this supposition. In the separated valves of *Spirifera radiata* of the Clinton and Niagara groups, there is a filling of the rostral cavity, and thickening of the dental lamellæ which are extended for half the length of the valve. The narrow median crest of the muscular impression is expanded and thickened towards the apex of the valve, but there is no evidence of a septum. In *Spirifera niagarensis* there is a filling of the rostral cavity and a thickening of the dental lamellæ, which are distinctly separate, but no appearance of a septum; and there is a low median crest in the muscular impression.

"In the Lower Helderberg group, the *Spirifera macropleura* has the rostral cavity filled to a greater or less extent, and the dental plates extremely thickened at their bases; while there is an obscure low median crest in the muscular impressions, which sometimes becomes thickened and expanded above; and

* It is upon this feature, or one of similar character, in its full development, that I understand Prof. WINCHELL proposes to found the Genus SYRINGOTHYRIS.

occasionally there is a little filling of the upper part of the fissure, resembling the incipient stages of growth of the septum. In *Spirifera cycloptera* the rostral cavity is more or less filled and solid, with diverging dental lamellæ; while the crest dividing the muscular impression is very unequally developed, and there is no appearance of a septum. In *Spirifera perlamellosa* the rostral cavity is filled to a greater or less degree, the dental lamellæ are short and strong, and thereis a sharp elevated median crest or septum in the muscular impression; but there is no indication of the transverse septum. In *Spirifera octocostata* the dental lamellæ are thickened, and there is a *vertical* septum reaching from the apex of the rostral cavity to the base of the muscular impression. In *Spirifera marylandica* of the Oriskany sandstone, there is sometimes a partial filling of the rostral cavity, with a reversed conical crest in the upper part of the muscular area. *Spirifera arenosa* has strong dental lamellæ; a filling of the rostral cavity in old shells; a low crest dividing the muscular impression, which becomes thickened in its upper part; a distinct pseudo-deltidial covering of the fissure, but no transverse septum.

"Among the Spirifera of the Upper Helderberg group, *Spirifera acuminata* has usually only a moderate thickening of the rostral portions, divergent lamellæ of moderate strength, and no transverse septum. In *Spirifera oweni* the rostral cavity is partially filled; the dental lamellæ are thickened; there is a reversed conical callosity at the apex of the cavity, the attenuated continuation of which divides the muscular area: the fissure is closed by a thickened plate or septum for one half its length from the apex. In *Spirifera raricosta* the rostral cavity is filled; the dental lamellæ are short and thick; the fissure is closed by solid filling for a part of its length, while from the bottom of the cavity there rises a thin vertical septum which extends to within one-third the length of the front of the valve. In *Spirifera gregaria* the rostral cavity is more or less filled by the thickened dental lamellæ, and sometimes the incipient growth of a transverse septum is perceptible.

"In several of the Spirifers of the Hamilton group the septum is well marked, while in others there is an incipient development of the same character. In *Spirifera granulifera* the upper part of the rostral cavity is filled with shelly matter, and this apparently encroaches upon the space below with the advancing age of the shell. The fissure becomes partially filled, and a thickened plate projects a little in advance of the solid filling of the beak; leaving behind it, or on the inner side, a conical cavity directed towards the apex of the shell. The muscular area is divided by a low longitudinal crest, which, in its extension towards the beak, becomes wider, and is often much thickened towards its junction with the solid shelly matter filling the rostral cavity. Looking at this from the apex of the shell, it presents a sub-conical form, and is more or less abruptly attenuated towards the centre of the muscular impression. This callosity sometimes becomes so prominent as to produce an emargination or indentation in the apex of the cast, and a similar feature is sometimes observed in the casts of other species of SPIRIFERA.

"Regarding the *S. granulifera* alone, there is little to attract especial notice, beyond the general fact of a partial filling of the rostral cavity with the exterior portion prolonged between the dental lamellæ, but so much thickened as scarcely to merit the term septum. In *Spirifera marcyi* this development of shelly matter has the character of a true septum, closing one-third or more of the length of the fissure from above, and leaving an open rostral cavity behind it. In *S. medialis* and *S. macronota* there is a thickened transverse septum extending from one-third to one-half the length of the fissure from the apex, and this feature is quite independent of the pseudo-deltidium. The rostral cavity lies behind this septum, and may be open or free from the accumulation of shelly matter to a greater or less extent; but it is not uncommon to find nothing more than a thickening of the base of the dental plates and a partial filling of the rostral cavity. This condition changes to a greater or less extent during the growth of the shell; but a partial filling of the fissure at its apex is probably more common than otherwise, particularly in full-grown individuals.

"In the Spirifers of the Carboniferous rocks which I have been able to examine, this feature is variably developed. In *S. plena* of the Burlington limestone, the septum extends for more than half the length of the fissure; while it is less developed in *S. grimesi*, and scarcely at all in *S. increbescens* and *S. opima*.

"The shell texture of Spirifera is usually regarded as fibrous, and this is true of all those I have examined in the older strata; though in some of the species of the higher formation, characters have been observed, which, with imperfect means of investigation, seem to be irregularly distributed ducts penetrating the shell. I have not been able to examine the shell of *Spirifera alta*, to learn whether any changes have taken place in its texture, not observed in other species of Spirifera; but in *S. textus*,* where the septum and tube are developed, the shell is penetrated by numerous pores or ducts which are somewhat coarser than the ordinary punctate structure of some other Brachiopoda; and though not in actual contact, are often arranged in regular order and frequently in close proximity to each other, not essentially differing from those of Spiriferina as given by Dr. Carpenter. The intermediate spaces have a distinctly and beautifully fibrous or prismatic structure, differing in no respect from ordinary Spirifers or Athyris.

"It should be observed, in this connection, that the dental plates, both in *Spirifera alta* and *S. textus*, reach to the bottom of the cavity, and partially surround the muscular impression, which is precisely like that of ordinary Spirifers.

"In these remarks, I have not intended to express an opinion of the generic value of certain characters; but merely to show, as it appears to me, a gradual or successive development in certain parts, which finally becomes so wide a departure from the characters of typical forms of Spirifera as to deserve especial attention. Nor can we deny that this progressive development of the septum and its modifications keeps pace, and corresponds with the geological succession; reaching its extreme state, so far as now known, in the Carboniferous period, where it is connected with a punctate texture of the shell."†

* In this species, and in *Spiriferina spinosa* of Norwood and Pratten, the pores or ducts are unequally distributed; being in some parts of the shell, closely crowded, while in others they are more distant and often following the line of growth, though frequently irregularly disposed.

Prof. Winchell remarks of the proposed Genus Syringothyris, that "the shell is impunctate in all conditions and under high powers."

† See note on page 256.

The *Spirifera alta* referred to in the preceding pages is an analogue of the European carboniferous *Spirifera cuspidata*, having a similar elevated area which is usually "slightly inclining forward or nearly rectangular to the general plane of the dorsal valve. The fissure is high and narrow, and is closed for two-thirds of its length from the apex by a concave septum which is entirely independent of the pseudo-deltidium." On page 249 of Vol. iv, *Palæontology of New York*, I have made the following remarks under the description of the species:

"This species is known to me only in the condition of casts of the interior, and its usual appearance is illustrated in the figures on Plate xliii. Its general aspect is much like that of the European *Spirifera cuspidata*, MARTIN; but there are important differences by which it may be distinguished: these are, the plications on the mesial fold, the larger area of the dorsal valve, and the shorter extension and greater divergence of the dental lamellæ by the sides of the muscular impression. Some of these characters, I conceive, are not likely to change to those shown by *S. cuspidata*. In the concave septum closing two-thirds of the fissure from above, it resembles that species as described by Prof. M'COY, who mentions the presence of a 'deep-seated pseudo-deltidium.'† In one of the figures given by Mr. DAVIDSON and referred with doubt to this species,‡ the casts shows a tubular perforation in the filling of the fissure, and a gutta percha impression from the same shows the mark of a foramen; but there is no positive evidence of a septum which is so conspicuous in our specimens, and which I suppose to be the feature characterized by Prof. M'COY as a deep seated pseudo-deltidium. In our species, I have not been able to discover any corresponding perforation; the only indication of this being the semi-cylindrical impression along the centre of the fissure (in the cast), showing a callosity of the septum behind the exterior wall.

"In form and proportions, this species bears a very close resemblance to one in the Waverly sandstone of Ohio, and also to one in the fine-grained sandstone of Burlington, Iowa; but of neither of these have I the necessary material for satisfactory comparison. It differs from the *S. subcuspidata*.§ of SCHNUR in the plications on the mesial fold and sinus, and the wider area of the dorsal valve; and also in the same characters it differs from the *S. textus* of the sandstone and argillaceous limestone near New Albany, Indiana." ||

† * * * *; triangular opening very large, often displaying the internal deep-seated pseudo-deltidium (without perforation, leaving the only opening to the shell at its base); * * * M'COY, *British Palæozoic Fossils*, p. 426.

‡ *Monograph of British Carboniferous Brachiopoda*, Plate ix, fig. 1 and 1*a*.

§ *Spirifer subcuspidatus*, HALL, *Geological Report of Iowa*, p. 646, Plate xx, fig. 6, is a distinct species, and apparently identical with *S. textus*, HALL, *Tenth Report on the State Cabinet*, p. 160, 1857. See *Nineteenth Report on the State Cabinet*, for remarks on this species.

|| The latter species, before alluded to as a punctate shell, has the fissure partially closed by a septum, and this is perforated near the apex by a circular foramen, which is continued in a longitudinal tube behind the septum and opens into the cavity of the shell below. The margins of the fissure are grooved for the reception of a pseudo-deltidium as in ordinary spirifers, and this appendage is partially preserved in some of my specimens.

NOTE.—After the matter quoted on the preceding pages had been some time in print in Vol. iv, *Palæontology of New York*, I saw in the *American Journal of Science* for May, 1866, a notice of a paper in the *Proceedings of the Academy of Science of Philadelphia*, entitled "Observations on the Microscopic shell structure of *Spirifer cuspidatus*, and some similar forms, by F. B. MEEK."

Thinking there might be some similarity in the results, and wishing to avoid all chance of future charge of plagiarism when the volume should appear, I sent the printed sheets to Prof. DANA, with a request that he would note the fact of receiving them, and in case any complaint should be made hereafter, simply to state that this matter was in print at that time. In order still further to guard myself against any future attack, I sent the sheets to Mr. J. P. LESLEY, of Philadelphia, asking him to communicate them to the Academy of Natural Science, with the explanation before given, with a view to avoid all cause of future complaint. There was no priority claimed, nor any expression indicating such intention. It was merely publishing matter already printed in another form. The matter was published in the *Proceedings of the American Philosophical Socieiy*, as "from the *Palæontology of New York*, Vol. iv, pp. 252–257; unpublished."

Notwithstanding all my efforts to avoid an attack, there appears in the *American Journal of Science* for May, 1867, an article "On the puncate shell structure of *Syringothyris*, by F. B. MEEK, with the following foot-note on page 408:

"In a paper on certain types of Spiriferidæ, published in the *Proceedings of the American Philosophical Society* for 1866, and presented to that Society in May of 1866, Mr. J. HALL presents facts confirming my observations communicated in a paper read before the Philadelphia Academy of Natural Science, in December, 1865, and published February, 1866, in which the presence of a punctate structure in shells of this type, and its coincidence with the internal tube of *Syringothyris*, were first announced. He, however, makes no allusion to my investigations, of which he certainly was not ignorant."

Now, Mr. MEEK saw by the publication that it was not "*a paper*" presented by me to the Society, but an extract from a volume printed and not published. It may have been quite disingenuous on his part to cite it as "a paper" presented in the usual manner, and he affects to believe that I was not ignorant of his investigations, etc. I have stated above simply the facts. The *Journal of Science* professes to *deal fairly and justly* in all scientific matters, and one of its editors was in possession of all the facts, and could have prevented all cause of ill feeling on the part of any one. I have only to say that my investigations, as they stand in print, had been made long before, and were in print before the time mentioned by Mr. Meek as the publication of his paper. Moreover, I had not at the publication of my own observations, nor have I to the date of this writing, ever seen Mr. Meek's paper, nor do I know more of it than has appeared in the *American Journal of Science.* Had I been writing on this subject after the publication of his paper, I might, perhaps, have written somewhat differently, and should have noticed his investigations. A paper embracing all this matter, as well as further investigations on the hinge structure of the Spiriferidæ, was communicated to the *Nineteenth Report on the State Cabinet;* but the Appendices of that Report have never been printed, and the accumulation of matter for the Twentieth Report has been so great that it has been impossible to procure the illustrations, and the paper is still further postponed.

VI. ON THE GENERA ATHYRIS, MERISTA AND MERISTELLA.

This paper was prepared for the *Nineteenth Report on the State Cabinet*, but was not reached in the course of printing. In the meantime, Vol. iv of the *Palæontology of New York* has been completed; and the notice of that volume in this Report, pp. 173–199, will give all the essential points in the later investigations of these genera, being in fact the substance of the paper prepared for the former Report.

These later investigations have added something to our knowledge of the interior structure or character of the internal spires of Athyris and Meristella, as illustrated in this notice. We have also seen enough of other forms to induce a doubt regarding the structure of the spires in some of the species heretofore referred to these genera, and, in two or three species, very positive differences have been observed.

In a former Report,* I discussed the nomenclature of these shells, with regard to the adoption of the use of the generic names Athyris and Spirigera, in a manner which I regarded as fair and just, and which I think will be so conceded by unprejudiced naturalists. These views have received the approbation of Mr. Davidson, who has copied my remarks in full in his *Monograph of the Palæozoic Brachiopoda of Great Britain;* and it is gratifying to have the approval of a gentleman who has made the special study of the Brachiopoda the principal work of a lifetime. My views, however, were fiercely attacked in the *American Journal of Science*, in an article bearing the marks of triple authorship, and also by one of the authors in his paper in the *Canadian Journal*, where, "by *geologic* blows and knocks," after having demolished the Genus Meristella, he sets up the Genus Charionella upon precisely the same grounds, except an impossible hinge structure.

In the July number of the *American Journal of Science* 1867, Mr. Billings devotes something over thirteen pages to a discussion of "the *classification* of the subdivisions of M'Coy's Genus Athyris as determined by the laws of zoölogical nomenclature." We are treated in the outset with a note in which Mr. P. P. Carpenter is reported as having "said that he thought Mr. Billings had clearly established his point," etc.

* *Thirteenth Report on the State Cabinet*, 1860.

"Mr. WHITEAVES stated that he was satisfied with the correctness of the view Mr. BILLINGS had taken," etc. "Principal DAWSON deplored the confusion that had arisen through conflicting views on the question of nomenclature, and, agreeing with Mr. BILLINGS in the conclusion he had come to, stated that this communication was valuable, insomuch as it cleared up a question that had been rendered obscure." *

Thus fortified in the outset, Mr. B. starts off upon his argument, which, could such a thing ever be suspected of this author, would have very much the appearance and arrangement of a case of special pleadings. He closes his article by a citation from a former one, recommending Mr. HALL to treat the subject "in a clear and unsophisticated manner."

We appreciate this appeal of Mr. BILLINGS, and sympathize in his dilemma, when, after appearing in several articles on this subject (in none of which has he added anything to our knowledge of the matter), he finds himself unable to present an "*unsophisticated*" view of the case, he appeals to his opponent to come to his aid. We would endeavor to oblige the courteous writer, but being just now very much engaged in the study of the structure and relations of these fossils, we have less time to discuss questions of nomenclature which have been for some time settled in the minds of most naturalists.

There are, however, one or two points which it may be well to take notice of here; and however a writer may choose to disguise the facts, they must necessarily become known to every investigator of fossils. The generic name ATHYRIS was given by Prof. M'COY, in 1844 (*Carboniferous Fossils of Ireland*, p. 146); and under it are cited in the following order, *A. concentrica*, *A. decussata*, *A. depressa*, *A. expansa*, *A. fimbriata*, *A. glabristria*, *A. globularis*, *A. hispida*, *A. planosulcata*, *A. squamosa*, and *A.* (?) *triloba*. These, with the exception of the last one, are retained by Mr. DAVIDSON, either as species or synonyms under the Genus ATHYRIS.

In 1847, D'ORBIGNY, objecting to the term ATHYRIS on account of its implying a zoölogical contradiction, proposed the name SPIRIGERA; making it precisely equivalent to ATHYRIS, and citing the same species under it, including also others, but making *S. concentrica* the typical species. Let us cite here a rule, which is likewise cited by Mr. BILLINGS:

* I trust the gentlemen here referred to will not take offence at being thus cited by me: this is neither my intent or animus. Whether or not it may have been in good taste to associate their names in this manner with the article in the *Am. Journal of Science*, I do not undertake to decide. Every one can appreciate the value of opinions expressed under such circumstances, where the parties themselves have made no investigations of the matter, and accept without criticism the statements of a writer or speaker.

"When two authors define and name the same genus, *both making it exactly of the same extent*, the latter name should be canceled *in toto*, *and not retained in a modified sense*."

Mr. BILLINGS gives an ideal figure of M'COY—or at least, if not ideal, it is given without a name in the *Carboniferous Fossils of Ireland*, p. 128 (fig. 19)—and speaks of it as the "typical figure." He copies *Spirigera concentrica* von BUCH, from DAVIDSON'S *Monograph of British Devonian Brachiopoda*, "a little restored, with the aperture in the beak made larger than it is in the original figure;" * at the same time forgetting to tell us that it is given by DAVIDSON as *Athyris concentrica*, and not *Spirigera concentrica*. All this is very "unsophisticated."

It is scarcely necessary to inform the student of Palæontology that Prof. M'COY placed *Terebratula tumida* of DALMAN under his Genus ATHYRIS only in 1852, in his work on the *British Palæozoic Fossils*, as follows:

"*Genus* ATHYRIS M'COY, 1844."
"Syn.=*Spirigera* D'ORB., 1848."

—Thus recording his own view of the matter in citing SPIRIGERA, without comment or qualification, as a synonym of ATHYRIS; a fact which Mr. BILLINGS has forgotten or omitted to state. †

Mr. BILLINGS, however, undertakes to tell us the operations of Prof. M'COY'S mind, and what he knew or thought upon the subject; some portions of which are interesting, though we acknowledge our inability to entirely comprehend the first sentence of the following paragraph. After quoting M'COY'S description of the Genus ATHYRIS, and his remarks upon this group of shells, from page 146 of *Carboniferous Fossils of Ireland*, 1844, he proceeds as follows:

"The above is all that he wrote about the genus at that time; and it will be perceived that he does not point out any particular species as the type; and, further, that there is nothing in his remarks from which it can be inferred that

* Fig. 2.—*Spirigera concentrica*, VON BUCH. The form is copied from DAVIDSON'S *Monograph of the British Devonian Brachiopoda*, Vol. iii, fig. 13. *Pal. Soc.* for 1862. The right hand side is, in this copy, a little restored, and the aperture in the beak made larger than it is in the orignal figure."

† Following the citation above, Prof. M'COY gives an amended description of the Genus ATHYRIS, which differs somewhat from that published in 1844, and is as follows:

"*Gen. char.*—Nearly orbicular or ovate, both valves convex; no cardinal area, foramen*, or hinge-line; spiral appendages to beak of entering valve very large, nearly filling the shell; a strong mesial septum in rostral part of entering valve; dental lamellæ moderate; tissue of shell appa rently fibrous."

* See note on page 378 of *British Palæozoic Fossils*, cited on page 300 of this Report.

he knew anything about the genera into which the group was afterwards subdivided.* Consequently it is impossible that he could have intended to confine the genus to any one of them, as is now affirmed by some of the naturalists who are opposed to the classification advocated in this paper. Instead of excluding species with an imperforate beak, such as *A. tumida*, the etymology of the word *Athyris* (without a door or opening), the expression 'in which there is no vestige of either foramen, cardinal area, or hinge-line,' and, also, his typical figures *all induce the belief* that he had before him one or more forms with the beak entire. This is rendered certain by what he says on page 147. Speaking of what he calls *A. concentrica*, he says: 'This species is not uncommon; it is figured in the *Bull. de la Soc. Géol. de France*, with a perforated beak, as in TEREBRATULA. I have, however, seen numerous specimens with the beak entire and imperforate, as in the other Palæozoic species.' It is *highly probable*, from all this, that he had in view such Silurian forms as *A. tumida*. This latter species is so common that it is almost certain that such a collection as he was then engaged upon would contain one or more specimens."

This, I suppose, we may consider as "unsophisticated" reasoning in relation to the subject. It amounts to this: "Prof. M'COY had in his mind the imperforate *A. tumida* as the type of his genus; but being engaged in describing Carboniferous fossils, he did not mention it, and followed his generic description with *A. concentrica*, etc., which species he says he had seen with imperforate beak."

We think Prof. M'COY did just what other naturalists would have done under similar circumstances. Seeing the necessity of a separation of these forms from TEREBRATULA, he proposed the obvious characters on which the distinction was founded. The question of perforate and imperforate beaks in this group of fossils may be open to discussion; at least in all that I have examined I have found no entire beaks; but in some of the gibbous forms the apex is so incurved as to give an "apparently imperforate" character, and the species are thus cited. In some species this perforation is well defined by deltidial plates below; but generally these are absent, and the upper side of the foramen presents a semicircular outline, communicating with a triangular space which at some period has been occupied by the deltidial plates. After a careful examination of hundreds of specimens, I am compelled to conclude that this feature, or its modification, is not reliable for specific distinctions, and certainly not of generic importance.

Mr. BILLINGS, after citing the list of species placed under the Genus SPIRIGERA by M. D'ORBIGNY, remarks as follows:

* Is it necessary that an author should know what is afterwards to be discovered, in order to understand what he intends to do at the present time?

"Several of the above species do not belong to the group. This list shows that D'ORBIGNY regarded the genus as including not only the types of ATHYRIS and SPIRIGERA, but also that of the Genus MERISTA (*M. herculea*), which I shall notice further on. I think it quite certain that had D'ORBIGNY been aware that the genus was capable of subdivision, he would have retained ATHYRIS for *one of the groups which have the beak imperforate.* Indeed, according to the laws of nomenclature, he could not have done otherwise with any probability of producing a permanent classification."

I can agree entirely with Mr. BILLINGS, that had D'ORBIGNY known of any group of these fossils with imperforate beaks, he might have retained for it the name ATHYRIS; or had he known all that has since been learned, he would have made some modification in his generic terms.

On the sixth page of his article, Mr. B. cites M'COY'S re-descriptions of the Genus ATHYRIS in 1852, when, for the first time, he placed *A. tumida* under it; forgetting, however, to allude to the fact already stated, that M'COY there cites SPIRIGERA as a synonym of ATHYRIS. According to the reasoning of Mr. BILLINGS, and to reach the object he desires, we are to wait, from 1844 to 1852, for Prof. M'COY to complete his generic description of ATHYRIS, and place under it a typical species of the genus. Suppose, in the meantime, some one had based a Genus BILLINGSIA on the *Terebratula tumida*, would the original description of M'COY have covered that too?

I will quote here the following paragraph of Mr. BILLINGS, from page 54 of the *American Journal of Science:*

"In the work cited, and in the third fasciculus, we find the following species: *A. tumida, S.* concentrica, ambigua, deroissyi, expansa, globistriata, globularis, gregaria, paradoxa, pectinifera* and *squamigera.* This shows clearly enough his views of the genus; that is to say, that, as it was then understood, it included both *A. tumida* and *A. concentrica.* In commenting on this, Prof. HALL says: 'The fact that M'COY cited this as an ATHYRIS, no more renders it an ATHYRIS than it was made ATRYPA by being thus described by DALMAN; and it was just

* "*S. concentrica,*" etc. Does Mr. BILLINGS mean to say, or does he mean to be understood that he is citing M'COY, and that this author used the *S.* signifying *Spirigera* before the species *concentrica.* We can only hope that it is a misprint of the *American Journal of Science.* In the *British Palæozoic Fossils*, page 106, the Genus ATHYRIS is re-described, and *A. tumida* placed under it as a Lower Palæozoic species. On page 378 we have, under Devonian Mollusca, the Genus ATHYRIS repeated (with a reference to page 196 where the genus is described), and the species *A. concentrica* placed under it. Again we have the same thing repeated on page 432, where the carboniferous species are introduced. As if to leave no farther doubt upon the subject, Prof. M'COY adds a note at the bottom of page 432, referring to page 196, as follows:

"I see that by some accident, in the character given at the above page [196], this genus is stated to be without foramen, from my old diagnosis, which escaped observation in correcting the proofs. I formerly supposed, with Prof. PHILLIPS, that the minute opening at the apex of the beak of the receiving valve was caused by fracture; continued observations have, however, since shown me that it is a natural character of the genus as the Continental authors contended."

as free for the foundation of a genus after the citation of M'Coy as before.' This is true enough in part. It was free for the foundation of a genus until 1853, when Davidson used it for that purpose; but since 1853 it has never been free."

This statement that Mr. Davidson used *A. tumida* for the foundation of a genus may be "unsophisticated" enough to serve the writer's purpose; but it seems to us that a little explanation may be necessary. Mr. Davidson, in a spirit of conciliation, proposed to retain Spirigera for *A. concentrica* and similar forms, and to restrict the term Athyris to such forms as *A. tumida*, *A. herculea*, etc.; but the remonstrances of naturalists against the violation of an established rule induced him to abandon Spirigera and adopt Athyris, citing the former as a synonym.* Mr. D. never used the *A. tumida* as the foundation of a genus in any other sense; and he himself abandoned the attempted compromise, and subsequently placed *A. tumida* with *A. herculea* under the Genus Merista of Suess, and this was where I found it when I began my investigations upon the species. Does this appear like using it for the foundation of a genus? Had the *A. tumida* proved, as it was supposed to be, congeneric with *A. herculea* (a Merista), would it still have been the type of Athyris? Certainly so, according to Mr. Billings' reasoning; and I might ask of him whether he knows its internal structure sufficiently to assert anything regarding its true generic place and relations beyond the fact that externally it is similar to Merista, and possesses internal spires? But whether these spires are similar to *A. concentrica* or to Meristella, as illustrated by the writer, remains to be proved.

It is, perhaps, not worth while to follow in detail the arguments of Mr. Billings. The rules of nomenclature cited by him seem to be opposed to his arguments, particularly the following:

"A generic name should always be retained for that portion of the original genus which was considered typical by the author."

Now what is the typical portion of the genus in this instance? Mr. Billings talks of the typical figure, which is given without a name, and therefore impossible of reference. We think there is another rule, which, if not as concisely expressed as that above, is nevertheless usually followed, and this is that where the author neglects to indicate the type of his genus, the first described species under it shall be taken as the type. Mr. B. cites some observations preceding the rule quoted above, which

* See Note on pages 304 and 305.

he says should be embodied in it, and intimates that this "rule bears directly on the question, because many naturalists are under the impression that the first species placed on the list must *necessarily* be regarded as the type where the author is silent on that point. But according to the above (and common sense), it is only so if found *accurately to agree with the definition. Spirigera concentrica* does not agree either with the name ATHYRIS, nor with M'COY's generic description, nor with *his typical figure.** Therefore, it cannot be arbitrarily selected as a type, and the name ATHYRIS, in consequence, retained for that group. Indeed, in many instances, it would be impossible that the first species placed in the genus should be the type, *for the author might not have the true type in the collection under investigation.*" That an author may describe a genus, and "*not have the true type in the collection under investigation*," seems a little latitudinarian; and so, perhaps, he may abandon all he has at first placed under the genus, and at some later day claim something else as his type. We have had a little of this sort of work in Palæontology of late years, with generic descriptions broad enough to include whatever you please, and indefinite enough to be shifted to any form that subsequent exigencies might require.

In the present case, Prof. M'COY has asserted that the beak of *A. concentrica* is often closed; and yet Mr. BILLINGS asserts that he could not have intended *A. concentrica*, because his description and *typical* figure do not accord with that species; and in order to prove that the beak is not closed, he has copied *A. concentrica* "with the aperture in the beak made larger than it is in the original figure." Can a genus be founded on a "*typical figure*" which is given without name or description?

I have occupied more space with these remarks than I intended; and I should not have noticed the article at all but for the suggestion of an author whose opinion I value. I cannot avoid the conviction that a critical study of interior structure will aid us much more than long discussions on nomenclature; and believing that our knowledge in this respect has been somewhat advanced within the past few years, I shall concern myself very little regarding this question of words. Before leaving the subject, however, I may remark that Mr. BILLINGS, in the concluding pages of his paper, cites his own previously published opinions to strengthen the case that was so well fortified by collateral support in the outset. Referring to an article in the *Canadian Journal*, he says:

* *Athyris concentrica* agrees with the generic description of 1844—perhaps not with that of 1852, unless we add the correction of Prof. M'COY, cited on the preceding page.

"In that paper I described two species with closed beaks, *A. clara* and *A. maia*, which no doubt belong to the genus. The others, with perforated beaks, I marked doubtful, thus: *A.* (?) *scitula*, HALL; *A.* (?) *clusia*, n. s.; *A.* (?) *unisulcata*, CONRAD; *A.* (?) *rostrata*, HALL; *A.* (?) *chloe*, n. s."

The paragraph following this does not seem to be relevant to the subject; and the remarks about Mr. HALL having proposed a genus MERISTELLA have been so often before the public in some form that it is scarcely worth while to occupy space by citing what is said in this place. I may, however, briefly allude to a former statement of Mr. BILLINGS, in the *Canadian Journal*, 1860, that I had proposed the name MERISTELLA for those "shells which have *Athyris tumida* for the type." This is quite incorrect, so far as I am aware. The generic name was proposed in 1860, and used by me in the descriptions of the plates of Vol. iii, *Palæontology of New York*; and under the generic description, published in 1861, I gave examples *M. lævis*, *M. bella* and *M. arcuata* of the Lower Helderberg group, besides others. I cited *M. tumida* as belonging to the genus, simply from a general similarity of external form, and similarity of muscular impression in the ventral valve. Of "the others with perforated beaks," etc., cited above, the *A.* (?) *scitula* has no more a perforated beak than has *A. tumida.* Nor does Mr. BILLINGS mention this fact in his original notice of the species in the *Canadian Journal;* and in the original description of A. (?) *clusia*, Mr. BILLINGS says "beak of ventral valve erect, apparently a little incurved at the tip." Of *A.* (?) *unisulcata*, Mr. B. says "the beak is incurved over the umbo of the dorsal valve, but its tip not quite in contact with the umbo of the dorsal shell." The figures of this species by Mr. BILLINGS do not show a perforation in the ventral beak, nor is it more conspicuously perforate than *A. tumida.* The *A.* (?) *rostrata* has a perforation, and is a TEREBRATULA. *A.* (?) *chloe* has a perforation in the apex, and belongs to the Genus TREMATOSPIRA = *T. hirsuta*, HALL, having since been placed under RETZIA by Mr. BILLINGS. Mr. B. afterwards proposed a Genus CHARIONELLA, under which he has placed the *A.* (?) *scitula*, *A.* (?) *rostrata*, and others, giving, as I have said before, an impossible hinge-structure.

We will merely give a moment to the two species which Mr. B. says "no doubt belong to the Genus ATHYRIS," quoted above. *A. clara* is the *Atrypa nasuta* of CONRAD, of which I have specimens from New York and Canada; and typical forms, from the original locality cited by CONRAD, are figured in Vol. iv of the *Palæontology of New York.* The beak of the ventral valve is often apparently imperforate from being closely incurved upon the other valve; but it is not imperforate in fact. If it be any satisfaction to Mr. Billings to know the fact, I may mention that a critical examination of the internal spires of this species has shown it to be somewhat different from the similar appendages of typical forms of Meristella; but whether they may correspond with the spires in the "*typical figure*" of Athyris cited by him, I am not prepared to say, nor can I assert that they correspond with the similar appendages in *M. tumida*. Of the other species, *A. maia*, I have had in my collection for many years specimens from the locality in Canada cited by Mr. Billings, and also from Ohio; but I have always regarded it as a true Spirifer, and until it shall be proved destitute of area,* and with internal appendages corresponding to Athyris, I shall prefer to know it as a Spirifer. Even admitting all that Mr. Billings has claimed in regard to Athyris, it does not appear that he is prepared to give us much information in regard to the extent and limits of the genus about which he has written so much.

Note.—Since it appears that zoölogical nomenclature and argument, and not structural characters, are to be relied upon for the establishment of the points in dispute; therefore, in order that the student of Palæontology may have the benefit of Mr. Davidson's opinions upon the question of nomenclature, regarding Athyris and Spirigera, I have translated from the French edition of his *Introduction to the Study of Brachiopoda*, 1856, the following observations. It is easy to understand how certain authors, following the views of Mr. Davidson, published in 1853, should have adopted the names of Athyris and Spirigera:

"In 1853, I was very much perplexed in regard to the name Athyris, proposed by Prof. M'Coy for certain species, which ill accorded either with the etymology of that name or with the diagnosis given briefly, and without detail at the outset; that is to say, *nearly orbicular, small; without area or cardinal line; spiral appendages very large, occupying the greater portion of the interior of the shell.* The author cites some examples, among which are shells evidently perforate, such as the *T. concentrica*, De Buch, and others which do not appear to be so; and, furthermore, some belonging to the Genus Spirifera of Sowerby. It is true that the Professor alleged, in support of his theory, that his type, cited above, was, when in a state of perfect preservation, imperforate, and that he had given to this section a name expressive of a real characteristic. In 1859, M. D'Orbigny opposed the appellation given by M'Coy, on the ground that it was in complete contradiction to the zoölogical characteristics.† He

* I might remark that although described as without area, the artist has taken the liberty of indicating something of the kind in the figure of the specimen.

† *Paléontologie Française; Terrains Crétaces*, Vol. iv, p. 357, 1847.

proposed to substitute in its place the name SPIRIGERA, and chose, moreover, as the type the *T. concentrica* of Baron DE BUCH. About the year 1835 or 1836, Prof. KING, having received from the Eifel a specimen labeled *T. concentrica,* but which was in reality the *T. scalprum,* described it by mistake as the species of the Baron, 'having the hinge-plates attached to a process resembling *a shoe-horn.*'* Imbued with this idea, and justly remarking certain important differences in the Permian species (*T. pectinifera*), he proposed to distinguish this latter by a particular generic appellation. He chose for this purpose the name CLEIOTHYRIS of PHILLIPS,† which, however, had not been used by its originator precisely in this sense. The fact is that the true *T. concentrica* and the true *T. pectinifera,* although distinct species, have an organization essentially similar and belong to the same group. But, on the other hand, the *Athyris concentrica* of Prof. KING possesses the characteristics of another section (MERISTA of SUESS), of which the *T. tumida,* DALM., or the *T. herculea* of BARRANDE may serve as types. As though to add to the confusion already existing in the nomenclature pertaining to this genus, we learn from a recent publication ‡ of Prof. M'COY that he has added to the *diagnosis* of ATHYRIS a trifling but *important* modification, which is '*that there exists a strong median septum in the rostral portion of the entering valve; the dental lamellæ are moderate; there is no foramen.* Example, *A. tumida,* DALM.' This diagnosis in no way befits the *T. concentrica;* but, on the contrary, it accords perfectly with the condition observable in the group characterized by the *T. tumida* and *herculea.* It is evident from all this that nearly all authors have united two distinct groups of shells under the name of ATHYRIS or that of SPIRIGERA. In order to put an end to this confusion, and to avoid at the same time the necessity of new names, I proposed in the English edition of my *British Fossil Brachiopoda,* 1853, to preserve the name ATHYRIS for the group characterized by the *T. tumida, herculea, scalprum,* etc., and the name SPIRIGERA of D'ORBIGNY for such shells as the *T. concentrica, lamellosa, roissyi, pectinifera,* etc., thereby avoiding, at least in some degree, the palpable contradiction of the name employed by Prof. M'COY, the name SPIRIGERA being evidently preferable to that of ATHYRIS. But this compromise has been criticised by many naturalists, who insisted on the fact of the term ATHYRIS having been originally and positively applied by its originator to the *T. concentrica,* and also on the impropriety of the other appellation to designate such shells as the *T. tumida, herculea,* etc. M. SUESS informs us § that, in 1851, he proposed the name MERISTA ‖ for the group comprising these latter shells. I therefore abandon the proposition I made in 1853, and retain indifferently ATHYRIS of M'COY or SPIRIGERA

* *Ann. and Mag. of Nat. Hist.,* Vol. xviii, p. 86, 1846. In this memoir Prof. KING has admirably described this remarkable process.

† *A Monograph of the English Permian Fossils* (Pal. Soc.), p. 137, 1843. Prof. PHILLIPS proposed to substitute the name CLEIOTHYRIS for ATRYPA of DALMAN, but he has not made use of it in this work. *Fig. and Desc. of the Pal. Fos. in the Cambridge Museum,* p. 196, 1852.

‡ *British Paleozoic Fossils in the Cambridge Museum,* p. 196, 1852.

§ *Neues Jahrbuch,* p. 62, January 1864.

‖ *Jahrb. d. K. Geol. Reichsanstalt,* ii, iv, 150, 1851; mentioned also in *Leonhard's Neues Jahrbuch,* p. 127, 1854.

of D'ORBIGNY for the *T. concentrica ;* and MERISTA of SUESS for the *T. tumida, herculea,* etc. I shall also follow Prof. KING and Prof. WOODWARD in placing those shells which have a punctate test, such as the *T. ferita, adrieni, serpentina,* etc., in the subgenus RETZIA of King, although, at the same time, it does not appear to me that the characteristics and tendencies of these latter sufficiently demonstrate the necessity of separating them from the group of *T. concentrica* (ATHYRIS, M'COY)."

VII. NOTE UPON THE GENUS ZYGOSPIRA AND ITS RELATIONS TO ATRYPA.

In the *Thirteenth Report on the State Cabinet*, page 69, I called attention to the existence of internal spires in the fossil known as *Atrypa modesta* (*Producta modesta*, Say sp.), which appear to be arranged as in Atrypa. Not being entirely satisfied with the observation I was then able to make upon the few specimens available, I proposed to give some further attention to the subject in the next Report. At the same time I added a note, asking for information or specimens that might aid in the elucidation of this and other forms. Dr. Rominger, of Ann Arbor, Michigan, responded very generously to my request; but it was not until the Fifteenth Report (1862) that I was able to give the illustrations of the internal structure in a satisfactory manner. In this Report I remarked that "the direction of the spires is nearly the same as in Atrypa, differing in the presence of the strong loop; while the shell, in its exterior character, is quite unlike Atrypa."

I gave the following generic description:

"Genus Zygospira.—Shells bivalve, equilateral, inequivalve; surfaces plicate in the typical species; a sinus in the dorsal valve. Internal spires arranged somewhat as in Atrypa, with a broad loop passing from the outer limbs of the spiral band entirely across from side to side, near to or above the centre, and close to the inner side of the dorsal valve."

The following illustrations of *Zygospira modesta* were given in the same connexion. Fig. 1 represents the internal spires as seen from the ventral side; fig. 2, the spires as seen from the dorsal side.

Fig. 1.

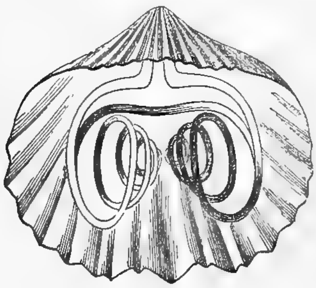
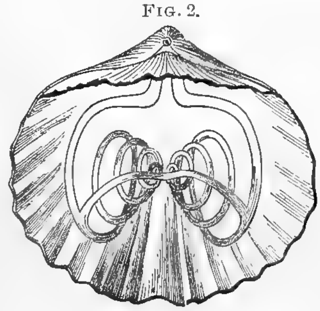
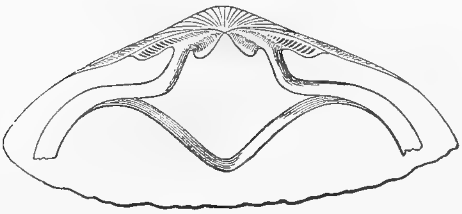


Fig. 2.



At that time the spires of Atrypa were not known to be connected by a loop, as has since been ascertained; and this renders the analogy between the genera still more close. In Zygospira, the species are more obliquely directed towards the centre of the dorsal valve than in Atrypa; the loop is attached much lower down on the limb of the spire, and is more direct, as is shown in fig. 3 (interior of the upper part of the dorsal valve of *Atrypa reticularis*), and the spiral coils are much more lax. These features, however, might not be of generic importance.

Fig. 3



In external characters, the Zygospira and its congeners differ from Atrypa in the depressed dorsal valve, with a distinct fold, embracing two or more simple plications; while the ventral valve bears a median fold which is marked by strong simple plications, or divided only close to their origin at the apex of the shell. The plications are all simple, showing no tendency to bifurcate below their origin, which is at or near the apex, and in this respect resembling Rhynchonella. So far as we are able to determine, the teeth-sockets are smooth, and not crenulate as in Atrypa.

In the characteristic species of the Genus Atrypa, the valves are convex, without distinct median sinus or fold, except towards the front of the shell. In the young shells the dorsal valve is often very depressed convex, and the beak of the ventral valve extended and perforate. The plications or costæ are rounded and frequently bifurcated, with numerous concentric lamellose striæ; differing in this respect very essentially from the simple angular plications of Zygospira. These are the most obvious differences between the genera, and are, I think, sufficient to distinguish them from each other. I believe, moreover, that there are important differences otherwise, and that a critical study of the fossils demands that these forms be generically distinguished.*

* The forms distinguished as Cœlospira are concavo-convex shells, with bifurcating and lamellose plications, and without distinctive mesial fold or sinus.

VIII. REMARKS UPON THE GENERA RHYNCHONELLA AND LEIORHYNCHUS.

In the fourth volume of the *Palæontology of New York*, pages 332–4, under the Genus Rhynchonella of Fischer, I have made the following remarks:

"The species *Rhynchonella loxia* is made the type of this genus by its author. It is only within a recent period that the name has been so extensively applied to nearly all the ovoid or subtrigonal plicated, and some smooth shells of all geological epochs, from Lower Silurian to the most recent formations, and it has been recognized in two existing species.

"In the *Introduction to the Study of the Brachiopoda* (page 95 of the English edition, page 117 of the French edition), Mr. Davidson remarks: 'The Genus Rhynchonella is one of the oldest types of animal life, having been repeated from the Silurian epoch up to the present period; two species are still found alive.'

"I have heretofore accepted the general views of palæontologists regarding this genus, and have described a number of species under it; but I have long been satisfied that, in making such extensive application of the term Rhynchonella, we are in danger of falling into an error of scarcely less magnitude than that of referring all similar forms, with many others, to the Genus Terebratula.

"Unfortunately the internal characters of *R. loxia* do not seem to be known; at least I have not seen them illustrated; and though cited as the type by Mr. Davidson, and figured upon the plate, it is not enumerated in his list of eighteen examples. Mr. Woodward gives as types *R. acuta, furcellata, spinosa, acuminata, nigrescens and psittacea*—species enumerated in Mr. Davidson's list—but he does not cite *R. loxia.*

"With the interior structure of the type of the genus unknown, while the parts are illustrated from recent species, or from fossil ones *supposed* to belong to the genus, we are not likely to make satisfactory progress in the arrangement of the fossils usually referred to it. A careful study of those fossils which have been cited as examples of genera, passing through all the geological stages and still existing, has proved, in some of them at least, that the assumption was not well founded; and I think we should hold such views with reservation. In the present instance I must be allowed to doubt whether *R. loxia* will be found to possess the characters of Lower Silurian and of existing Rhynchonellæ; nor do I consider the characters of the existing species as congeneric with those of the older Silurian or Devonian formations. The necessity felt for some other designation to apply to some of these forms has induced the names Hypothyris, Hemithyris, Cyclothyris, etc.; but these do not appear to have been founded on reliable structural characters. That some subdivision will become necessary, and will be adopted, I have no doubt; but such a desirable end can only be consummated after the study of the interiors of numerous specimens, with large collections for comparison.*

"Although having adopted the name RHYNCHONELLA for our Devonian species, I have lately observed characters which appear to me to separate them so widely from the recent species of the genus, that I am compelled to substitute some other designation.

"Among genera of the same family we must necessarily make distinctions upon the modifications of certain parts which they may all possess in common; and the importance of these modifications of interior parts or appendages should not be overlooked. Not only do the recent and fossil forms referred to RHYNCHONELLA possess great similarity in the ventral valve, teeth and dental plates, but they are not very dissimilar from the same parts in genera of the Spiriferidæ. It is in the dorsal valve and its appendages that we find characters the most important and reliable for generic distinction; and it is only necessary to follow these in the genera of the Terebratulidæ and Spiriferidæ to recall the most curious and interesting modification of the parts which this valve supports. I am therefore inclined to regard these modifications as of generic importance.

"In many of the fossil species referred to RHYNCHONELLA, one of the most conspicuous features in the dorsal valve is the strong septum, which becomes broader, and often shows indications of division at the apex, or at least evidence of a small and shallow V-shaped pit.

"The recent species of RHYNCHONELLA do not certainly furnish any evidence of similar characters, so far as I have been able to examine specimens or illustrations. The dental plates of the ventral valve are not, it is true, essentially different in fossil and recent RHYNCHONELLA; but the same comparison may be made with other genera, even out of the family Rhynchonellidæ.

"With these facts before us, I propose to revive the name STENOCISMA † of CONRAD for the species under consideration, extending the term to include the typical species *Rhynchonella formosa* of the Lower Helderberg group."

* The reliance upon external forms for the determination of generic affinities or differences, although a compulsory condition, in many instances, is far from satisfactory. As an example of this kind, I may remark that, having recently occasion to compare *Terebratula sappho*, BARRANDE, with *Rhynchonella sappho*, HALL, the former presented so much of a rhynchonelloid aspect as to suggest the propriety of regarding the latter as a synonym. A careful examination of the Bohemian species, from cutting down the solid fossils, has revealed the fact that it is furnished with calcarous spires arranged as in ATRYPA, the spires directed into the cavity of the dorsal valve, and the crura connected by a loop in a similar manner.

† In his second Annual Report (page 59, 1839), Mr. CONRAD, speaking of the rocks of New York, says: "The Genus TEREBRATULA is wholly unknown, and the shells usually "referred to that genus I propose to group under the generic name of STENOCISMA, derived from the two Greek words signifying narrow fissure, a character these shells possess under the imperforate apex of the larger valve, and which serves to connect the genus with DELTHYRIS, from which it differs in having no cardinal area. The last-named character, on the other hand, connects it with the Genus STRYGOCEPHALUS. I refer to it the common Silurian bivalve *Terebratula schlotheimii*, VON BUCH."

Notwithstanding the assertion of imperforate apex, we have learned that many of these forms, and probably all those which have been referred to TEREBRATULA, have had, at some period of their growth, a perforate apex. It was also a Lower Helderberg species (*Rhynchonella formosa*) which was referred by Mr. CONRAD to "the common Silurian bivalve *T. schlotheimii*." I have

Since the preceding matter was in print, as cited above (Vol. iv, *Palæontology of New York*, pp. 332–4), my attention has been called to an article published in the *Smithsonian Contributions to Knowledge* (p. 172), and entitled *Palæontology of the Upper Missouri*, etc., etc., Part I, by F. B. MEEK and F. V. HAYDEN, on the sixteenth page of which I find the following note:

"In the *Fifteenth Report of the Regents of the University of New York*,* 1852 (pp. 154–5), Prof. HALL proposes the name ZYGOSPIRA for a genus of which *Producta modesta*, SAY, is the type. It seems, however, that Mr. CONRAD had suggested for this shell the generic name STENOCISMA, which Prof. HALL proposed in Vol. i, *Palæontology of New York* (1847, p. 142) to adopt, should this type prove to belong to a distinct genus. As there was no necessity for a new name, STENOCISMA will have to take precedence over ZYGOSPIRA."

The tone of this paragraph denotes the language of a man accustomed to speak with authority, and no one is expected to take exceptions. "*It seems, however, that Mr.* CONRAD *had suggested for this shell the generic name* STENOCISMA," etc. Where did Mr. F. B. MEEK get the information that Mr. CONRAD had ever suggested for *Producta modesta* (SAY), the name STENOCISMA, or any other name? The conceit and ignorance shown in this paragraph are only equaled by its disingenuousness. I have already quoted the remarks of Mr. CONRAD in reference to the genus STENOCISMA † from his Second Annual Report.

In the first volume of the *Palæontology of New York* all the Brachiopoda of the general form of ATRYPA, RHYNCHONELLA, TEREBRATULA, etc., were described under the generic name ATRYPA, since they had not then been sufficiently studied to assign them to their proper relations; and the use

in my possession a lithographed plate of the fossils of the Lower Helderberg group by Mr. CONRAD, with the names, in his own hand, written beneath the figures; the species I have since designated as *R. formosa* having there been identified with *Terebratula schlotheimii.*

Although the generic characters were not fully described, and with imperfect reference to species, I think it preferable to adopt this name instead of introducing a new one.

The name HEMITHYRIS, applied by some authors to certain rhynchonelloid forms, has been used to include very heterogeneous materials; and without citing a long list to prove this, I may mention *H. angustifrons*, M'COY; *H. subundata*, M'COY; *H. hemispherica*, var. *scotica*, M'COY; all figured on the same plate, and belonging to three distinct genera; the first named being undoubtedly a MERISTELLA, and having internal spires. This generic term, therefore, cannot be adopted unless re-defined and very much restricted in its application.

* The *Fifteenth Annual Report of the Regents of the University of the State of New York on the Condition of the State Cabinet of Natural History*, etc., was published in 1862. The *Fifteenth Annual Report of the Regents of the University of the State of New York* was published in 1787. The two documents should not be confounded.

† *Palæontology of New York*, Vol. iv, p. 144, and p. 310 of this Report. Had the species referred to been the *T. schlotheimii*, we should have had the name STENOCISMA proposed for the type of the Genus CAMAROPHORIA.

of the term ATRYPA had, in a measure, superseded that of TEREBRATULA. After describing *Atrypa extans*, *A. nucleus*, *A. cuspidata*, *A. bisulcata*, *A. deflecta*, *A. recurvirostra*, *A. exigua* and *A. modesta*, I wrote as follows at the close of the last description:

"This species, with the three preceding ones, form a group, presenting characters which may require their separation from the true Atrypæ. These characters consist in the elevation of the dorsal* valve along the centre, with a depression or sinus on the ventral valve, being the reverse of the usual arrangement. The beak is incurved, with a perforation at the apex, which occupies, also, a part or all of the deltidial area, being usually narrow and long.

"Mr. CONRAD some time since proposed the name STENOCISMA for some specimens of the group of Atrypæ or Terebratulæ, which he subsequently abandoned. Should the characters here noticed be found persistent, and accompanied by the narrow foramen, I propose to restore the name first indicated by Mr. CONRAD for the genus."

I intended to restore the name STENOCISMA, should these species be found to possess characters corresponding with those given by Mr. CONRAD to his genus. We have the assertion, however, from this palæontologist "that Mr. CONRAD had suggested for this shell (*A. modesta*) the generic name STENOCISMA." He does not seem to consider it necessary for him to say when or where Mr. CONRAD had made this suggestion, but merely to make the assertion: nor does it appear that he had ever seen Mr. CONRAD'S Report, or knew anything about it. He might, however, recollect a code older than the Linnæan system of nomenclature, which says, "Thou shalt not bear false witness against thy neighbor."

When Mr. MEEK was writing this note, he either knew, or he did not know, what Mr. CONRAD had written of STENOCISMA. If he did not know, it would have been well to have expressed a less decided opinion; and if he did know, he has falsified the record. This is only one of many, not dissimilar cases, where this author assumes the rectification of other people's errors, or the assertion of scientific facts, with just about the same degree of correctness as he exhibits in the above-quoted paragraph. This mode of treating a scientific question may serve his purpose or suit his animus, but it is scarcely in accordance with the dignified character of the *Smithsonian Contributions to Knowledge.*

* The terms "ventral" and "dorsal" were then used in reverse sense of that in which they are now employed.

GENUS LEIORHYNCHUS, Hall.

At the time of proposing the Genus Leiorhynchus, I had some ground for believing it referable to the Spiriferidæ; but later examinations have not shown the existence of internal spires, while, so far as I have been able to determine, the hinge-structure is very similar to that of Rhynchonella = Stenocisma. The septum in the dorsal valve has a decided triangular pit at its upper or rostral end, while the crura are apparently reduced to short curving processes. Externally the species of Leiorhynchus may be distinguished from those usually referred to Rhynchonella by the low rounded plications, which are often bifurcating and become obsolescent on the sides and towards the beak of the shell. These very distinctive external characters are, I believe, sufficient to warrant the separation from any other genus, and I have no doubt they will be found connected with internal characters differing from Rhynchonella or any other genus of fossil shells.

Some of the species are only plicated towards the front, and the mesial fold and sinus are often limited to the lower half of the shell. Even the more distinctly plicated forms are comparatively broader and smoother than any of the Rhynchonellæ. When occurring in the same beds with Rhynchonella, the aspect and condition of the shells of this genus are quite different; and the geographical range of species of the two genera is likewise very different, the Leiorhynchus having a more restricted vertical and horizontal distribution. I have only to regret that all efforts to develop and illustrate the interior structure have thus far proved unsatisfactory.

IX. ON THE GENERA PENTAMERUS AND STRICKLANDINIA, AND THEIR SUPPOSED RELATIONS WITH RENSSELÆRIA.

THE essential points of this paper are presented on pages 190–194 of this Report, and it will, therefore, be deferred till the illustrations are completed; to appear in the next *Report on the State Cabinet.*

CORRECTION.—The observations regarding *Pentamerus lens* were based upon a species from Anticosti, identified with the European species by Mr. BILLINGS. An examination of the figures of the *P.* (*Stricklandinia*) *lens* in Mr. DAVIDSON'S *Monograph of Silurian Brachiopoda* shows it to be very distinct from the species which I examined under that name from Anticosti.

X. NOTE ON THE GENUS EICHWALDIA.

A KNOWLEDGE of the internal structure of the shell described as *Atrypa coralifera* * in the second volume of the *Palæontology of New York* has long been a desideratum. Specimens of this shell, with two or three unsatisfactory casts from the Niagara shale of New York, remained for a long time in my drawers, with a doubt expressed regarding their generic relations, and were usually referred to by a name indicating the smooth umbo of the ventral valve, which had apparently been denuded of the reticulate covering. It was only after much delay, and by careful working among the specimens of a similar species from Waldron, Indiana, that I was able to ascertain the internal structure of the shell.

While preparing to publish a note upon this fossil, under the generic name of DICTYONELLA, my attention was directed to the figures of EICHWALDIA in the *Annual Report of the Canadian Geological Survey*, 1857–8. The only feature in the figures, from which I inferred there might be identity of generic character, was the naked or denuded beak of the shell. I, therefore, deferred publication of my note upon the internal structure, and subsequently obtained from Sir W. E. LOGAN the privilege of examining the original specimens described by Mr. BILLINGS. These specimens were all silicified, and consisted of two separate valves with one nearly entire specimen. Although to a person not suspecting other than an ordinary smooth shell, these specimens might not indicate a different external structure; yet I conceive that the regularity in the arrangement of the little points or nodes of silica (not the usual irregularly distributed concentric nodes) indicates an original reticulate structure which is obscured or destroyed by silicification. The *E. subtrigonalis* of BILLINGS, therefore, I believe to have had originally a similar shell-structure to those of the Niagara group, and to be congeneric with that species.

The following description of the genus, with observations thereon, is copied from the Report cited above:

* This species is very similar to, and by some authors has been considered identical with, *Terebratula capewelli* of England.

"GENUS EICHWALDIA, Billings.

"Generic Characters.—Large valve perforated on the umbo for the passage of the peduncle ; the place of the foramen beneath the beak occupied by an imperforate concave plate, the interior divided by an obscure medio-longitudinal ridge ; interior of smaller valve divided throughout from the beak to the front by a very prominent medio-longitudinal ridge ; no hinge-teeth, sockets, or other articulating apparatus in either valve.

"After a great deal of examination and comparison, I have not been able to refer the species for which the above generic name is proposed to any of the described genera. Although several silicified specimens exhibiting the interior have been obtained, they do not show any muscular impressions. The perforation on the back of the beak was at first supposed to be a fracture, but we have now specimens which exhibit its characters so completely that I do not think it possible there can be any mistake. The internal structure of the larger valve somewhat resembles that of Pentamerus or Camarophoria, the concave plate beneath the beak appearing to be the homologue of the floor of the triangular chamber found in these genera. I cannot make out, however, that it is in any way connected with the medio-longitudinal ridge, as is the case in both Pentamerus and Camarophoria. In removing the limestone from silicified specimens, the delicate processes in the interior of species of Brachiopoda are very often destroyed ; and it is possible that the connection in question may exist in perfect specimens, but not appear after treatment with acids. It is, therefore, uncertain whether or not it is attached to the plate beneath the beak. If it should be hereafter ascertained that it is so connected, the foramen on the umbo would still be sufficient to show that this is a new genus, to the establishment of which the characters of the smaller valve and the absence of any articulating and apophysary apparatus would be additional characters."

Although not entirely corresponding with some parts of the above description, I conceive that the species I have referred to this genus really illustrate its true characters. The accompanying fig. 1 illustrates the general form and surface texture of *Eichwaldia reticulata* of the Niagara group, from Waldron, Indiana. Fig. 2 is a cardinal view of the same, showing a smooth or denuded beak.

Fig. 1.

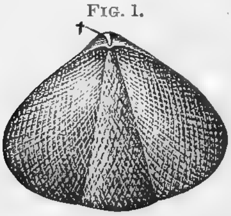
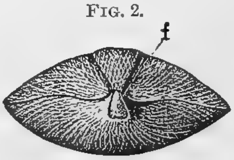


Fig. 2.



An enlargement of the surface shows a texture like the accompanying figure 3, which is carefully drawn from the specimen figured. A vertical section of the shell enlarged, fig. 4, shows the superficial textile spaces narrowing downwards, and the inner layer of the shell become solid. The exterior reticulate structure of the shell is therefore a part of the shell proper.

Fig. 3.

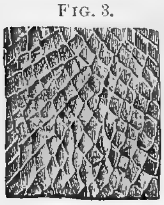


Fig. 4.

The interior of the dorsal valve, fig. 5, shows a narrow longitudinal septum S, which, beginning at the apex, reaches nearly to the base of the shell. The great elevation of this septum is shown in figure 7. There is a very slender cardinal process, J, beneath the apex of the beak, and long narrow grooves or teeth-sockets, B, B. In the ventral valve, fig. 6, the margins, at some distance below the apex, are convex or elevated and attenuate, resting in the long narrow groove in the margin of the opposite valve. So far as observed, there are no distinct dental lamellæ, the margins of the valve performing that function, and serving as fulcra in the opening and closing of the valves. There is no evidence of a longitudinal septum in the ventral valves of two species of the Niagara age; but there is a transverse septum or diaphragm extending across the base of the rostral cavity, and continuing to the apex of the shell. Below this diaphragm, and between it and the outer shell, there is a narrow space or slit which extends to the apex of the shell. This diaphragm, or interior shell, is smooth and solid, extending to and forming the smooth umbo and acute apex of the valves, beneath which is a false area, as shown in the figure.

FIG. 5.

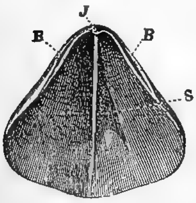
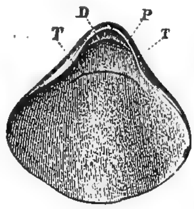


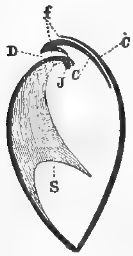
FIG. 6.



The character of the dorsal septum is better shown in fig. 7, which is a longitudinal section of the two valves. The apex of the ventral valve is very narrow and pointed; the close solid shell of the diaphragm is apparently folded back to form the false area D, and there does not usually appear any evidence of a foramen at the apex. There is evidently a continuous space between the diaphragm C, and the shell C′, as shown in the figure; and this separation extends along the central portion at least for the width of the sinus, and, continuing towards the beak, has given the denuded apex, which sometimes has the aspect of a partially closed foramen *f*. It seems scarcely in accordance with the usual structure of the Brachiopoda, that the pedicel should pass through the narrow slit between the diaphragm and the outer shell, entirely outside of the rostral cavity; still this space has evidently served the animal for communication with the exterior. We have some analogy to this condition in the Genus SIPHONOTRETA, and I have supposed that the diaphragm may represent a modification of the dental lamellæ. The muscular impressions are just below the margin of the diaphragm.

In the longitudinal section of the shell, fig. 7, it will be noticed that the apex of the dorsal valve, or cardinal process, extends far into the cavity of the ventral valve, while the cardinal muscle was apparently attached just below the margin of the diaphragm or transverse septum of the opposite valve. The great length and ventral extension of the longitudinal septum of the dorsal valve is a remarkable feature. The mode of articulation of the valves is much in accordance with the recent Rhynchonellidæ, except that the dental lamellæ are not distinctly developed. At the present time, however, I am far from feeling satisfied regarding the true relations of this peculiar genus.

FIG. 7.



The figures given illustrate all that we have observed in regard to the interior structure of this genus, which is represented by several very pretty species. I hope that the author of the generic name may feel disposed to accept this contribution of facts regarding its more important characters as aiding in the establishment of one of the most interesting genera among the Brachiopoda.

GENUS EICHWALDIA, BILLINGS, 1858.

GENERIC CHARACTERS—AS EMENDED.—Shells ovate or subtrigonal; with or without mesial fold and sinus. Ventral valve obscurely perforate on the umbo; apex acute and entire, the space beneath it occupied by an imperforate concave plate; the interior of the rostral cavity lined by a transverse septum or diaphragm, below which is the pedicel (?) opening. Dorsal valve with a slender cardinal process, and a very elevated medio-longitudinal septum. Valves articulating by a long narrow groove in the cardino-lateral margins of the dorsal valve, in which rest the elevated corresponding margins of the opposite valve. Surface of the shell reticulate; the texture solid and fibrous beneath.

The American species known at present are: *E. subtrigonalis*, BILLINGS, from the Lower Silurian, Canada; *E. coralifera*, HALL, Niagara, New York; *E. reticulata*, HALL, Niagara, Indiana; *E. gibbosa*, HALL, Niagara, Tennessee; *E. concinna*, HALL, Niagara or Lower Helderberg, Tennessee.

EICHWALDIA SUBTRIGONALIS, BILLINGS.

Report on the Geological Survey of Canada, 1858, p. 192.

EICHWALDIA CORALIFERA, HALL.

Atrypa coralifera, HALL; Palæontology of New York, p. 281, 1852.

This species occurs in the Niagara shale at Lockport and Rochester.

Eichwaldia reticulata, Hall.

Rhynchonella (?) *reticulata*, Hall; Transactions of the Albany Institute, Vol. iv. p. 217, 1862.

From the Niagara group at Waldron, Indiana.

Eichwaldia gibbosa, n. s.

Shell ventricose, rather above the medium size, sub-triangular or broadly ovate in outline; baso-lateral angles abruptly rounded, and the anterior border straight or scarcely emarginate. Ventral valve strongly convex in the umbonal region, becoming very slightly depressed on the anterior part by a broad undefined sinus, which extends one-half the width of the shell; beak small, pointed and strongly incurved over that of the opposite valve; the denuded surface of the beak small. Dorsal valve a little more gibbous than the ventral, very prominent in the upper half; the anterior part occupied by a broad undefined elevation which is barely distinguishable from the general convexity of the valve. Surface reticulations very fine, about three or four in the space occupied by one on the *E. coralifera*, and two or three to that of one on *E. reticulata.*

This species may be distinguished from either of the other species of the genus by its greater gibbosity, even surface, and by the much finer reticulations of the exterior structure.

Geological Formation and Locality.—In rocks of the age of the Niagara group, in Perry and Decatur counties, Tennessee.

Eichwaldia concinna, n. s.

Shell small, sub-triangular in outline, a little wider than long, broadly rounded in front, nearly straight in the middle, and more abruptly rounded on the baso-lateral angles. Valves somewhat regularly convex; the ventral valve a little more elevated than the opposite, and having a broad undefined sinus on the anterior half of the shell; umbo prominent; beak small and closely incurved, the nude space longer than wide. Dorsal valve regularly convex, without visible trace of mesial elevation. Surface reticulation fine; pits elongate in the direction of the length of the shell; interspaces a little flattened on the surface.

This species differs from *E. coralifera* of New York in its general broad triangular form, absence of mesial elevation on the dorsal valve, and undefined sinus on the lower part of the ventral valve; in the finer reticulations, as well as the flattening of the interspaces. From *E. reticulata* it differs in the finer and more elongate pits and entire absence of mesial fold; although that species sometimes has a scarcely-defined fold, yet the reticulation is always much coarser.

Geological Formation and Locality.—In rocks of the age of the Niagara or Lower Helderberg, Tennessee.

XI. ON THE GENUS TROPIDOLEPTUS.*

The Genus Tropidoleptus was proposed by me in the *Tenth Report on the State Cabinet*, published in 1857. The shell made the type of the genus was the *Strophomena carinata*, Conrad, published in the *Annual Report on the Palæontology of the State* for 1859. At the time of proposing this generic name, very little was known of the interior structure of the shell, and it was separated on account of hinge structure and the punctate texture of the shell.

Fig. 1.

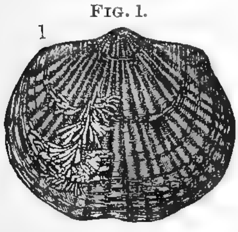
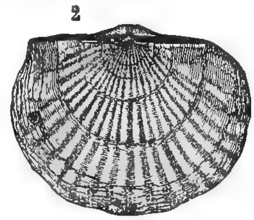


Fig. 2.



The accompanying figures will give a general idea of the form and exterior character of the *Tropidoleptus carinatus*. Fig. 1 is a dorsal view, with the surface partially covered by a delicate bryozoan; fig. 2 is a ventral view.

In 1850, I had obtained some further knowledge of the interior, as represented in fig. 3 of the interior of the ventral valve, showing the area, foramen, teeth, etc., enlarged; and fig. 4 of the interior of the dorsal valve, showing the cardinal process, the dental fossets, the bases of the crura, and the septum.

Fig. 3.

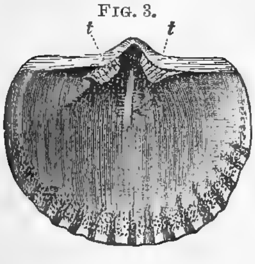
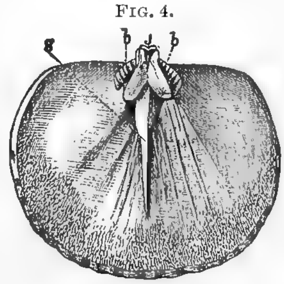


Fig. 4.



There seemed still something not quite understood in regard to its interior structure; and it was only as the description was going to press in Vol. iv, following the Strophomenidæ, that I resolved to make some further efforts to discover its entire structure; which resulted in determining the characters of the loop illustrated in figs. 5 and 6, page 323. In placing the genus at the end of the volume, and following Terebratula

* This paper was communicated to the *Nineteenth Report on the State Cabinet*, but not printed. The *Notice of Vol. iv, Palæontology of New York*, published in the present Report, in which the observations on this genus are cited, causes some unavoidable repetition.

and allied genera, I do not mean to be understood as placing it without reserve among the Terebratulidæ: nevertheless this seems to be its nearest relation, according to our present views of the classification of the Brachiopoda. In thus placing it, I have written as follows (*Palæontology of New York*, Vol. iv): "We had originally supposed that TROPIDOLEPTUS would find its place among the Strophomenidæ; but there have been at all times some important objections to placing it in this relation, while later discoveries have rendered such a reference unnatural. Notwithstanding the concavo-convex form, area, and large fissure under the beak of the ventral valve, still the punctate structure of the shell and the character of the crura seem to indicate its relations to be with the Terebratulidæ; and I have accordingly placed it in an order following the authentic genera of that family."

In the ventral valve, the peculiarities lie in the strong crenulate teeth, which are a little separated from the margin of the area (fig. 3). These teeth are quite strong and thickened below, and their crenulate summits are inserted into similarly crenulated teeth-sockets at the base of the strong cardinal process of the opposite valve. In this valve, the divaricator muscular impressions are broadly flabelliform. The occlusor muscular impressions have not been satisfactorily observed.

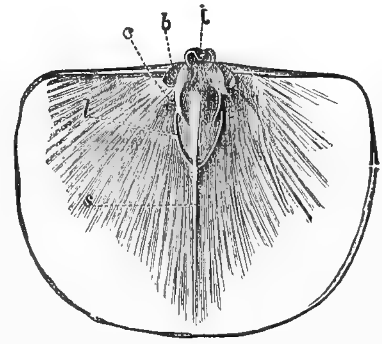
The dorsal valve has a narrow area, and a wide and strong cardinal process which nearly or quite fills the foramen of the opposite valve. This process is often simple exteriorly, above the limit of the smooth or striated pseudo-deltidium which covers it near the hinge-line; but just within the valve it is broadly grooved in the middle, usually with two small deep pits just within the external smooth callosity, and on each side there is a groove and accessory lobe, frequently not conspicuous. The divisions made by the median groove diverge and terminate below in obtuse processes which have some similarity with the bases of crural processes in ORTHIS, but have more analogy with the Terebratulidæ. These processes are sometimes clearly broken at their termination, but are often smooth, as if the roughened surface had been cicatrized during the life of the animal. Below these forks of the process there is a narrow median crest or septum which reaches beyond the middle of the valve, and sometimes nearly to the front. From the limbs of the thickened divergent processes there proceed slender crura which, at first bending slightly outwards, send off a short spur into the ventral cavity and are thence directed forwards, and gently curving, join the median crest, to which they are attached, forming a loop of peculiar character.

The occlusor muscular impressions have rarely been seen with any degree of distinctness; but the depressions just at the termination of the crural processes, and on each side of the median ridge, are striated; and this striation often extends in a wide flabelliform expansion, probably due to vascular impressions. Towards the margin, the interior of both valves is strongly pustulose.

The accompanying wood-cuts illustrate the parts referred to above. Fig. 5, interior of the dorsal valve; fig. 6, longitudinal section of the same; *j*, cardinal process; *b*, teeth-sockets; *c*, crural processes; *l*, loop; *s*, septum.

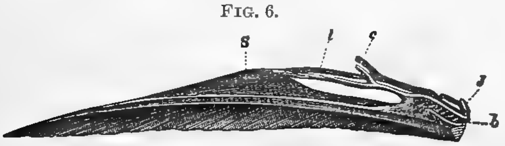
In the punctate texture of this shell it differs from either of the Genera Leptæna, Strophomena or Strophodonta; but this might not be an objection to admitting Tropidoleptus into the family were the other characters coincident. The area is longitudinally striated, and presents a different aspect from any of the Strophomenidæ, but has analogy with some of the Orthides. The teeth are not extensions of the lamellæ bounding the foramen, but distinct from it and deeply crenulate or lobed, and inserted into corresponding crenulate sockets in the dorsal valve. The form of muscular impressions, so far as known, is not very dissimilar to those of Strophomena or Orthis.

Fig. 5.



In comparing the form of the cardinal process and its appendages, we shall find it almost entirely similar to that of Leptocœlia, as shown in two authentic species (*L. flabellites* and *L. fimbriata*), and the muscular impression of the ventral valve is quite like that of the same species.

Fig. 6.



The exterior extremity of the cardinal process presents considerable variety of aspect when a large number of individuals are examined. In some of them this part, if stripped of the external callosity or pseudodeltidium, would have the main process bilobed, with a sinus a little below the apex, and an accessory lobe on each side, similar to some of the species of Productus.

XII. NOTE ON THE GENUS PALÆASTER AND OTHER FOSSIL STAR-FISHES, WITH DESCRIPTIONS OF SOME NEW SPECIES, AND OBSERVATIONS UPON THOSE PREVIOUSLY DESCRIBED.

GENUS PALÆASTER, HALL.

IN the second volume of the *Palæontology of New York*, page 247,* I proposed the name PALÆASTER to include a species from the Niagara group, and one from the Hamilton group. I have subsequently referred to the same genus a species from the Trenton limestone, which I previously published under the name of *Asterias matutina.* The original specimen described under this name was in such a condition that the ambulacral and adjacent plates could not be distinctly recognized, and the upper side remained imbedded in stone. The generic description is therefore very meagre, and the figure was intended to illustrate all that could be seen. The species is thus described:

"Body stellate; disc small; arms short, terete, with a deep avenue on the lower side, which is margined by short strong spines; centre of plates (in the fossil) nearly smooth, margins strongly granulate; lower side of the arms showing two ranges of plates on each side of the avenue; the outer range composed of short hexagonal plates, with an inner range of smaller ones alternating, the latter usually covered by tufts of spines; a large pentagonal plate inserted at the base of the arms, on the lower side."

I have distinctly recognized the two ranges, marginal and adambulacral plates; but the inner ones are not shown in the figure as they should have been, while the large plate at the axil of the ray (though the adjacent small oral plates of the inner range are not seen) is evidently part of an incomplete series, and clearly belongs to the marginal range.

In 1856,† Mr. SALTER adopted the name PALÆASTER for fossil star-fishes without disc and having deep avenues, etc.

* This volume was printed in 1850, but was published in 1852.
† *Proceedings of the British Association*, August, 1856.

[Originally published December, 1866.]

In Decade iii, *Canadian Fossils*, Mr. BILLINGS has reproduced the figure of PALÆASTER, HALL, to show the differences between it and his Genus STENASTER; and the wood-cut is so treated as to obscure the indications of adambulacral plates shown in the original figure.

In STENASTER = URASTERELLA, however, we have the absence of adambulacral plates, which should be regarded as of generic importance.

In the Genus PETRASTER of Mr. BILLINGS, we have "both marginal and adambulacral plates" [as in Palæaster], "with a few disc-plates on the ventral side." * * * * "It differs from PALASTERINA by the presence of large marginal plates outside of the disc-plates; and still more from STENASTER, which has neither disc nor marginal plates."

The character of PETRASTER here described, and illustrated in the figure (3 *a*, Plate 9), gives an intercalated partial range of disc-plates, *between* the adambulacral and marginal plates, which will separate these forms from any of the Palæasters in my collection. Figure 3 *b* of the same plate (Decade iii) shows no intercalated plates; and though supposed by Mr. BILLINGS to be the dorsal side of the same "species, with the plates along the centre of the rays removed," it has much the appearance of the ventral side of a species of PALÆASTER, and has a different aspect from fig. 3 *a*.

The Genus PALÆASTER has two ranges of plates on each side of the ambulacral groove; marginal and adambulacral plates on the lower side, besides ambulacral or poral plates. The upper or dorsal side has three or more ranges of plates.

In several species examined, the ventral side presents no disc-plates or any plates in the axils of the rays which do not belong to the marginal series, or to the plates of the dorsal side, which are sometimes pressed beyond the marginal plates of the lower side.

The following species belong to this genus:

PALÆASTER MATUTINUS.

PLATE IX, FIG. 2.

Asterias matutina, HALL. Palæontology of New York, I, p. 91, Plate 29, fig. 5.

The specimen described shows the dorsal side only; the rays are regularly tapering, rather slender, having three ranges of plates with two stronger plates at each axil. The body or disc above consists of strong plates. The marginal plates of the ventral side are visible on the side of the rays below the outer range of dorsal plates.

The ventral surface shows a range of marginal and one of adambulacral plates, the latter much smaller, but the same in number and alternating with them. Two ranges of poral plates are visible in the groove, each one being more deeply excavated on the inner or posterior, than on the outer margin, to form the pore.

These features of the ventral side have been ascertained by removing a portion of one of the rays from the original specimen.

Geological Formation and Locality.—The specimen figured is from the Trenton limestone at Trenton Falls, and I have seen another specimen from the same neighborhood.

PALÆASTER SHÆFFERI, N. S.

PLATE IX, FIG. 1.

Body of about medium size, composed of five tapering, acutely pointed rays, which, in the specimen examined, measure seven-eighths of an inch from the centre of the disc to the extremity. The lower side of the ray is formed of two ranges of plates bordering the ambulacral groove. The marginal range consists of moderately convex plates which gradually decrease in size from the base to the extremity of the ray, twenty-two or twenty-three in number, besides a small terminal one at the angle of the range; each plate of the marginal range is marked on its outer surface by a comparatively large cicatrix for the attachment of a strong spine. The inner range of plates (adambulacral) are somewhat smaller, about the same in number, alternating with those of the marginal range; the basal pair (oral plates) are elongate-triangular, and slightly constricted near the middle. Ambulacral areas narrow, composed of a double range of poral plates, which at the middle of the ray are about of equal length and breadth. Pores not observed. Upper surface of the ray composed of three ranges of subnodose plates, the outer ranges bearing a strong spine on each plate: the central range apparently destitute of spines.

This species differs from *P.* (*Asterius*) *antiqua*, TROOST, in the more slender and acutely pointed rays, and in the smaller marginal plates, the basal one of which is quite different in form, that one being triangular with the apex towards the axil of the ray. The ambulacral range also differs in number of plates; TROOST'S species having about twice as many in the marginal range.

It differs from *Palæaster jamesi* = *Palasterina jamesi*,* Dana (*American Journal of Science*, n. s., Vol. xxxv, p. 295), according to the figures given by Prof. Dana in the form of the rays, the marginal plates, and many other important characters.

Geological Formation and Locality.—In shales of the Hudson River group, Cincinnati, Ohio. From Mr. D. H. Shæffer.

Palæaster granulosus,† n. s.

Body of medium size, five rayed; rays a little more than twice as long as their breadth at base; obtusely rounded at the extremities. Upper surface of rays composed of numerous very small tuberculose or subspinose plates; the madreporic tubercle large, quite distinct, situated laterally at the base of two of the rays. Under surface of rays composed of a marginal range of small tuberculose plates, about twenty-five on each side in a ray measuring one inch and a quarter from base to apex; and an inner (adambulacral) range of smaller plates, of which about forty-two or forty-three can be counted on the same ray; the terminal or oral plates are small, elongate, subtriangular, in pairs at the base of the adjacent rays. Ambulacral areas composed of a double series of short, broad, slightly curved poral plates (ossicula), each plate marked by a sharply elevated ridge along its entire breadth, commencing on the one plate at the outer posterior angle and terminating on the anterior inner angle, and running in the opposite direction on the adjacent plate. When the outer ridged surface of the poral plate is ground away, the narrow openings or pores are visible between the plates, apparently in two rows in each series, making four ranges of pores in each ambulacral area. (The marginal ranges of pores are obscure, and may only be apparent.) On the under surface, near the bases of the rays, the tubercles bear short spines, some of which are still in place.

This species differs from *P. shæfferi* in the form and proportions of rays, the greater number of ambulacral plates, and the form and number of poral plates; the dorsal surface differs in the numerous short subspiniform appendages and absence of longer spines.

* This is not a *Palasterina*, having no disc-plates filling up the angles, as in the typical species, and as required in the generic description given by Mr. Salter, and followed by Mr. Billings, *Can. Org. Rem., Dec. iii*, p. 76.

† See remarks upon this species at the end of this Paper.

Some figures of a PALÆASTER, closely allied to or identical with this one, from Cincinnati, Ohio, have been circulated by the Natural History Society of that place, under the name of *Asterias primordialis;* but no description of it has ever been published, so far as I know, nor do I find it at all recognized in the catalogues.

Geological Formation and Locality.—In shales of the Hudson River group, Lebanon, Ohio. From J. KELLY O'NEALL, Esq.

PALÆASTER WILBERANUS.

Petraster wilberanus, MEEK & WORTHEN; in Proc. Acad. Nat. Sci. Phil., p. 142, 1861.

The description informs us that "this beautiful star-fish resembles rather closely the *Petraster rigidus* of BILLINGS (Decade iii, *Canadian Organic Remains*, Plate ix, fig. 3 *a*), but is smaller, and has more slender rays, with more angular spaces between them. It also differs in having but two ranges of plates on each side of the ambulacral grooves on the under side, instead of three."

The fact of having two ranges of plates only on the lower side must separate this species from PETRASTER of BILLINGS, since the presence of a partial intermediate range, or "a few disc-plates" on the ventral side form an essential feature of that genus.

Geological Formation and Locality.—In the Lower Silurian strata of the age of the Trenton or Hudson River group, at Oswego, Kendall county, Illinois.

PALÆASTER ANTIQUATUS.

Asterias antiquata, LOCKE; in Proc. Acad. Nat. Sci. Phil., III, p. 32 (with wood-cut), 1846.

This species was noticed by Dr. LOCKE, as cited above, but without specific description, and expressing a doubt whether it was or was not identical with the *Asterias antiqua* of TROOST. The figure would indicate a distinct species from that of Dr. TROOST; and if we can judge from the illustration, it is not a PALASTERINA. The question may not be determined, however, without reference to the original specimen.

In the figure of Dr. LOCKE there are two ranges, and in some places three ranges of plates, represented as bordering the ambulacral groove.

Geological Formation and Locality.—The specimen is from the shales of the age of the Hudson River group, near Cincinnati, Ohio.

PALÆASTER JAMESI.

Fossil *Asterias:* Report of G. GRAHAM, J. G. ANTHONY and U. P. JAMES to the Western Acad. of Nat. Sciences, in American Journal of Science (n. s.), I, p. 441. 1841.
Asterias anthonii, DANA. Manual of Geology, p. 221 (with figure). 1863.
Palasterina (?) *jamesii*, DANA; in Amer. Jour. Science (n. s.), XXXV, p. 295. 1863.

This species, if we may judge from the figure given, is not a PALASTERINA, as it wants the "*plated disc which fills up the angles*," * an essential character of the genus.

In the figure in the *American Journal of Science*, the plates of some of the rays are shown as extending from the ambulacral groove to the margin, while in others they are shown as divided, giving a marginal and adambulacral range, as in PALÆASTER; and in the absence of disc-plates, I can see no other reference for the species but to that genus.

Geological Formation and Locality.—This species occurs in the shales of the age of the Hudson River group, at Cincinnati.

PALÆASTER (ARGASTER) ANTIQUA, TROOST.

Asterias antiqua, TROOST; in Trans. Geol. Soc. Penn., I, p. 232, Plate x, fig. 9. 1835.
Petraster (?) *antiqua*, TROOST; in SHUMARD'S Cat. of Palæozoic Fossils, etc., p. 386. 1865.

Body of medium size, five-rayed; rays flexuose. Marginal range of plates large, somewhat quadrangular, with their outer faces subnodose: the basal plates of the series single, broadly triangular, with slightly truncated lateral angles; the obtuse angle of the plate directed towards the axil of the rays. This form of the basal plate, leaves at the base of the marginal ranges and bordered by the adambulacral ranges, a small triangular space which is filled by minute plates or granules; a character not observed in any other species of this genus. Adambulacral ranges, composed of small plates, which are nearly twice as numerous as those of the marginal range; the basal plates of the ranges are elongate, triangular, in pairs from the adjacent rays. Ambulacral grooves, occupied by a single row of sub-quadrate ossicula, which extend across and alternate with the adambulacral plates of each margin: the pores have not been observed. Upper or dorsal surfaces not known, except from a few small plates, outside of the marginal plates, which appear to have been crowded over by pressure. (Perhaps these latter plates may have formed a slight disc between the rays.)

* SALTER, *Annals and Mag. Nat. History*, Nov., 1857; cited by BILLINGS, Decade iii, p. 76. 1858.

The specimen is so imperfect that it is not possible to give a full description of parts; the outer limits of the rays having been obscured by scraping and the too free use of acids, before the specimen came under my observation, so that the exact number of marginal and other plates cannot be determined. This form differs, however, from all others described or known, in the comparatively large marginal plates, the triangular spaces at the base of the marginal ranges, and the single series of ambulacral ossicula. It is possible that this last character may prove to be of generic importance, could we obtain specimens sufficiently well preserved to show these and other characters in a more perfect manner.

Geological Formation and Locality.—The specimen is from the Hudson River group, Harpeth River, Davidson county, Tennessee.

PALÆASTER EUCHARIS, N. S.

PLATE IX. FIGS. 3, 3*, 3*a* and 4.

Body rather large; the largest individual being one inch and seven-eighths from the centre of the body to the extremities of the rays; the whole having a robust aspect; rays acutely pointed at the extremity. Upper surface of rays composed of three ranges of large, highly convex or tuberculiform plates which are nearly circular at the bases of the rays, becoming quadrate and widened towards the extremities; separated from each other in the lower part by numerous minute plates or granules, which become fewer near the middle of the ray, and disappear before reaching the extremity. The central portion of the disc is occupied by an elevated pentagon, the angles of which are formed by the abrupt termination of the central row of plates of each ray: the whole composed of very minute, highly convex plates, which vary in size, the larger ones pentagonally arranged. The angles between the rays have a few small plates outside of the outer ranges of tuberculose plates on the upper side, uniting with the marginal plates below. Madreporiform tubercle distinct, situated laterally at the bases of the outer range of large plates of two adjacent rays. Ventral surface having deep ambulacral grooves, bordered by two ranges of strongly tuberculose plates; the outer marginal range consisting of twenty-seven or twenty-eight plates, besides a large, round, terminal or axillary plate; the others are wider than long in the basal portion of the ray, becoming gradually shorter towards the extremity where they are rounded. All the marginal plates are visible from the upper side, and usually appear as an additional range of plates on each margin of the ray, making five with the three properly belonging to the upper surface. Those of the inner range bordering the ambulacra (adambulacral plates) are smaller than the marginal plates, about thirty-eight to forty in number; the basal or oral plates are triangular, those of the adjacent rays uniting by their longer margins; and with a single minute plate situated at these points. The plates of the exterior surface, both upper and lower, present a granulose or striato-granulose surface which appears to have been produced by short setæ or spines; and at the angles of the rays the marginal plates are armed by a few spines, which are as long or longer than the transverse diameter of the plates. Ambulacra composed of a double range of short broad poral plates (ossicula), equal in number to the adambulacral plates; their outer ends excavated on the posterior border, forming a comparatively large pore, just within its junction with the adambulacral plate. There appears to have been but one range of pores in each set of ossicula, but these are large, distinct, and pass between the plates.

In the collection, there is an impression of a single ambulacral area of this species, which is spread open laterally and measures about two and a half inches in length by nearly three-fourths of an inch in width in the middle, broadly petaloid in shape, and showing the form and number of poral plates, with the position of the pores and their junction with the adambulacral plates.

This species differs very remarkably from any of the preceding, and every other described species, in its robust form, its more numerous and proportionately larger marginal plates, and in the large and deep ambulacral grooves and poral plates. In the single large tuberculose plate at the base of the marginal range it resembles the Niagara species; and in having more adambulacral than marginal plates, it resembles *P. granulosa*, but differs from the last in the large plates of the dorsal side.

Geological Formation and Localities.—In rocks of the Hamilton group, near Hamilton, Madison county, and near Summit, Schoharie county; also from near Cooperstown, Otsego county, whence I received a specimen retaining the impression of the lower side, from Paul F. Cooper, Esq., of Albany.

GENUS URASTERELLA,* M'Coy, 1851.

STENASTER, Billings, 1858.

The Genus Stenaster is described by its author as having slender rays, with only a single range of plates (adambulacral) on each side of the ambulacral groove. In this respect it appears to me to correspond with the figures of *Uraster ruthveni* and *U. hirudo* of Forbes, species which M'Coy proposed to include in the Genus Urasterella. The British species are from strata of Silurian age (Ludlow rocks).

Urasterella (Stenaster) pulchella.

Palæaster pulchella, Billings. Geol. Surv. of Canada, Report for 1856, p. 292.
Stenaster pulchellus, Id. Decade iii, p. 79, Plate x, fig. 2.

The specimen which I have referred to this species has long slender arms, with a narrow ambulacral groove and a single range of short plates on each side. It preserves two rays nearly entire, and parts of others. The single range of plates on each side (adambulacral) only, would preclude its reference to the Genus Palæaster as defined by me.†

Geological Formation and Locality.—In the Trenton limestone, near Canajoharie, New York.

GENUS EUGASTER, n. g.

[*ευγε, præstans; αστηρ, aster.*]

Body stellate, consisting of a central alated disc, and five long, slender, somewhat flexuous rays. Disc composed of small, polygonal tuberculose or subspinose plates on the ventral side. Rays consisting of

* Proposed as a generic name for *Uraster ruthveni* and *U. hirudo* of Forbes, *British Palæozoic Fossils*, p. 59.

† Mr. Salter, apparently overlooking my description of *Palæaster niagarensis*, has placed both the above-cited European species under Palæaster, as defined by himself; but as it has been shown that this genus has two ranges of plates on each side of the ambulacral groove, these forms cannot, with propriety, be arranged with typical Palæasters.

There was the same reason for adopting the generic term Urasterella as for adopting Palasterina, both of which were proposed by M'Coy at the same time, and the typical forms of each were specified. Mr. Salter has for some reason recognized the Genus Palæaster proposed by me a little earlier, but probably published after that of M'Coy; and has given the two species of Urasterella to that genus. Now that there seems no reason for continuing them under that generic term, they should be restored to their proper position as indicated above. The two species of Forbes must either be placed under Urasterella as proposed by M'Coy, or fall under the latter Genus Stenaster of Billings. Were the latter genus of my own proposing, I should nevertheless return to Urasterella, and I have no doubt that Mr. Billings will accord with this view.

a double series of alternating subquadrate ambulacral ossicles, and a series of curved adambulacral plates bordering the grooves, and forming the margin of the ray: the outer ends overlap the edge of the next plate in advance. Oral plates ten, arranged in pairs, forming the terminal plates of the adambulacral ranges. Pores large, arranged in two rows in each ray; penetrating the ray at the junction of the ambulacral and adambulacral plates in such a manner that four different plates border each perforation. Adambulacral and disc-plates bearing spines. Dorsal surface unknown.

The genus is allied to PROTASTER, FORBES, but differs in the structure and arrangement of the component parts of the ray, and in the manner in which the pores penetrate the plates; it also differs in the form of the disc, which is not circular, but extends for some distance along the rays, forming acute alations on their margins. The plates of the disc are polygonal, united by their lateral faces, and not squamose as in PROTASTER. The Genus PALASTERINA has "the arms a little produced" beyond the disc, while in this one they are much produced. The structure of the ray is in general characters similar in the two genera, but in PALASTERINA the adambulacral plates are large and quadrangular, while in this they are subsquamiform, spiniferous subimbricating.

EUGASTER LOGANI, N. S.

PLATE IX, FIGS. 7 and 8.

Body stellate, with a small disc and long attenuate flexuose rays. Disc composed of numerous small polygonal plates with radiated surfaces; the diameter, measured from the sinus to its extension on the opposite ray, is about half as great as the length of the ray measured from the centre of the disc. Rays, as seen from the ventral side, narrow, attenuate, with the ambulacral plates curving, and near the base of the rays a little wider than long, and towards the extremities longer than wide, with a strong elevated transverse ridge. There are about eight pairs of plates enclosed within the limits of the disc. Pores penetrating the interstices near the outer extremities of the plates, while near the inner end there is a depression or pit resembling a partially excavated pore. The adambulacral plates as seen from below are extremely narrow and very convex on their outer surfaces, forming the margins of the ray. Oral plates in pairs, narrow and elongate.

This specimen measures, from the centre of the disc to the extremities of the rays, about one inch and a half; the widest part of the ray, which is near the margin of the disc, is about an eighth of an inch in diameter. The rays towards their extremities, have the ambulacral field covered by the curving of the marginal plates over the groove, and which, closely uniting by their margins, give a teretiform termination of nearly one-third the entire length, each one having the aspect of a slender crinoidean proboscis.

Geological Formation and Locality.—In the Hamilton group, near Fenner, in Madison county, New York. The specimen was collected during the geological survey, and is now in the State Museum.

GENUS PTILONASTER, N. G.

[*πτιλογ, penna; αστηρ, aster.*]

Form and general features as in EUGASTER, but differing in the plates of the rays. Rays composed of an ambulacral, adambulacral and marginal series, which are united by their edges, and apparently not imbricating, the projecting or oblique anterior face of the marginal plates bearing spines which are inclined towards the extremity of the ray. Margins of the rays alated by the extension of the disc.

I had originally united this form with EUGASTER, but further examination has shown the ray to have a range of marginal plates outside of the adambulacral plates, and I am unable to discover any such feature in *Eugaster logani.*

This and the preceding genus belong to the Ophiuridæ, to which may also be referred the Genus PROTASTER.

PTILONASTER PRINCEPS, N. S.

PLATE IX, FIG. 9.

The specimen consists of the impression of the greater part of one ray, with parts of two others, and intervening portions of the disc. The disc has extended along the ray nearly an inch from the centre of the body; the plates are small, and have been furnished with slender spinules. The ray is strong and extremely elongate, having been at least four and a half inches in length; its greatest width is outside of the disc, where it measures seven-sixteenths of an inch. The ventral side of the ray shows three series of plates—ambulacral, adambulacral and marginal—on each side of the centre; of these at least seven ranges have been included within the disc. The ambulacral plates are a little wider than long, arranged in alternating order. The pores penetrate the interstices near the outer extremity of the plates, while the partial or obsolete pores are obscure, becoming deeper and more conspicuous towards the extremity of the ray. Near the base of the ray there are twelve plates in the length of an inch, and fourteen plates in the same distance in the central portion, while towards the extremities there are twenty or more in the same space. The marginal plates are subhexagonal, a little longer than wide, and ornamented by long slender spines on their outer margins.

This is a much larger and more robust species than the *Eugaster logani*, and in its entire condition it is the largest star-fish known in our palæozoic rocks.

Geological Formation and Locality.—In the Chemung group. The specimen is in a brownish-gray sandstone, which weathers to a very light ashen color. It was received from Henry S. Randall, Esq., of Cortlandville, in the vicinity of which place it was obtained.

Note.—It is only as these pages are going to press that my attention has been directed to the similarity of structure in the ray of Palæcoma of Salter with that of the proposed Genus Ptilonaster. In the illustrated species of the former genus (*Palæocoma marstoni*) the disc is proportionately larger, and the rays much shorter, while the outer range of plates is represented as imbricating; but being characterized by a double row of plates bordering the ambulacral area, it must be regarded as very nearly related if not generically identical with Ptilonaster.

GENUS PROTASTER, Forbes.

Protaster, Forbes; in Memoirs of the Geolog. Survey of Great Britain, Decade i. 1849.

The description of the genus is as follows:

"Body circular, covered with squamiform plates; genital openings in the angles of junction of the arms beneath; arms simple, formed of alternating ossicula."

In the third volume of the *Palæontology of New York*, page 134, I have adopted this generic designation, applying it to a fossil from the Lower Helderberg group of rocks, which hold nearly the same geological position as the Ludlow rocks of England, in which the original of the genus was found. The American species has a circular disc, composed of squamiform spiniferous plates and five long flexuous rays. These rays I have represented as composed, on the lower side, of a double range of plates, as described and represented by Prof. FORBES; but finding outside of these a range of small ossicles to which are attached the spine-bases, these have been shown as a part of an articulating spine (in the illustration, Plate vii, A, loc. cit.), an unnatural representation, which I am now able to correct.

In the species from the Lower Helderberg group, *Protaster forbesi*, the ventral surfaces of the rays are composed of an ambulacral and adambulacral series of plates on each side. The ambulacral plates are obliquely quadrangular and alternating in a slight degree; the adambulacral plates as seen from the lower side are narrow, elongate, oblique, and laterally imbricating, presenting the appearance of an oblique ridge with the anterior extremity projecting, and forming the point of attachment for the spines, with which each one is furnished. When the ray is abruptly curved, these plates project outwards, sometimes almost rectangularly; and when at the same time the ambulacral area is obscured by adhering matrix, these plates might readily be mistaken for appendages of the inner ranges. The pores are comparatively large, truncating the outer adjacent angles of the ambulacral plates, while the base of one adambulacral plate and the side of another form the exterior margin. The centres of the upper sides of the rays are composed of two ranges of subimbricating plates, which are closely joined along the median line; the marginal plates are the upper edges of the adambulacral plates, which bear on their anterior ends one, two or three short spines.

The structure of the lower side of the ray does not agree with the description or with the figure given by Prof. FORBES (loc. cit.), nor with that of Mr. SALTER, given as an illustration of *Protaster miltoni*.* In the latter species, Mr. SALTER says the arms "are made up of a double row of about forty pairs of squarish concave plates above, placed exactly opposite, not alternating as in other species" (Plate ix, fig. 4 *b*). On the lower side the ray is represented as made up of two ranges of plates,

* *Annals and Magazine of Nat. History*, second series, p. 330, Plate ix, fig. 4 *c*.

ambulacral and adambulacral, on each side of the ambulacral groove, which are opposite each other, with a large oval pore between them, while the outer margins of the adambulacral plates are garnished with spines.

Notwithstanding these differences, which would be of generic importance, I am still inclined to refer our species to the Genus PROTASTER, knowing how dificult it is for the palæontologist, with imperfect material at his disposal, to give always the true interpretation and representation of parts, which further examination and additional material enable him to furnish. I am disposed to believe that the plates represented as opposite will be found slightly alternating, and that the structure of the lower side of the ray in *Protaster miltoni* will prove to be not very dissimilar from that of *Protaster forbesi.*

NOTE ON THE GENUS PETRASTER, BILLINGS.

In examining the several species of PALÆASTER, certain features were revealed which showed a very intimate relation with the species described by Mr. BILLINGS under the generic name of PETRASTER. Through the kindness of Sir WILLIAM E. LOGAN, I have been permitted to examine the originals of *Petraster rigidus* (figs. 3 *a* and 3 *b*, Plate ix, Decade iii, *Canadian Organic Remains*).

The specimen, fig. 3 *b*, is the ventral side of a true PALÆASTER, having all the essential features of the genus, and none other. It is a small individual of *Palæaster matutina*, presenting all the characteristics of that species.

The specimen illustrated in fig. 3 *a*, has a few small intercalated plates between the marginal and ambulacral ranges in two of the axils of the rays; and there are a smaller number of granules in a similar position, but unequally distributed on one side of another axil; while two of the axils do not show any such intercalated plates or granules. In one of the rays, at least, the ambulacral, adambulacral and marginal plates are distinctly visible, without intercalated plates on either side.

The presence of these unequally distributed plates or granules is apparently an abnormal structure, probably the result of accident during the growth of the animal; and this view is sustained by the fact that the other parts have the ordinary structure of PALÆASTER, and in all other respects the specimen agrees with the typical *Palæaster matutina.*

NOTE ON THE GENUS TÆNIASTER, BILLINGS.

The Genus TÆNIASTER is thus described:

"*Generic characters*: Body deeply stellate; no disc or marginal plates; rays long, slender, flexible, and covered with small spines; two rows of large ambulacral pores; adambulacral plates elongated and sloping outwards, so that they partly overlap each other: adambulacral ossicles contracted in the middle, dilated at each end."

Mr. BILLINGS remarks that this genus differs from PROTASTER (as described by Mr. SALTER in the *Annals and Magazine of Natural History*, November 1857) in the following particulars:

"1. PROTASTER has a well developed disc;"
"2. It has also the pores outside of the ambulacral ossicles [see Mr. SALTER'S fig. 40 in the article above cited];"
"3. The same figure shows that the oral plates of *P. miltoni* are formed of two of the ambulacral ossicles, instead of two of the adambulacral plates."

In reviewing the characters of PROTASTER and EUGASTER, I became satisfied that there was an intimate relation between these and TÆNIASTER of BILLINGS; and in order to satisfy myself on this point, I have, since the preceding pages were printed, requested, and kindly received from Sir WILLIAM E. LOGAN, permission to examine specimens of *Tæniaster spinosus* and *T. cylindricus* (Decade iii, *Canadian Organic Remains*, Plate x, figs. 3 and 4).

An examination of the specimen illustrated in fig. 3 (ut. sup.) reveals what I conceive to be a disc not at all unlike the disc of PROTASTER, but less extended than in the Lower Helderberg species. The structure of the ray is precisely of the same character as the ray of that species which I have named *Protaster forbesi*, the proportions of plates and relations of parts showing specific differences.

It is true that the figure of Mr. SALTER represents the oral ossicles as proceeding from the ambulacral plates; a feature which I think can scarcely exist, and the representation is probably due to an oversight, or to a distortion of the specimen. I believe, moreover, that on examination of more perfect material, Mr. SALTER will ascertain that the position of the pores is not precisely as represented.

Mr. BILLINGS remarks, under the description of *T. spinosus*, that "the ambulacral ossicles appear in some places to alternate with each other, but this is owing to a distortion; those on one side of the furrow are opposite to those upon the other."*

* *Canadian Organic Remains*, Decade iii, p. 81.

Now the specimen of this species which I have examined, and which I suppose to be the one figured upon Plate x, figures 3 *a*, 3 *b*, has the ambulacral plates alternating; and however these minute structures may present themselves to our eye, I believe that we have in no Echinoderm two adjacent series of plates which are precisely opposite one another.

In the specimen of *T. cylindricus* examined, the ambulacral plates are less distinctly alternate; but the relation of the adambulacral plates and the pores are the same as in the other form. Not having seen the specimen showing the dorsal view, figure 4*a* of Plate x, I can only remark that the structure of the rays is very similar to that of Protaster. If the appearance of a disc be fallacious, then we have in Tæniaster a structure in all respects similar to that of Protaster, wanting the disc. If the structure of Protaster, as represented by Mr. Salter be the true one, then the New York species must be referred to another genus. Notwithstanding the difference shown between the figures of Prof. Forbes and Mr. Salter, and between these and the illustrations here given, I am still inclined to believe that our species is congeneric with the original of Prof. Forbes' type of that genus.

GENUS LEPIDECHINUS, Hall.

Lepidechinus, Hall. Descript. New Species of Crinoidea; Preliminary Notice, p. 18. 1861.

This genus was described as "Subspheroidal, the form and arrangement of the ambulacral and interambulacral series as in Palechinus, with the plates of the interambulacral series imbricating from the dorsal side, and the lower edges of each range overlapping those below; while the plates of the ambulacral areas are imbricating in the opposite direction, narrow and deeply interlocking at their joining edges, each plate pierced near the opposite extremity by two pores. Surface granulose."

This genus was separated from Palechinus on account of the imbricating character of the plates, both of the ambulacral and interambulacral areas, and also from the more numerous ranges of plates in the interambulacral areas. In its essential characters, it is much further removed from that genus.*

* Dr. B. F. Shumard, in his *Catalogue of Palæozoic Fossils*, in adopting the generic name Lepidechinus, adds: "Compare Oligoporus (Meek & Worthen)." I am at a loss to understand any near analogy between a fossil having the "ambulacral areas about half as wide as the interambulacral spaces," and the "ambulacral pores in four ranges with some irregular intercalated smaller pieces between," and one having the pores in pairs, two to each piece, and arranged in four double rows, two on each side of the mesial ridge or convexity of each ambulacrum.

Lepidechinus has a *double* range of poral or ambulacral plates, and two pores in each plate near the outer end, making two double rows of pores only; while the interambulacral areas are many times as wide as the ambulacral areas, and differ from those of Palechinus in having more than five ranges of plates.

Lepidechinus rarispinus, n. s.

PLATE IX, FIG. 10.

Body spherical or depressed spheroidal. Interambulacral area having from nine to eleven ranges of imbricating, mostly hexagonal plates, in their widest part, which gradually decrease in size towards the upper end; while on the lower side the central ranges terminate before reaching the apex, and the outer ranges only reach the oral aperture. The plates are imbricated from below upwards, and from the centres of the areas outwards; the central range overlapping those adjoining on either side. The ranges immediately bordering the ambulacra are small, and mostly furnished with small spines. The plates of the next range are the largest of the body; each alternate plate in the upper part larger than the adjacent one, and having a strong central spine. Each of the other plates of the areas, in the upper part of the body, bears one or more spinules; while in the central portion these become strong spines. Ambulacral areas narrow, contracted towards their upper ends, composed of a double series of very short curved poral plates, alternating and interlocking at their adjacent margins; each plate pierced by two small pores near the outer extremity. There are from three to four of these plates in the space of one-tenth of an inch, and they are slightly imbricated in a direction opposite to those of the interambulacral areas.

The summit of the specimen is composed of several ornamented plates, arranged in the form of a pentagon; the precise number and form of these plates cannot be determined. Just within one of the angles of this pentagon, and occupying the position of the madreporic tubercle in modern Echinoderms, there are impressions of what appear to have been the bases of several [six ?] plates, arranged in a circle, and having precisely the appearance of the ovarian pyramid as seen in Agelacrinus. The oral aperture has been quite small, and centrally situated.

This species, in its generic features, is identical with *L. imbricatus*, the type of the genus from the Burlington limestone; and in its specific characters it is very similar.

The imbrication of the plates is a very marked feature in two specimens of this species, and their condition is such as to leave no question that the imbrication is from the ventral side, and not from the apex, being the reverse of the relation described in the *L. imbricatus;* and it is possible that from the imperfect condition of the specimen described, I may not have distinguished the relations of parts. In the species under consideration, there is a central range of vertically imbricating plates which cover the lateral margins of the adjacent ranges, so that the lateral imbrication passes beneath them, instead of showing an alternation along the central line or suture, as in the Burlington species.

Formation and Localities.—In rocks referred to the age of the Chemung sandstones: at Meadville, Pennsylvania (an impression in a specimen of the rock associated with *Crania leoni?*); and in the ferruginous sandstones of Licking county, Ohio. The latter was received from Prof. Carter, formerly Professor of Natural History in the College at Granville, Ohio.

The fossil from Meadville occurs in such position and relations that I believe no one will question the geological horizon; but the sandstones of Licking county, Ohio, constitute the upper part of the Waverly sandstone series of that State, and have been referred, by many geologists, to a higher position than the Chemung of New York.*

GENUS EOCIDARIS, Desor.

After a careful study of the "*Echinus drydenensis*" of Vanuxem, it was found to possess certain characters which separate it from Archæocidaris, and also from Palechinus; and the generic description below was written before I had observed its similarity to the Genus Eocidaris, to which I now propose to refer it.

Body spheroidal, composed of five ambulacral and five interambulacral fields. Ambulacra composed of a double series of plates, each perforated near its outer extremity by two small pores. Interambulacral

* Since these pages have been in type, Dr. Newberry, Director of the Geological Survey of Ohio, has announced the well marked distinctions of typical Chemung rocks with *Spirifera verneuili* and *Leiorhynchus mesacostalis,* and the Waverly sandstones, which in that State constitute a very distinct group. It now becomes very important to determine the source of the Meadville specimen.

areas, each consisting of two continuous ranges of medium-sized pentagonal plates bordering the ambulacra, and two or more ranges of hexagonal plates; some of the latter ranges becoming obsolete before reaching the extremities of the areas. Plates of the interambulacral areas, with their centres occupied by a single rounded tubercle for the attachment of a spine. No elevated ring surrounding the tubercle has been observed. Spines of medium length, slender, muricated. Ovarian apertures dorsal. Oral aperture ventral, centrally situated.

This genus is intermediate in characters between PALECHINUS, SCOULER, as given by M'COY (*Synopsis of Carboniferous Fossils of Ireland*, p. 171), and ARCHÆOCIDARIS, M'COY = ECHINOCRINUS, AGASSIZ, = PALÆOCIDARIS, DESOR [Idem, p. 173]. From the former it differs in having a central tubercle and only one spine on each plate, features which are made prominent among the generic characters. From the latter genus it differs in having the interambulacral areas composed of a larger number of smaller plates, with the central ranges becoming obsolete before reaching the extremities of the areas; while those of ARCHÆOCIDARIS gradually decrease in size, but reach to the top and bottom of the interambulacral fields.

The following is Mr. DESOR's description of the Genus EOCIDARIS:

"EOCIDARIS, nov. gen. Like the Genus ARCHÆOCIDARIS, this genus is yet known only by some plates and some spines. These plates being hexagonal, they should consequently be placed in the tribe of the TESSELATES. One large tubercle on each plate. This tubercle is smooth at the base, and perforated at the summit; but it differs from those of the Genus ARCHÆOCIDARIS in the absence of a second ring. Ambulacra unknown. Spines slender, ornamented with small sporadic spines.

"Found in Devonian, Carboniferous and Permian strata."

It is probable that some of our American species, heretofore referred to the Genus ARCHÆOCIDARIS, will prove to belong to this genus; and since they can be determined by the character of the separated plates and spines, there will be little difficulty in the identification.

Eocidaris drydenensis.

Echinus drydenensis, Vanuxem. Report of Third Geol. District of N. Y., p. 184. 1842.
Archæociduris (?) *drydenensis*, Vanuxem; in Shumard's Cat. Palæozoic Fossils. 1865.

Body spheroidal, having the poles deeply impressed. Ambulacral areas comparatively wide, contracted in the upper part, composed of very short broad plates, about five in the space of a tenth of an inch; each pierced by two small pores, making four rows of pores to each ambulacral field. The adjacent ends of the plates are depressed, forming a longitudinal groove passing along the middle of the field, with a slight ridge in the centre. The ranges of pores have an undulating direction, corresponding with the curving edges of the adjacent plates of the interambulacral areas. Interambulacral areas, in their widest part, composed of seven ranges of plates, two of them being pentagonal and five hexagonal. These decrease in size towards the ends of the areas; and the central ranges become obsolete in turn, until at the summit of the area the outer ranges only exist. Each plate of the interambulacral areas, so far as can be determined, is characterized by a central tubercle for the attachment of a single spine.

The spines, as seen scattered over the surface of the rock, are slender, and vary from one-half to three-fourths of an inch in length, with a slight annulation around the lower end for the attachment of the muscles.

Summit structure not known. The oral aperture, to judge from the impressions of the oral ossicles left on the rock, has been comparatively large.

One specimen, as it occurs flattened upon the stone, is nearly two and three-fourths inches in diameter.

The specimen described by Mr. Vanuxem is upon a thin slab of shaly sandstone of about ten by eleven inches—one of the angles, being nearly a fourth of the area, having been broken off. Upon this slab is one specimen better preserved than the others, from which the characters have been mainly derived. There are three other individuals possessing the form and showing the ambulacral fields, and there are parts of four others, with multitudes of slender spines scattered over the surface.

Geological Formation and Locality.—In the shaly sandstones of the Chemung group, in the town of Dryden, Tompkins couuty, New York. The position of this fossil is in the lower part of the group, and probably not more than one thousand feet above the upper beds of the Hamilton group. Up to the present time the species is not known in any other locality, and it remains the earliest known form of this group of fossils.

GENUS AGELACRINUS, Vanuxem.

Agelacrinus hamiltonensis.

Agelacrinus hamiltonensis, Vanuxem. Rep. of Third Geol. Dist. N. Y., pp. 158, 306, fig. 80.

Body comparatively large, discoid or depressed-convex; the border composed of several ranges of imbricating plates, those of the marginal range minute, the others gradually increasing in size towards the inner edge of the border. The range of plates adjacent to the inner area or disc is composed of large transversely elongate plates, with alternating smaller ones. Arms long, slender, curving; the anterior arm and the left antero-lateral and postero-lateral arms sinistral, the other two dextral. The extremity of the right postero-lateral ray extends into the anal area, and passes just behind the ovarian pyramid. The arm-grooves are covered by a large number of elongate triangular plates, arranged along their margins; those of the opposite sides alternating, and their adjacent ends interlocking. The arms have their origin in a transverse pyramid, situated in the central area about two-fifths of its diameter from the anterior margin: this pyramid is composed of six plates, five of them triangular, their bases forming the termination of the rays, and their apices uniting above; the sixth or posterior plate, rising from the anal area, is larger and somewhat shield-shaped. The ovarian pyramid is scarcely elevated, situated subcentrally in the largest interradial area, composed of nine very elongate triangular plates. Interradial areas composed of comparatively large polygonal plates (not squamosely arranged or imbricating), uniting by their lateral faces, and their centres elevated into angular ridges. The surfaces of the squamose plates which form the border, are simply granulose.

This species, the type of the genus, differs from all others yet described, in having two of the rays dextral and three sinistral; also the plates composing the interradial areas are not squamose, as in most other species. The pyramid, originating the arms, is composed of a greater number of plates than any of the Silurian species of the genus.

The original specimen consists of impressions of the exterior of five or six individuals, some of them quite young, the largest one measuring about one inch and a quarter in diameter. No other specimens of this species have been found, so far as I know.

Geological Formation and Locality.—In the arenaceous shales of the Hamilton group, at Hamilton, Madison county, New York.

(M.)

DESCRIPTIONS OF NEW OR LITTLE-KNOWN SPECIES OF FOSSILS FROM ROCKS OF THE AGE OF THE NIAGARA GROUP.*

By JAMES HALL.

I. RELATIONS OF THE NIAGARA GROUP WITH THE LECLAIRE, RACINE AND GUELPH LIMESTONES.

In the study of the fossils of the Niagara group and associated strata, previous to the publication of the final *Report on the Fourth Geological District*, and also to the publication of the second volume of the *Palæontology of New York*, I separated a few species found in the impure drab-colored limestone from Wayne county, New York.

The limestone containing these fossils became exposed only in the bed of the canal during its excavation; and the low country, or deeply drift-covered surface in the vicinity, did not admit of any exposure of the rock in place. The materials were thrown out of the excavation in connection with the soft marls of the Onondaga salt group, and the specimens of rock containing the fossils preserved the peculiar celluliferous structure and characteristic color of the argillaceous limestone of that formation. Differing so essentially from any known beds in the Niagara group, I did not hesitate to refer them to the Onondaga salt group, since there was no evidence of any other formation in the neighborhood.†

* This Paper was originally printed in advance, in December, 1864, for the *Eighteenth Report on the New York State Cabinet*.

† The same reference of the species had, in fact, been made during the Geological Survey, and they were thus published in the *Report on the Fourth Geological District*, in 1843.

Throughout the State of New York, the country along the junction of the Niagara and Onondaga salt formations is low and level, or covered by drift accumulations; and no opportunity offered of discovering any exposure of similar beds along the course of the outcrop. In some places in Monroe county we have been able to trace the two formations to within a few feet of their contact with each other; but no fossiliferous beds, similar to those of Wayne county, have been found. Subsequently, after a considerable portion of Vol. ii of the *Palæontology of New York* had been printed, my attention was called to some peculiar fossils collected at Galt, in Canada West; and in visiting that locality, I discovered some species identical with those before known, from beds which I had regarded as of the Onondaga group in New York. As this limestone at Galt (and Guelph) was clearly above the great Niagara limestone of the Falls, and contained an almost entirely different set of fossils, I very naturally inferred that it belonged to the next higher formation, or the Onondaga salt group, and that the Wayne county locality was a feeble representation of the limestone of Galt.* For these reasons the two were treated as identical, and referred to the age of the Onondaga salt group; an opinion at that time sustained by the members of the Canadian Geological Survey.

At a later period, during the Geological Survey of Iowa, I recognized, at the Leclaire rapids on the Mississippi River, a limestone holding the same relative position, having the same lithological character, and containing some identical and many similar fossils with the limestone of Galt or Guelph, in Canada West; and I thus announced its apparent relations in the *Report on the Geology of Iowa*, 1857, Vol. i, p. 75:

"Should the identity of the limestone of these two distant localities be proved, it will afford sufficient ground for separating these beds from the Onondaga salt group, and for establishing a distinct group. It seems quite probable that the limestones of this period have their eastern extremity in Central New York, where, from their small development, as well as from similarity of lithological character, there seemed no sufficient ground for separating them from the non-fossiliferous beds of the Onondaga salt group.† Since, however, in Canada, these beds attain considerable importance, and (admitting the conclusions above given) acquire a still greater thickness and

* The name "Galt" being considered objectionable on account of a similar term already in use, and the same rock occurring also at Guelph, it has been called the "Guelph formation" in the nomenclature of the *Geological Survey of Canada*.

† My views regarding the presence of the Onondaga salt group proper in Wisconsin and Iowa have somewhere been called in question, and I have only to remark in this place that I have seen no reason on my own part, nor facts adduced on the part of others, to change my opinion in reference to the occurrence of this formation in the localities I have heretofore cited.

more distinctive character on the Mississippi River, it seems necessary to elevate them to the same rank as the other groups of the series."

Some two or three years later I explored the geology of the central and eastern portions of Wisconsin and the adjacent parts of Illinois. I here found the limestone of Racine, and a part of Waukesha and some other localities, resembling in all respects that of Leclaire and holding many of the same fossils. It is likewise underlaid by the even-bedded darker-colored limestone, bearing *Halysites catenulatus*, *Pentamerus oblongus*, and many large Orthoceratites, which are everywhere regarded as evidence of the Niagara age. I could not hesitate, therefore, to parallelize the succeeding beds with the limestone of Leclaire, though we had failed to trace that formation across the country in a continuous outcrop. At the same time, on critical examination of the collection of fossils made at Racine and at some other points, I detected many species known as characteristic of the Niagara formation in the State of New York, requiring its recognition as a member of that group (rather than of the Onondaga salt group), and uniting with it as identical in position the Leclaire limestone.*

At the same time, we have recognized from Racine and adjacent localities, including Leclaire in Iowa and a single locality in Illinois, the following species which are identical or very closely allied to those from Galt in Canada West: *Pentamerus occidentalis*, an *Obolus*-like fossil, a *Favosites* and a species of *Amplexus* which are identical in several localities, *Cyclonema sulcata*, *Murchisonia logani*, *Murchisonia* identical or closely allied to *M. mylitta*, Billings, an undescribed *Murchisonia* from Racine identical with one from Galt, *Subulites ventricosa*, *Pleurotomaria solaroides ?* *Loxonema longispira*, besides other forms which are closely allied to species of the Guelph limestone.

An examination of several localities in Wisconsin shows that this peculiar fossiliferous limestone is very unequally distributed. At Racine it has a very considerable thickness;† while in other places, either from denudation or other causes, it is very thin, or even absent. In some places in the vicinity of Milwaukee and Waukesha, there are indications of beds of passage from the regularly bedded limestones below to the unequally bedded rock above. There appears indeed very good evidence of the irregular or unequal accumulation of this higher rock in many of the localities along a considerable portion of the outcrop; and where the lower

* *Report on the Geology of Wisconsin*, p. 67. 1861.

† I am inclined to believe that I have over-estimated the thickness of the limestone at Leclaire from the presence of lines of false bedding, but I have had no opportunity of a reëxamination of the locality.

part of the formation comes to the surface, the upper rock does not appear to be developed. I am therefore induced to believe that this limestone at Racine, the mass at Leclaire and extending thence into Iowa, as well as the Guelph formation in Canada and the feeble representation of the same in New York, are really lenticular masses of greater or less extent, which have accumulated upon the unequal surface of the ocean bed in a shallow sea during the latter part of the Niagara period. These isolated masses of limestone have close relations with each other, while their relations with the Onondaga salt group, though very intimate in the single locality in Central New York, become less and less conspicuous in a westerly direction.

In the *Geology of Canada*, published in 1863, the Guelph limestones are described as constituting a distinct formation; but Sir. W. E. Logan remarks:

"It has already been stated that the strata seen near the mouth of the Rivière aux Sables, at Chief's Point, probably strike along the coast by Lyell Island to Cape Hurd, and belong in part to the Niagara formation, whose characteristic fossils are met with in several localities along the shore. These strata, however, have for the most part the lithological characters of the Guelph formation, and some of their undescribed species of Murchisonia have a strong resemblance to others found in this series. The *Pleurotomaria huronensis*, which belongs to the Guelph rocks, occurs on Lyell Island associated with *Pentamerus oblongus* and other characteristic Niagara species; so that it is not impossible that some of the strata along this coast may constitute a passage between the Niagara and Guelph formations.

"The Guelph formation appears to be absent from the State of New York; and in Canada it probably has the form of a great lenticular mass, the limit of which between Niagara and Guelph is uncertain, though it appears to extend beyond Ancaster. In the other direction, it seems to thin out in Lake Huron, before reaching the northern peninsula of Michigan."

I should not omit to say here, that so far as my investigations have extended on the islands of Lake Huron and Lake Michigan, with the peninsula between the latter and Green Bay, I have found the presence of the lower portions of the Niagara group, with the general absence of the higher beds. At the same time, along this great extent few fossils occur except *Pentamerus oblongus*, *Halysites catenulatus*, and two species of Favosites, with some other corals; and it is only on continuing the observations to the southward in Wisconsin, that we find a larger number of the Niagara species proper. This indication of beds of passage, pointed out by Sir W. E. Logan, will, I presume, be found in all or nearly all localities where a junction of the two formations can be seen.

II. DESCRIPTIONS OF FOSSILS OF THE NIAGARA GROUP.

ECHINODERMATA.

In the *Report of Progress of the Geological Survey of Wisconsin* for 1860,* I described several species of Crinoidea, two Cystideans, several species of Brachiopoda, Gasteropoda and Cephalopoda, from the limestones of Racine and Waukesha; leaving a considerable number of species undescribed for want of satisfactory material. It has not been in my power to make such collections as I then anticipated; and the following descriptions relate almost exclusively to species that have been in my cabinet for several years, and which were studied, and many of them determined, at the time of making the report above cited.

Some of the Crinoidea are very interesting; but the Cystideans possess a peculiar interest, as offering forms which, so far as I know, have not been discovered in any other localities. The specimens, with few exceptions, are casts of the interior of the test, or impressions of the exterior left in the matrix. A few of the species retain the plates to such an extent that the structure can be determined. Since it appears probable that we shall, for some time at least, be dependent upon similar imperfect materials for our knowledge of these fossils, I shall endeavor to give such descriptions as will enable the student to recognize the species, with the hope that some of them at least will be illustrated at a future period.

GENUS GOMPHOCYSTITES, N. G.

[*γομφοσ, clavus; κυστοσ, vesica.*]

Body elongate pyriform, very narrow at the base, gradually enlarging above, and inflated near the upper extremity. Surface composed of numerous series of polygonal plates which have a spiral arrangement. Apertures upon the upper surface, one of them being subcentral, and the other a little eccentric. Arms sessile, lying in grooves excavated in the surface of the plates, originating near the

* *Report of the Superintendent of the Geological Survey,* Legislative Documents, 1861.

mouth, and curving spirally outwards and downwards over the body, reaching to or even below the point of its greatest diameter. The central aperture appears to have been closed by a pyramid of five or six small plates.

The fossils of this genus are remarkable for their elongate form, attenuate base and swelling upper extremity; they were probably supported upon a short pedicel, but we do not know its character. The body is composed of numerous ranges of short hexagonal or polygonal plates, the spiral arrangement of which can be traced in their marking upon the cast.

In a fragment of one of these from the Niagara shale of New York, there is but a single subcentral opening visible, the arms all originating on one side of this. In the casts of other species from Wisconsin, there is evidence of a smaller aperture near the round subcentral one.

A large proportion of the specimens observed are unsymmetrical in greater or less degree, and this feature is apparently very variable in the same species. In a view of the summit, the position of the apertures and disposition of the arms resemble Agelacrinus, but the plates are of different character, being strongly granulose, and the sutures of the plates are so close as to make it difficult to distinguish them.

Gomphocystites tenax, n. s.

PLATE XII, FIG. 15, AND PLATE XII *a*, FIGS. 1, 2.

Upper part of body ventricose, somewhat rapidly attenuated below; principal aperture round, subcentral; the pyramid of plates which probably closed the orifice are unknown, leaving a margin of small unequal plates. The plates forming the summit of the body are small, polygonal, with surface strongly granulose. The arm-plates appear to have been furnished with tentacula, as in Apiocystites and other genera.

Formation and Locality.—This species occurs in the Niagara group at Lockport, New York. Collection of Col. E. Jewett.*

Gomphocystites glans, n. s.

PLATE XII, FIG. 14, AND PLATE XII *a*, FIGS. 4 AND 5.

Body elongate, clavate, with the upper extremity extremely ventricose, often more or less unsymmetrical, and the summit unequally convex on the upper side, somewhat abruptly contracted below, and thence

* Now in the collection of the Cornell University.

gradually attenuate. Principal aperture subcentral; arms originating close to the aperture, and curving in a spiral direction over the summit and along the sides to the point of greatest expansion, or sometimes a little below.

The specimens of this species are from one to three inches in length, with a diameter in the greatest expansion of from less than half an inch to an inch and a half.

The illustrations are of a large unsymmetrical specimen, and one of symmetrical form somewhat smaller.

Formation and Locality.—In the limestone at Racine, Wisconsin.

Gomphocystites clavus, n. s.

PLATE XII *a*, FIG. 3.

Body clavate, gradually expanding to the upper part which is elongate ovate, nearly or quite symmetrical, summit regularly convex; principal aperture at the apex, and essentially central. Arms originating from one side of the central aperture, curving a little spirally downwards, and reaching below the apex a distance about equal to the greatest diameter of the body.

Below the expanded portion, the body becomes obtusely pentagonal, a feature but obscurely shown in the cast; base unknown.

This species is very nearly symmetrical, and much more gradually expanding from below to the greatest diameter, and less abruptly rounded above; while the arms have a more nearly vertical direction.

It is possible that this may be only a modification in form of the *G. glans;* but among a considerable number of specimens of that species, I have not observed gradations to this form; and I therefore designate it as a distinct species until it can be proved identical, or until its relations with the preceding species can be more satisfactorily determined.

Formation and Locality.—In the limestone at Racine, Wisconsin.

GENUS HOLOCYSTITES, n. g.

[*'ὁλος totus; κυστος, vesica.*]

Body elongate, sub-cylindrical, elliptical or sub-ovate, composed of numerous (six or more) ranges of comparatively large plates, or of alternating series of large and small hexagonal or polygonal plates; apertures at or near the summit, one of them central or subcentral, the other eccentric. Supported on a short pedicel. Sessile arms none; free arms unknown; no evidence of pectinated rhombs.

The specimens referred to this genus are generally composed of large plates in pretty regular alternating series, or sometimes a range of large plates alternating with a range of small ones. There are no indications of sessile arms as in GOMPHOCYSTITES; though there may have been free arms around the central aperture of the summit. The surface of the plates is strongly granulose, and sometimes marked by ridges and central nodes.

I had originally referred these forms with some doubt to the genus CARYOCISTITES;* but an examination of other specimens has shown that there is no lateral aperture as in the species of that genus, and I therefore propose a distinct generic term.

HOLOCYSTITES CYLINDRICUS, HALL.

PLATE XII, FIGS. 4, 5; PLATE XII *a*, FIGS. 7, 8.

Caryocystites cylindricus, HALL. Ann. Rep. Geolog. Survey Wisconsin for 1860, p. 23. 1861.
Geology of Wisconsin, I, p. 69. 1862.

Body elongate obovate or subcylindrical, rounded at top and abruptly contracted at base near the junction with the column; basal plates undetermined. Above the basal plates the first range consists of eight elongate hexagonal plates, their length once and a half their greatest width, gradually expanding in width from below upwards; these are succeeded by a second, third, fourth and fifth range of eight plates in each, all somewhat regularly hexagonal, their length a little greater than their width. Of these, the fourth range is usually the widest, situated at a little more than one-third the length of the body from the summit, and at the point of greatest diameter. In the sixth range above the basal, the plates are much smaller than the others, and narrower at the upper end. Alternating with these last, is a seventh range of smaller plates, surrounding those of the summit, and enclosing the summit openings. Column small, round, rapidly tapering below the point of attachment. Surface of plates granulose.

* *Annual Geological Report of Wisconsin for* 1860, published 1861; and *Geology of Wisconsin*, Vol. i, p. 69. 1862.

Several specimens, more or less entire, exhibit the characters here given. While the surface of the plates is coarsely granulose, there is no evidence of ridges or nodes. Some of the specimens show irregularities in the form and proportions of the plates, indicating the possibility of a gradation between this and the following species; but the material I have is not sufficient to determine this question.

Formation and Locality.—In the limestone at Racine and Waukesha, Wisconsin.

HOLOCYSTITES ALTERNATUS, HALL.

PLATE XII, FIG. 9; PLATE XII*a*, FIG. 6.

Caryocystites alternatus, HALL. Ann. Rep. Geolog. Survey Wisconsin for 1860, p. 23. 1861.
Geology of Wisconsin, I, p. 69. 1862.

Body extremely elongate, subcylindrical, the greatest diameter above the middle and nearer the apex. Summit irregularly rounded, a little flattened or depressed on the side of the aperture; base gradually tapering to the summit of the column. The body is composed of twelve ranges of plates varying in size and shape; in some of the ranges they are large, mostly octagonal, eight in number in each range. In the alternating ranges they are smaller, five or six-sided, and about as many as in the ranges of large plates. Near the summit, and apparently between the eleventh and twelfth ranges from the base, there is a distinct aperture, with another smaller one more nearly on the summit. Surface strongly granulose. These apertures correspond to the mouth and anal aperture as described by VON BUCH in CARYOCYSTITES; but the lower lateral one, or ovarian aperture, has not been recognized in this or any other species of this genus.

The specimens of this species are partial casts, but the forms of the plates are fully preserved, and the structure of the body is very distinctly shown. The specimens with alternations of larger and smaller ranges of plates are usually less robust than those where the series are more nearly equal in size.

Formation and Locality.—In the limestone of Racine, Wisconsin.

HOLOCYSTITES ABNORMIS, N. S.

PLATE XII, FIGS. 7, 8.

Body subcylindrical, abruptly attenuate below to the short column, composed of about eight or nine ranges of plates; summit rounded; the principal aperture near the centre is marked by a depression of the surface. In the third range from the base, two or more of the large plates are surrounded by smaller ones; but the four ranges of plates below the dome are large plates of nearly equal size and equal length and breadth. Surface of plates granulose.

Formation and Locality.—In limestone of the age of the Niagara group at Racine, Wisconsin.

HOLOCYSTITES WINCHELLI, N. S.

PLATE XII, FIG. 3.

Body clavate or elongate ovate, ventricose above, and the summit abruptly rounded; rapidly contracting towards the base, which is unknown. The subcentral aperture of the summit is very large. The form is unsymmetrical, being flattened on one side and arcuate, perhaps partially from accident.

The specimen described is imperfect at the base, but from the aperture at the summit to the broken lower extremity it preserves eight ranges of plates. The lower ones are hexagonal and in alternating series; but approaching the summit and following the curve of the arcuation, there are apparently three or four plates in direct succession, which are truncate above and below, but maintain a hexagonal form from becoming wider above, and having a short sloping side adjacent to the upper straight margin.

This species is readily distinguished from the three preceding ones by the elongate-ovate ventricose form, and the more numerous ranges and smaller plates, as well as their arrangement in direct succession. The two or three lower ranges of plates preserved, somewhat resemble those of *H. cylindricus*, but they are quite free from nodes. It is impossible to know the entire number of ranges of plates from the base upwards, since no perfect specimens are in the collection. There are fourteen or sixteen plates in the circumference, some obscurity existing on one side.

The specimen preserving eight ranges of plates has a length of about two inches, and the diameter where broken off below is more than half an inch. A section below the summit is subelliptical, having its greatest diameter nearly an inch and a half, and the shorter diameter a little more than one inch.

Formation and Locality.—In the limestone of the Niagara group at Waukesha, Wisconsin.

The two following species, both on account of their form and the great number of small polygonal plates, may prove distinct from the typical forms of this genus:

Holocystites ovatus, n. s.

PLATE XII, FIG. 2.

Body from the summit to near the base symmetrically ovoid; a little depressed at the central aperture, and elevated at the eccentric one; sides regularly curving; composed of more than ten ranges of alternating polygonal plates, which are as wide as long, or wider, elevated in the centre, and coarsely granulose.

A specimen of one inch and three-fourths in length, and perfect at the base, shows ten ranges of plates between the broken lower margin and the summit aperture. The greatest diameter of the same individual is one inch and a half, while it is about half an inch in diameter where broken off, and there have probably been two or three ranges of plates below that point. A section below the summit is very broadly elliptical, and this has probably been the original form.

This species differs from *H. scutellatus* in being a more robust form, with less elongate base, and with plates larger, more equal in size, and prominent in the middle; while the larger plates in that species have central nodes from a nearly flat surface.

Formation and Locality.—In the limestone of the Niagara group at Waukesha, Wisconsin.

Holocystites scutellatus, n. s.

PLATE XII. FIG. 1.

General form of body ovoid ventricose, abruptly attenuate below, and swelling above into an ovate outline; composed of twelve or more ranges of plates, which are somewhat irregularly disposed, there being in the upper part a distinct arrangement of one large polygonal plate surrounded by smaller ones, this large plate having a node in the centre. The summit is broadly rounded, with evidence of one large subcentral aperture, and a depression indicating a second aperture. Surface of plates strongly granulose.

The ventricose ovate form and abruptly attenuate base are distinguishing features of this species. Though the *H. cylindricus* sometimes assumes an ovate form with attenuate base, yet the species here described has a much larger number of plates, which are differently disposed.

Formation and Locality.—In limestone of the age of the Niagara group at Waukesha, Wisconsin.

GENUS APIOCYSTITES, FORBES.

APIOCYSTITES IMAGO, N. S.

PLATE XII, FIG. 12; PLATE XII *a*, FIG. 9.

Body irregularly elliptical, about three-fifths as wide as long, a little larger above than below the middle. Basal plates occupying more than one-fourth of the entire height of the body. Second range consisting of five large plates. In the third range the plates are about half the size of those of the second range. The fourth range consists of at least six plates; the two over the ovarian aperture are smaller than the others. The fifth range consists of six plates of smaller size than the others, and of a pentagonal form, the upper margins being determined by the number of apicial plates, which are unknown. The ovarian aperture is situated over the right superior angle of the hexagonal basal plate, and the space is excavated from the upper margin of the plates of the third range and the lower margin of one of the fourth range. The pectinated rhombs upon the right side of the ovarian aperture occupy the adjacent margins of two plates, and are on the same parallel with the aperture. The other pectinated rhombs are not preserved in the specimen. The plates of the four lower ranges are longitudinally ridged in the middle, and in their perfect condition have probably had a central node. The circa-ovarian plates, and those of the centre of the summit or apex, have not been determined.

The specimen described is a cast, but so well preserved as to indicate very satisfactorily its most important characters. It is a more elongate form than any cystidean of this group (PSEUDOCRINITES, APIOCYSTITES, *etc.*) that I have seen from American rocks.

Formation and Locality.—In the Racine limestone of the Niagara group at Racine, Wisconsin.

GENUS HEMICOSMITES, VON BUCH.

This genus was established by VON BUCH for a fossil figured by PANDER, under the name of *Echinosphœrites malum.*

The body consists of four series of plates; the basal series containing four plates, of which two are hexagonal and broad, and two narrower and pentagonal, similar to those of CARYOCRINUS. The second or subradial series consists of six plates, which are likewise very similar to those of CARYOCRINUS, except that three, instead of two, are truncated at their upper margins; and two of them are excavated on their upper adjacent lateral angles for the ovarian aperture which lies between these and the base of one of the plates of the succeeding range. In the third range of plates this genus differs from CARYOCRINUS in having nine instead of eight plates; the ninth comes in by a truncation of a plate of the second range, which corresponds to the plate directly opposite the ovarian aperture of the other genus. The mouth is represented by VON BUCH as central. It is not known to possess arms or tentacula.

Among the fossils of the Niagara group in New York are some separated plates which I have supposed may belong to this genus; but their relations have not been fully established; though I have little doubt that further examinations in some of the more prolific localities will show the occurrence of this genus.

Among the cystideans of the same group in Wisconsin there are several specimens which preserve the structure and general features of this genus; but they are for the most part obscure.

HEMICOSMITES SUBGLOBOSUS, N. S.

PLATE XII, FIG. 13.

General form subglobose, a little longer than wide, somewhat narrower above than below; the ovarian aperture above the middle of the length; scarcely produced at the base, which is sometimes subtruncate or even a little depressed. [This latter feature is probably due to accident.] In the lower range the plates are short, and the second range consists of comparatively wide plates, giving it a greater proportional width than the typical species of the genus. The mouth is at the summit, but it cannot be determined whether it is or is not proboscidiform. The ovarian aperture is situated above the second range of plates, and is apparently more nearly at the summit of the plate on the right, which has a somewhat different form from the corresponding plate in *Hemicosmites pyriformis.* The plates of the body are granulose and marked by striæ parallel to the margins, having the centre elevated in a low node from which there are radiating ridges to the angles of the plate.

Formation and Locality.—In the Racine limestone of the Niagara group, Racine, Wisconsin.

Among the collections from Racine, and associated with the preceding species, there are several specimens of a peculiar form, apparently cystideans, but of different structure from any described genus, which, from the nodes or spines upon the surface of the species known, I propose to name ECHINOCYSTITES.

GENUS ECHINOCYSTITES, N. G.

Body subspheroidal, composed of four ranges of plates. The basal plates are probably four, and are succeeded by two ranges of five plates each and a series of dome plates. The mouth is central, with an eccentric or lateral ovarian aperture.

ECHINOCYSTITES NODOSUS, N. S.

PLATE XII, FIGS. 10, 11.

Body subglobose, base slightly protuberant in the centre; basal plates short. The five plates of the second range are large, forming part of the basal curve, and extending up the sides; they are furnished with strong nodes which are directed obliquely downwards. In the third range the plates are of equal size with the second range, and nodose in like manner; the sides of the body between the nodes being nearly straight in the vertical direction; the nodes of the lower range project a little beyond those above. Number and form of the summit plates not determined. There is evidence of a central aperture, which is probably the mouth; while at the upper lateral angles of two adjacent plates of the third series, and succeeded by a plate of the fourth series, is situated the ovarian aperture.

The specimens examined are casts of the interior, some of which retain parts of the test, and preserve, in a greater or less degree, marks of the structure.

Formation and Locality.—In the Racine limestone of the Niagara group, Racine, Wisconsin.

The two following species I place among the Cystidæ with some hesitation, notwithstanding the unsymmetrical form and peculiar character of one of them, which closely resembles in its general features the HOLOCYSTITES.

In many of the Crinoidea proper, we find the plates arranged in successive order of one, two or three following each other directly in what are termed the radial series; while between these rays are interradial plates in the usual order of a larger one below, which supports two plates in the second range, followed by a like or greater number in the third range.

In the Cystideans of the described genera the plates do not follow this order of arrangement, and cannot be separated into radial and interradial series, according to the usual mode in Crinoidea. In the Cystideans, where there are a considerable number of plates, they are arranged in alternating order, so that each succeeding range above the second have their lower margins more or less pointed and inserted partially between and resting upon the sloping upper faces of those of the preceding range. This feature is seen conspicuously in HOLOCYSTITES, where the plates are numerous. It sometimes happens, that owing to a curving form the plates follow each other in direct order.

Among the specimens which I had provisionally placed among the HOLOCYSTITES is a small species of unsymmetrical, sub-clavate form, having the two lower ranges of plates alternating as in that genus, while above these the plates are arranged in consecutive order, until we reach the last range, where every alternate one is omitted, thus producing a contraction of this part.

Since this form cannot be consistently referred to any described genus, I propose the name CRINOCYSTITES.

GENUS CRINOCYSTITES, N. G.

Body elongate, composed of plates of sub-equal size. The number of basal plates undetermined. These support five hexagonal or heptagonal plates in the second range, and upon the upper edges of these, three plates of similar form follow in direct succession; and upon the third is a fourth plate supporting one or two arms. Between the upper sloping faces of the plates of the second range, there is inserted a pentagonal plate, which supports a range in direct succession of two or three hexagonal plates. The summit is unsymmetrical, and in one specimen there is an apparent central aperture or mouth, and an eccentric or ovarian aperture; and the margin is marked by what appears to be the bases of slender arms or tentacula.

Such a structure, in the ordinary nomenclature of the Crinoidea, would be described as a range of basal plates, succeeded by a radial series of four or five plates.

The distinctly unsymmetrical form of one of the species having this structure, together with the peculiar character and parts of the summit, give it a decidedly cystidean aspect; while it cannot be allied with the crinoidean genera at present known.

Crinocystites chrysalis, n. s.

PLATE XII *a*, FIGS. 10, 11.

Body small, claviform, unsymmetrical, gradually enlarging from the base for half its length and then swelling a little more rapidly, and again contracting more abruply towards the summit. The expansion being greater on one side, while the other is nearly straight or a little concave, gives an unsymmetrical form. There are about six ranges of plates; the lower range being comparatively long, the number unknown; the second range consists of elongate heptagonal plates which, on their upper truncate faces, support in direct series three smaller hexagonal plates, and above the last one there is apparently a small arm-bearing plate. Between these direct series of plates there is an intermediate or interradial series of three plates alternating with the others, the upper ones of which are pointed above, allowing the fourth plate of each of the adjacent radial series to join at their lateral margins, giving but five plates in the range immediately below the summit. The summit is unsymmetrical, showing evidence of two apertures and five slender arms or tentacula. Surface of plates striate.

Formation and Locality.—In limestone of the age of the Niagara group at Racine, Wisconsin.

GENUS EUCALYPTOCRINUS, Goldfuss.

This genus has usually been described as having five basal plates; but Dr. Troost, in his Memoir on the Crinoidea, has described the genus as having four basal or pelvic plates.

In the study of the collections from Waldron, Indiana, in 1861–62, this feature was fully ascertained, thus confirming the original observations of Dr. Troost.*

The basal plates of the species of this genus are usually small, and either concealed in the depression or covered by the column.

The form and relations of these plates are shown in fig. 1, which represents the basal and first radial plates of *Eucalyptocrinus cœlatus* as seen from the inside, and showing more conspicuously than on the exterior. In the original specimen both these and the lower part of the first radial plates are covered by the column. In the diagram, fig. 2, the basal plates of *E. cœlutus* are given of the natural size, and in their relation with the first radial plates; the plates are shown from the exterior, the ring indicating the extent of the column.

Fig. 1.

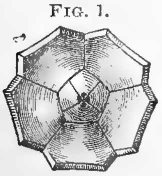
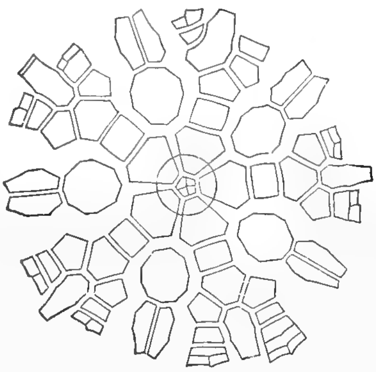


Fig. 2.



This determination of the basal plates will remove the Genus Eucalyptocrinus from its present position among the Crinoidea which have five basal plates, and bring it into association with Melocrinus.

Eucalyptocrinus cornutus, n. s.

PLATE XI, FIGS. 8, 9, 10.

Body (without the arms) somewhat turbinate, distinctly angular, with the base broadly truncate and more or less concave. Basal plates comparatively large, extending from the centre nearly one half the distance to the edge of the truncation. First radial plates large, forming the circumference of the base, and abruptly bending upwards they extend nearly one-third the height of the calyx; second radial plates small; third radials much larger than the

* I did not at that time publish an account of this structure in my paper on the Waldron fossils, wishing that it might first appear in the publication of Dr. Troost's Memoir; but since that has been delayed, I notice it in this place, giving Dr. Troost the credit of the original discovery.

second, supporting the first supraradials, which are of moderate size. The first interradial plate is comparatively large, commencing just above the edge of the basal truncation, and supporting two smaller plates above. Each of the first radial plates, on the part just above the basal truncation, bears a strong central spine, with a prominent rounded ridge on each side, extending to the upper lateral margin and joining a similar ridge on the interradial plate, and another ridge extends from the upper side of the central spine, and joins a similar ridge on the succeeding plate; this is continued to the third radial, where it divides and extends on the supraradials. The interradial plates of the first series are marked by similar strong ridges, which culminate in a prominent node or short spine in the centre. The finer surface markings are not known. Arms unknown.

The specimens occur in a magnesian limestone; the test has been dissolved, leaving casts of the interior and impressions of the exterior surface, and it is from these that we are able to derive the form and character. This species is readily distinguished by its strong nodes and ridges, and the spines upon the first radial plates.

EUCALYPTOCRINUS CORNUTUS, var. EXCAVATUS, HALL.

PLATE XI, FIGS. 6, 7.

This variety differs from the typical forms in having the base deeply and broadly excavated; the cavity embracing the basal, and nearly the entire length of the first radial plates. The plates are marked by ridges and nodes. In some of the specimens the second radial plates are very imperfectly developed, being reduced to a mere flattened node which is entirely surrounded by the first and third radial plates.

In these specimens the dome has not been observed, and the arms and axillary plates are unknown. The third radial plate is truncated above by a long narrow plate, and the first interradial by two narrow plates separated by a vertical suture, and has in all respects thus far the character of the genus; but above this, the cavity appears to have been larger, and shows no marks of the axillary plates, as usual in the dome of EUCALYPTOCRINUS.

Formation and Locality.—In limestone of the age of the Niagara group at Waukesha and Racine, Wisconsin.

EUCALYPTOCRINUS CRASSUS, HALL.

PLATE XI, FIGS. 2, 3.

Eucalyptocrinus crassus, HALL; in Transactions of the Albany Institute, IV, p. 197. 1862.

Specimens which are casts of the interior and impressions of the exterior, present the general aspect of this species. It is extremely variable in form. Sometimes it is regularly turbinate and convex on the sides; other specimens are extremely elongate and sometimes abnormal in their development, having the supraradial plates united at their lateral margins, and the second interradials with the first axillary plate resting upon their upper sloping sides, instead of the truncated upper face of the interradial and third radial plates. This variation sometimes extends only to one or two of the rays, and sometimes, as far as can be seen, to all the plates of these series.

Formation and Locality.—In limestone of the Niagara group at Racine, Wisconsin.

EUCALYPTOCRINUS OBCONICUS, N. S.

PLATE XI, FIG. 1.

Body small, reversed conical; base narrowly rounded or obtusely pointed; basal plates small and curving upwards. First radial plates comparatively large; the second and third smaller. The two supraradial plates join at the lateral margins, and the narrow interbrachial rests upon them, and does not truncate the third radial. First interradial plate large, narrowly truncate above.

This species occurring in several specimens is a remarkable form of EUCALYPTOCRINUS, being much more slender than any other species of the genus known to me; and presenting the peculiar relations of the interbrachial plates, which are elevated to a higher position than they occupy in the normal structure of the genus.

The position of the interbrachial plates, which appear to be uniform in this species, is sometimes observed in specimens of *E. crassus.*

Formation and Locality.—In limestone of the Niagara group at Racine, Wisconsin.

Eucalyptocrinus ornatus, Hall.

PLATE XI, FIGS. 4, 5.

Eucalyptocrinus ornatus, Hall. Rep. Prog. Geol. Survey Wisconsin for 1860, p. 20. 1861.

This species is common at Racine and Waukesha. It occurs as casts of the interior, but retaining the marks of its structure in a greater or less degree of perfection. The impressions of the exterior in the compact limestone are very well marked and characteristic of the species.

Some specimens of the casts have a somewhat obtusely pentagonal form, with a broad spreading base, and a constricted upper margin. In this condition they much resemble in form and proportions the *Rhodocrinus melissa* of the Niagara shale at Waldron, Indiana.

Eucalyptocrinus cælatus, Hall.

Eucalyptocrinus cælatus, Hall. Palæontology of New York, II, p. 210, Plate 47, fig. 4.

Some specimens of casts of the interior and impressions of the exterior surface of a species of Eucalyptocrinus, from Waukesha, appear to me not to be distinguishable from the New York species.

GENUS CYATHOCRINUS, Miller.

Cyathocrinus pusillus, Hall.

Cyathocrinus pusillus, Hall; in Transactions Albany Institute, IV, p. 200. 1862.
Compare *Poteriocrinus pisiformis*, Roemer. Die Silur. Fauna des Westlichen Tennessee, p. 54, Plate iv, fig. 7.

Specimens of a small species of Cyathocrinus or Poteriocrinus, resemble the one described by Roemer, presenting characters somewhat intermediate between that species and *C. pusillus*.

Formation and Locality.—In limestone of the age of the Niagara group at Racine, Wisconsin.

Cyathocrinus cora, n. s.

PLATE XI, FIGS. 13, 14.

Body rotund, somewhat broadly turbinate, rounded below, and gently contracted a little below the middle of the subradial plates and swelling out above; having the upper margins of the radial plates incurved and prominent in the middle. There is a single small anal plate. The basal plates are comparatively large, rising above the curve of the base to nearly one-third the height of the cup. The subradial plates form nearly one-half the height. The column is large and round. Arms unknown. The surface of the plates in the casts is marked by strong radiating striæ.

Formation and Locality.—In limestone of the age of the Niagara group at Racine, Wisconsin.

Cyathocrinus waukoma, n. s.

PLATE XI, FIGS. 11, 12.

Calyx rotund below, subhemispheric; the sides above the middle of the subradial plates nearly straight or but little spreading. Basal plates small; subradial plates large, curving upward for about half their length; radial plates about as large as the subradial. The subradial plates have been marked by a central node, from which radiate strong ridges to the margins, joining similar ridges on the adjacent plates. Two of these from the lower sides of each of the radial plates converging to near the centre of that plate, and uniting, extend in a single ridge to the upper margin. The surface markings beyond the strong ridges are unknown.

This species is of different form, with more elevated sides and different surface markings from *C. pusillus*, which occurs in the same formation.

Formation and Locality.—In limestone of the Niagara group at Racine and Waukesha, Wisconsin.

GENUS ICHTHYOCRINUS, Conrad.

Ichthyocrinus subangularis, Hall.

PLATE XI, FIGS. 15, 16.

Icthyocrinus subangularis, Hall; in Trans. of the Albany Institute, IV, p. 201. 1862.
Ichthyocrinus corbis, W. & M.; in Mem. Bos. Soc. Nat. Hist., I, p. 89. 1865.

This species is more narrowly turbinate than the *I. laevis* of the Niagara group in New York, and has the calyx distinctly angular.

The original of the species occurs at Waldron, associated with well marked Niagara forms; and a specimen of the same species has been found at Bridgeport, Illinois, in limestone of the age of the Niagara group.

Possibly a larger collection of specimens may show gradations from the rounded and broadly turbinate typical species of the genus, to the narrow and subangular forms of Indiana and Illinois; but we have no intermediate forms at the present time.

GENUS RHODOCRINUS, Miller.

Rhodocrinus (Lyriocrinus) sculptilis, n. s.

Body turbinate, rounded at the base, with the arm bases prominent. Basal plates (?) concealed beneath the column attachment. Subradials long, heptagonal. First radials wider than long, heptagonal. Second radials much smaller than the first, somewhat quadrangular in general form, but having the upper or lateral angles more or less widely truncated. Third radials broad and short, much smaller than the second, and supporting on each of the upper sloping sides two or three supraradials; giving two arms for each ray. The first interradial plates are hexagonal or heptagonal, supporting two or three smaller plates in the second range, with several smaller plates above. The arms, as far as known, are two from each ray. The dome is depressed convex, with a somewhat large proboscis on the anal side (the spaces between the arms being a little greater on that side). The surfaces of the plates are marked by node-like ridges radiating from the centre, and the sutures between the plates are deeply marked and apparently nearly flat in the bottom.

The specimens vary from three-fourths of an inch to one inch in height, with a diameter of one-half to three-fourths of an inch. They occur as casts of the interior, and the characters of the exterior have been derived from the natural mould in the limestone.

Formation and locality.—In limestone of the age of the Niagara group at Waukesha, Wisconsin.

Rhodocrinus? rectus, n. s.*

PLATE XI. FIG. 10.

Body subcylindrical, rounded below; basal plates of medium size; those of the second range much larger, and supporting three other plates in direct superposition, the last one or fourth plate of the series sustaining two small arm plates. The intermediate range consists of four plates in direct succession, the last one narrowed above and

* Published in the first edition of the Report, page 318 as *Crinocystites? rectus*, and corrected in the addenda, page 379, as follows: Having made some careful examinations of the structure of this species, I am induced to believe that it possesses five basal plates, which are shown to be succeeded by five others, holding the place of subradials, and supporting two interradial plates, while the oblique upper faces of the subradials support in succession three radial plates.

lying between the arm-bearing plates. The position of the aperture has not been determined.

The specimen described has a length of one inch and a diameter of five-eighths of an inch.

Formation and Locality.—In the Racine limestone of the Niagara group at Racine, Wisconsin.

Among the collections from which the preceding species have been described, there are some other obscure or imperfect fragments which apparently belong to cystidean forms, but they are not in a condition to be designated.

These localities in Wisconsin have proved more prolific in species of this family of fossils than any others known to me, and some of the forms are more remarkable than any heretofore described from rocks of this age. In nearly every locality where these cystideans occur, the *Caryocrinus ornatus* has been found. The specimens, however, are for the most part small or of medium size, and usually more elongated than the same species in the Niagara group of New York or in Tennessee.

GENUS GLYPTASTER, Hall.

Glyptaster occidentalis, Hall.

PLATE X, FIG. 3.

Glyptaster occidentalis, Hall; in Transactions of the Albany Institute, IV, p. 204. 1862.

The original specimens of this species were derived from the Niagara shales and shaly limestones at Waldron, Indiana. Among the collections from Racine, are some casts which are undistinguishable from those of Waldron, and I have thus referred them.

There are, however, some casts of a less rotund form, which is apparently a distinct species.

Glyptaster pentangularis, n. s.

PLATE X, FIG. 4.

Body reversed pyramidal, pentangular, regularly expanding to the bases of the arms. Basal plates five, small; subradial plates short, showing the commencement of ridges which unite on the first radial plates. First and second radials marked by a central longitudinal ridge, which divides on the third radial plate, as in other species of the genus. Interradial spaces quite flat.

This species is much more slender in form than *G. occidentalis.* In its casts which is the usual condition of the specimens, the smaller individuals resemble the *Stephanocrinus angulatus*, with which it corresponds in size and proportions. The larger specimens have a length of an inch and a half, with a diameter of one inch at the summit.

Formation and locality.— In limestone of the Niagara group at Racine, Wisconsin.

GENUS ACTINOCRINUS, Miller.

Actinocrinus (Saccocrinus) whitfieldi.

Megistocrinus marcouanus, W. & M.; in Mem. Bos. Soc. N. H., I, p. 87, Plate ii, fig. 5.
infelix, W. & M.; in Mem. Bos. Soc. N. H., I, p. 110, Plate ii, fig. 7.
Actinocrinus christyi, Hall; in Transactions of the Albany Institute, IV. 1862.
Not *Actinocrinus christyi*, Shumard. Geol. Rep. of Missouri, p. 191, Pl. A, fig. 3. 1855.

This fine species resembles the *Actinocrinus* (*Saccocrinus*) *speciosus*, Hall (*Pal. N. Y.*, II, p. 205, Pl. 46, fig. 1); differing however in the size and proportions of the plates, and the more prominent ridges upon the plates of the radial series; but principally differing in having a second bifurcation of the ray before the arms become free.

This species from Waldron sometimes attains a length of nearly three inches, and having a diameter at the summit of one inch and a half. Some specimens of casts from Wisconsin have the form and arrangement of parts corresponding with the Waldron specimens. Most of these are small, scarcely exceeding an inch in height, but a single specimen from Waukesha is nearly three inches in length; and a fragment of another from Racine indicates an individual of still larger dimensions. The casts of the smaller specimens have the arm — bases more prominent than is usual in the Indiana specimens.

Formation and Locality.—The original specimens are from a calcareous shale of the Niagara group at Waldron, Indiana. It occurs in limestone of the Niagara group at Racine and Waukesha, Wisconsin.

Actinocrinus (Saccocrinus) semiradiatus, n. s.

PLATE X, FIG. 1.

Body elongate, urn-shaped, slightly constricted near the top of the first radial plates, the sides above being sub-parallel; base obtusely rounded. Basal plates rather large, forming about one-fifth the height of the calyx. First radial plates very large, nearly equalling half the entire height of the calyx, much higher than wide; second radials small, elongate, hexagonal; third radials smaller than the second, wider than high, and variable in form, being mostly heptagonal, supporting on their upper sloping faces supraradials, the number and extent of which are unknown. First interradial plates large, hexagonal, succeeded by two vertical ranges of smaller polygonal plates. Anal area unknown.

The specimen from which the above description is taken is an internal cast, imperfect on one side, so that the entire characters are not seen; but the large size of the first radial plates, and the constriction of the sides above the middle of these plates, is very remarkable. From the characters on the cast it would appear that the plates were marked by rather strong radiating ridges, which rising from a point above the centres of the first radials, pass to the interradial plates above, while the first radials are smooth below, and in their upper part are marked by sharp rounded ridges, rising from the same point as the oblique ridges, extending upwards and bifurcating with the divisions of the ray as far as preserved in the specimen.

This feature of narrow rounded ridges, following the divisions of the rays, is approached in some specimens of *Saccocrinus christyi* = *A.* (*S.*) *whitfieldi;* but the oblique ridges have not been observed, while the entire calyx is much less expanded than in that species.

Formation and Locality.—In limestones of the age of the Niagara group, at Racine, Wisconsin.

GENUS MACROSTYLOCRINUS,* HALL.

CYTOCRINUS,† ROEMER.

MACROSTYLOCRINUS STRIATUS, HALL.

PLATE X, FIGS. 7, 8.

Macrostylocrinus striatus, HALL; in Transactions Albany Institute, IV, p. 207. 1862.

The originals of this species are from Waldron, Indiana. A cast of a species of this genus from Racine is similar in form and proportions, and is probably identical with those from Waldron.

* *Palæontology of New York*, Vol. ii. 1852.
† *Silurische Fauna des Westlichen Tennessee.* 1860.

GENUS MELOCRINUS, Goldfuss.

Melocrinus verneuili, Troost.

PLATE X, FIG. 5.

Actinocrinus verneuili, Troost; in Proc. Amer. Asso. Adv. Science, II, p. 60. 1849.
Actinocrinus obpyramidalis, W. & M.; in Mem. Bost. Soc. N. H., p. 87, Plate ii, fig. 4. 1865.
Turbinocrinites verneui.i, Troost, MS.
Not *Actinocrinus verneuilianus*, Shumard. Geol. Rep. of Missouri, p. 193, Plate A, fig. 1.

Body turbinate, strongly lobed at the arm-bases. Basal plates four; succeeded by five radial series of three plates each, and subdividing upon the last one. Interradial series composed of one, two and three plates in the successive ranges. Anal area scarcely differing from the other interradial spaces.

This species has the structure of Melocrinus, and though differing in form from the typical species of the genus, I see no sufficient reason for separating it at the present time.

Formation and Locality.—In limestone of the age of the Niagara group at Racine, Wisconsin. Dr. Troost's specimens are from Decatur county, Tennessee.

GENUS GLYPTOCRINUS,* Hall.

Glyptocrinus nobilis, Hall.

PLATE X, FIGS. 9, 10.

Glyptocrinus nobilis, Hall. Rep. Progress Geol. Survey Wisconsin for 1860, p. 21. 1861.

Body large, robust; from base to the first bifurcation of the ray sub-hemispherical; arm-bases above this point prominent, giving a strongly lobed form; dome highly elevated, the distance from the base of the free arms to the base of the proboscis being once and a half as great as the distance below. Proboscis strong, subcentral, entire length unknown. Basal plates of moderate size, spreading almost horizon-

*In a paper upon some Niagara fossils from Indiana, published in the Transactions of the Albany Institute in 1860, I made some observations upon the Genera Glyptocrinus, Glyptaster, Balanocrinus and Lampterocrinus. At that time I had overlooked the fact, that the generic name Balanocrinus had been proposed by Prof. Agassiz, in 1846, in *Bulletin Soc. des Sciences Naturelles, Neuchatel;* and therefore the same name proposed by Dr. Troost in his Catalogue of 1849, for a very different fossil, cannot be sustained. In 1860, Dr. Ferdinand Roemer proposed the name Lampterocrinus in *Die Silurische Fauna des Westlichen Tennessee,* for the same fossil to which Dr. Troost had given the name Balanocrinus, and this later generic designation will necessarily be adopted.

It may however, on the final revision of the crinoidean genera, become a question, whether those forms now distinguished as Glyptocrinus, Glyptaster and Lampterocrinus should not constitute a single genus.

tally from the column. First radial plates large, second radials hexagonal, much wider than high; third radials broadly pentangular, supporting on each upper sloping side a series of four supraradials; the upper one of which is a bifurcating plate, and supports on the upper oblong sloping edges a series of arm plates; giving eight arms to each ray, so far as determined. First interradial plate large, six or seven sided, with two smaller plates in the second range, three in the third, and several small polygonal plates above, filling the interbrachial spaces and connecting with the dome plates. Anal series unknown. Dome near the base, composed of small polygonal plates, gradually increasing in size towards the proboscis; the dome is strongly lobed, and the depressions correspond with the interbrachial spaces. Surface of calyx plates marked by a single set of strong radiating ridges, which connect at the sutures with those of the adjoining plates; the interspaces occupied by one or more small round nodes, which are sometimes confluent. The ridge along the radial series is much the strongest, and forms a node on the centre of each plate. The dome plates are marked by similar, but less distinct lines, and a small round node on the centre of each plate.

This species differs from *G. decadactylus* (*Palæontology New York*, Vol. i, p. 281, Plates lxxvii and lxxviii) in the larger size; the shortness of the base; the very large dome, and strong proboscis; as well as in the surface marking and greater number of arms.

Geological Formation and Locality.—In limestone of the age of the Niagara group, Racine, Wisconsin.

Glyptocrinus armosus (McChesney).

PLATE X, FIG. 11.

Glyptocrinus siphoñatus, Hall. Rep. Progress Geol. Survey Wisconsin for 1860, p. 22. 1861.
G. siphonatus, 20th Report St. Cab., first edition; rectified in description of plates.
Eucalyptocrinus armosus, McChesney. New Palæozoic Fossils, etc., p. 95. Feb., 1861.

Body large, broadly obovate, the greatest width being above the origin of the arms; calyx narrow below, spreading gradually to the bases of the arms; dome inflated on the anterior (?) side. Arms rising from the body in pairs with deep constrictions between; arrangement and forms of plates of calyx not fully determined; those of the dome are small and polygonal.

The above description is drawn from internal casts. This species differs from *G. nobilis* in the much greater length of calyx which is not contracted in the lower part, while in that species it is broad and spreading. It appears not to have had a proboscis; but in the casts there is the filling of a cavity which has passed from the summit of the dome between the postero-lateral arms, where it turns outwardly, as if it had opened on the exterior surface in the form of an anal aperture.

Geological Formation and Locality.—In rocks of the age of the Niagara group; Racine, Wisconsin.

GENUS LAMPTEROCRINUS, Roemer.

Lampterocrinus inflatus, Hall.

PLATE X, FIG. 6.

Balanocrinus inflatus, Hall. Report Progress Geol. Survey Wisconsin for 1860, p. 22. 1861.

Body below the arms subturbinate, with sides somewhat inflated in the lower part; arm-bases prominent, leaving deep interbrachial spaces; dome low, strongly inflated on the anal side, surmounted by a slender subcentral proboscis. Basal plates small, pentagonal. Subradial plates proportionally large, hexagonal. First radials heptagonal, a little larger than the subradials; the form of the second and third radials undetermined; the second are as large as the subradials; the third very small. Interradial plates, six; the first hexagonal, as large as the second radials, with two in the second range, and three in the third range, uniting with the dome plates. Anal plates numerous; form and arrangement unknown.

The above description has been drawn from the internal casts of several specimens, which exhibit the division of the plates.

This species differs from *B. sculptus*, Troost; *Lampterocrinus tennesseensis*, Roemer (*Silurian Fauna of Western Tennessee*), in being more distinctly turbinate or obconical; in the deeper interbrachial spaces; the inflation of the dome on the anal side; and in its uniformly smaller size.

BRACHIOPODA.

GENUS OBOLUS, Eichwald.

Compare TRIMERELLA, Billings.

Obolus conradi, n. s.

PLATE XIII, FIGS. 1, 2; PLATE XXV, FIGS. 1, 2, 3.

Shell depressed orbicular or subdiscoid; width usually greater than the length, gibbous in the middle and compressed towards the margins. Dorsal valve more convex than the ventral. Surface unknown.

The rostral portion of the valves is extremely thickened, for muscular attachments; and this area extends in an elevated plate or transverse septum which becomes free at its anterior margin, except where it is supported in the middle by a vertical septum. The interior surface of this plate, towards the antero-lateral margins, is marked on each side by a rhomboidal muscular scar, varying somewhat in the two valves, and in different individuals. On each side and just without the upper or posterior lateral margins of this plate, there is a depressed oval or reniform muscular scar, varying in character and area in the two valves. In the dorsal valve, and probably in the ventral valve also, there is an elongate ovate imprint, extending from a narrow point, at what may be regarded as the extremities of the hinge line, close to the cardino-lateral margins, and gradually expanding below, reaching nearly half way to the anterior margin of the shell. This transverse plate in the ventral valve sometimes shows muscular markings just below the rostral area as well as anteriorly. The cast of the rostral cavity is small and neatly defined, with marks similar to those of dental lamellæ (?) along the cardinal slopes. The cast of the dorsal valve shows the impression of a broad, shallow, spoon-shaped plate, with the median septum extending nearly to the base of the shell.

The figures on Plate xiii are given from casts of the dorsal and ventral valve. The impressions from these are given on Plate xxv of this edition of the Report.

Some ten years since, having these fossils under consideration, I proposed a new generic name for them; but sending drawings to Mr. Davidson, he gave me the opinion of himself and Mr. Woodward that they belonged to the Genus Obolus. There are certain points of difference, however, which I have been inclined to believe are of generic importance, and I am not entirely satisfied in referring them to that genus, as illustrated, though closely allied to it.

In the mean time, Mr. Billings has published a Genus Trimerella, illustrating it by a specimen from the Guelph limestone. Now the fossils under consideration, in the earlier stages of growth, have the transverse plate but partially attached at the sides; and the processes shown in Mr. Billings' figures are sometimes slightly simulated by the casts of the spaces on each side of the median septum, which extend between this transverse plate and the exterior shell. There are, however, no evidences of three longitudinal septa.

The exterior of the shell is unknown, but probably is essentially smooth, or with only lines of growth. From the fact that in numerous specimens collected from these rocks there is no shell preserved, I infer that it was calcareous and not phosphatic as in Lingula and Discina, which usually preserve the shell in all the dolomitic limestones.

Formation and Locality.—In the Leclaire limestone, upper part of the Niagara group, at Leclaire, Iowa, and in limestone of the same age at Racine, Wisconsin.

GENUS STROPHODONTA, Hall.

Strophodonta profunda, Hall.

PLATE XIII, FIGS. 3, 4.

Leptæna profunda, Hall. Palæontology N. Y., II, p. 61, Plate xxi, figs. 4, 5. 1852.
Strophomena niagarensis, W. & M.; in Mem. Bost. Soc. Nat. Hist., I, p. 92, Plate ii, fig. 9. 1865.

Shell large, the full grown individuals having a width of more than two inches, with a length exceeding one inch and a half; deeply concavo-convex; the extremities sometimes angular or extended, but more often in the casts obtuse or rounded. Surface of young shells somewhat regularly marked by strong elevated striæ, with four, five or more finer striæ between. In older shells the striæ become more irregularly fasciculate, and the stronger ones rise in unequal ridges upon the surface. This feature is, in greater or less degree, impressed upon the casts of the interior, which, combined with strong vascular markings, gives a distinguishing character to specimens in that condition. The hinge line is crenulate, with a broad foramen; the muscular impression of the ventral valve is ovate or flabelliform, and extends for two-fifths the length of the shell.

There is a central longitudinal callosity extending from the apex sometimes for one-third of the length of the muscular impression.

The *Strophomena niagarensis* of WINCHELL & MARCY (loc. cit.), appears to me to be identical with this. The specimens in my possession, from western localities, show a considerable variety of form and proportions, and yet preserving the essential character of the species.

A specimen communicated by Prof. WINCHELL under the name *S. niagarensis*, has the divaricator scars proportionally a little more elongate than usual, but the same feature is preserved in other specimens.

The specimen figure 3 is of a young or medium size, preserving a part of the exterior surface of the ventral valve on the lower margin, while the other portion is the impression of the exterior of the dorsal valve. Fig. 4 is the cast of the interior of the ventral valve.

Formation and Locality.— In limestone of the Niagara age, at Racine, Wisconsin; Bridgeport, Illinois, and Waldron, Indiana.

GENUS SPIRIFERA.

SPIRIFERA EUDORA, HALL.

PLATE XIII, FIGS. 5, 7.

Spirifer eudora, HALL. Rep. Progress Geol. Survey Wisconsin for 1860, p. 25. 1861.
S. eudora, HALL. Transactions of the Albany Institute, IV, p. 211. 1862.

Shell of moderate size, transversely subovate, length and width as three to four, valves extremely gibbous; hinge-line less than the width of the shell below; cardinal extremities rounded; area moderately high; foramen triangular, a little higher than wide; marked by three to four simple, strong, angular plications on each side of the mesial fold and sinus. Dorsal valve regularly arcuate; beak somewhat incurved; mesial fold of moderate width, flattened above and slightly depressed in the lower part. Ventral valve most prominent near the umbo; beak strongly incurved over the area; mesial sinus broad and deep.

The minute surface markings, as shown in specimens from Waldron, Indiana, are fine radiating striæ, precisely like those of *S. macropleura* of the Lower Helderberg group of New York. The specimens from Wisconsin are all casts of the interior.

This species bears some resemblance to *S. macropleura*, but it is proportionally more gibbous, the front more rounded, the area higher, and the plications not directed so obliquely outwards from the beak.

Formation and Locality.—In limestone of the age of the Niagara group, Racine, Wisconsin, and also in rocks of the same age at Waldron, Indiana.

SPIRIFERA GIBBOSA, HALL.

PLATE XIII, FIGS. 6, 8.

Spirifer gibbosus, HALL. Rep. Progress Geol. Survey Wisconsin for 1860, p. 25. 1861.

Shell somewhat below the medium size, gibbous; beaks slightly incurved, area less than the width of the shell below, about three times as wide as high; cardinal extremities rounded; foramen large, higher than wide; valves marked by about four simple low rounded plications on each side of the mesial elevation. Dorsal valve extremely gibbous on the umbo, regularly arcuate transversely; mesial elevation broad, flattened above; plications not extending to the beak. Ventral valve deeper than the dorsal, but less arcuate; mesial depression broad and deep, rounded at bottom. Surface of both valves (in well preserved specimens) show evidence of fine radiating striæ.

This species resembles *S. crispus* of the Niagara group in New York, but is much larger, frequently more than twice as wide as that species; the mesial elevation is wider and not so high. The specimens described are all internal casts, so that the external surface characters cannot be fully given.

Formation and Locality.—In limestone of the age of the Niagara group, Racine, Wisconsin.

SPIRIFERA PLICATELLA, var. RADIATA, SOW.

PLATE XIII, FIGS. 9-11; PLATE XXV, FIGS. 4-6.

Spirifera plicatella, var. *radiata*, SOW., *Delthyris lineatus* (text), *radiatus* (index): Sow. Min. Con., V, p. 493, figs. 1, 2. 1825: not *Anomia lineatus*, MARTIN.
Spirifer radiatus, J. DEC, SOW. Silurian System, Plate xii, fig. 6. 1830.
Spirifer radiatus, M'COY. Synopsis of the Silurian fossils of Ireland, p. 37. 1848.
Spirifer plicatellus, SALTER; in Memoirs Geol. Survey of Great Britain, II, p. 328. 1848.
Spirifer cyrtæna, DAVIDSON; in Bul. Soc. Géol. de France, 2d series, V, p. 324. 1848.
Spirifer radiatus, HALL. Pal. N. Y., II, pp. 66, 265, Plate xxii, fig. 3; Plate liv, fig. 6. 1852.
Spirifer plicatellus, var. *radiatus*, SALTER. Siluria, Plate ix, fig. 12; Plate xxii, fig. 7. 1859.
Spirifera plicatella, LINDSTROM; in Proc. Royal Acad. of Science of Stockholm, p. 358. 1860.

It seems not worth while to risk the addition of another synonym for any variety of this very variable species, but the Wisconsin specimens commonly referred to it present some unusual characteristics. The form is rhomboidal or transversely oval, and usually very gibbous. The cardinal extremities are rounded and the area more or less distinctly defined. Some remains of surface striæ are sometimes distinguishable on the cast, and this marking is often well preserved in the matrix from which the shell has been dissolved. Sometimes the margins of the valves, or their impression in the cast, are undulated, and there are obscure remains of broad low plications, which usually extend but a short distance, though sometimes continuing nearly to the beak. The latter forms may perhaps be regarded as *S. plicatella* proper; such specimens are very gibbous, with a high area and broad deep sinus in the ventral valve, while they differ in form from the simply striated specimens.

The peculiarity noticed in the smooth or finely striated species is the presence of distinct lamellæ in the dorsal valve (as shown in fig. 9 of Plate xiii) diverging from the apex and presenting all the characters of the dental lamellæ of the ventral valve. These marks upon the cast are not simply sharp cut depressions, but the edges of distinct thin plates, which are joined to the inside of the shell, sometimes for half its length. A specimen, fortunately broken, shows the interior of a shell without filling, and these dorsal lamellæ are seen extending downwards half way to the base, and uniting with the shell precisely as the dental lamellæ of the ventral valve. These lamellæ are divided near their origin, and give off the crura from which the spires have continued.*

Specimens of this character are rhomboidal, gibbous, with distinct mesial sinus and fold; small specimens like the one figured, are more common than larger ones, though they are sometimes found of much larger size, and assuming a transversely oval form. From all the observations made, it appears as though the dorsal lamellæ were much stronger in the young shell, and that they become partially absorbed or almost entirely disappear in the older shells. In specimens regarded as the same species from Indiana and New York, the evidence of lamellæ is confined to the apex of the valve, and is never observed to extend towards the front of the shell.

Formation and Locality.—This species is common in limestone of the Niagara age, at Racine, Wauwatosa and elsewhere in Wisconsin, and at Bridgeport, Illinois.

* These features are more fully shown in fig. 6 of Plate xxv.

Spirifera meta, n. s.

PLATE XIII, FIGS. 12, 13.

Spirifer radiatus, pars, Hall. Palæontology N. Y., II, p. 66, Plate xxii, figs. 2s, 2t.
Compare *Cyrtia myrtia*, Billings. Palæozoic Fossils, p. 165, fig. 149.

Shell small, semioval in outline. Ventral valve low pyramidal; height equal to one half the width, or a little less; length and height nearly equal; hinge-line equaling the entire width of the shell; ventral valve with the area erect or slightly arcuate; foramen narrow; deltidium highly convex, perforated near the apex; sinus broad, nearly one-third the entire width of the valve, deep, and somewhat angular at the bottom. Dorsal valve regularly convex, the mesial fold moderately elevated, very narrow at the umbonal region; the interior of the ventral valve possessing very strong dental lamellæ, which extend more than one-third its length. Exterior surface of shell marked by a few distinct concentric lines of growth, and fine close radiating striæ.

This species is of the type of *Spirifer trapezoidalis*, Dalman; but differs in its greater proportional width on the hinge, the less elevation of the ventral and more convex dorsal valve. From *S.* (*Cyrtia*) *myrtia*, Billings, it differs in the same particulars, as well as the rounding of the hinge-extremities. In fact these two species, *S. myrtia*, and *S. trapezoidalis* are so closely allied that a careful comparison with each other might lead to an identification. The specimens with elevated area, figured on Plate xxii, Vol. ii, *Palæontology, N. Y.*, as varieties of *S. radiata*, are of this species.

Formation and Locality.—In limestones of the age of the Niagara group, near Milwaukee, Wisconsin, and in the Clinton group, at Rochester, N. Y.

Spirifera nobilis, Barrande.

PLATE VIII, FIGS. 14, 15 16, 17.

Spirifer nobilis, Barrande. Silurische Brachipod. Böhmen; in Haidinger's Naturwissen schaftliche Abhandlungen, Band 2, Tab. xviii, fig. 2, a, b.
Spirifer racinensis, M'Chesney. Palæozoic Fossils, p. 84. 1861.
Spirifer inconstans, Hall. Rep. Progress Geol. Survey Wisconsin for 1860, p. 26. 1861.

Shell transversely elliptical, the length a little more than half the width; hinge-line two-thirds as long as the greatest width of the shell; cardinal extremities rounded; both valves moderately convex, marked by strong angular dichotomizing plications. Dorsal valve most prominent on the umbones; mesial fold broad and simple on some specimens, and on others divided into two, three or more plications in front; beak produced and moderately incurved. Ventral valve larger than the dorsal; beak very prominent, but little incurved; area high; deltidium large, height and width nearly equal; sinus broad and deep, simple or with two or more plications. Entire surface marked by strong distinct radiating striæ. The specimens are casts of the interior and exterior.

From the figures and descriptions of Barrande (loc. cit.), I am compelled to regard this American species as identical with the Bohemian form. Not only is the general form and dichotomizing of the plications similar, but the peculiar elevation and attenuation of the beak of the ventral valve represents very precisely the Racine specimens.

This species may be readily distinguished from others by the strong angular bifurcating plications, the number of which vary in different individuals; some being nearly simple, having but four or five on each side of the mesial fold, while others have nearly double that number on the front margin. The number of plications on the mesial fold and sinus are subject to the same variation.

Formation and Locality.—In limestone of the age of the Niagara group, Racine, Wisconsin.

GENUS PENTAMERUS, Sowerby.

Pentamerus multicostatus, Hall.

PLATE XIII, FIGS. 22, 23, 24.

Pentamerus multicostatus, Hall. Rep. Progress Geol. Survey Wisconsin for 1859, p. 1. 1860.

Shell obtusely subcuneate, the valves nearly equally convex below the middle, ventricose on the umbones; sides somewhat straight, and abruptly widening from the beaks; greatest width in front, nearly equal to the length of the shell. Surface marked by numerous, even, rounded, little elevated striæ, which are preserved on the lower half of the cast. Both valves are often slightly impressed in the centre below the middle. Longitudinal septa of the dorsal valve reaching more than one-third the length from the beak. The spoon-shaped cavity of the ventral valve is narrow and deep, and the septum reaches more than half way to the base of the shell.

This species of PENTAMERUS is usually from one inch to an inch and a half in length. It is readily distinguished from other species in the rock by its narrowness at the beaks, and by the numerous longitudinal striæ which mark the casts.

Formation and Locality.—In limestone of the age of the Niagara group, at Wauwatosa and Waukesha, Wisconsin.

PENTAMERUS (PENTAMERELLA) VENTRICOSUS.

PLATE XIII, FIGS. 18-21.

Pentamerus ventricosus, HALL. Rep. of Prog. Geol. Survey Wisconsin for 1859, p. 2. 1860.

Shell ventricose, subglobose, wider than long; hinge-line extended and abruptly rounded at the extremities. Ventral valve much the more convex, and broadly sinuate below the middle of the shell; the sinuosity sometimes not reaching the beak, but prolonged into a broad linguiform extension in front. The sinus of the ventral valve and the mesial fold of the dorsal valve are marked by three or four obscure, or sometimes conspicuous, rounded plications. The casts are marked by strong concentric laminæ of growth, and some faint, rather broad, radiating striæ: muscular impression of the ventral valve broad, subcordiform, and radiatingly striated. The triangular pit beneath the beak small and shallow, and the median septum short, reaching no more than one-fourth the length along the curve of the valve. Dorsal valve having the septa united at the base of junction with the shell, spreading very slightly above, and reaching nearly half way to the basal margin.

This shell presents some variation from the strict characters of PENTAMERUS, and will probably fall under the proposed genus PENTAMERELLA.*

Formation and Locality.—In limestone of the age of the Niagara group, at Waukesha, Saukville and elsewhere in Wisconsin, and at Bridgeport? Illinois.

* See page 193 of this Report.

LAMELLIBRANCHIATA.

The following species, including several heretofore described, have been recognized in the Niagara limestone of Wisconsin and adjacent parts of Illinois.

GENUS AMBONYCHIA, HALL.

AMBONYCHIA APHÆA, N. S.

PLATE XIV, FIG. 3.

Shell somewhat obliquely ovate; anterior side broadly rounded; beak in the cast acute; hinge-line straight, and about half the length of the shell. The posterior basal extremity is somewhat abruptly rounded. Muscular impressions large, situated below the centre of the length of the shell. The greatest width of the shell is equal to about two-thirds the length.

This species is proportionally broader and shorter, with the beaks less extended than *A. acutirostra* from the same horizon.

One specimen measures one inch and seven eighths in length and one inch and a quarter in width. Other specimens are smaller than the one measured.

Formation and Locality.—In limestone of the age of the Niagara group, at Wauwatosa, Wisconsin, and Bridgeport, Illinois.

AMBONYCHIA ACUTIROSTRA, HALL.

PLATE XIV, FIG. 2.

Ambonychia mytiloides, HALL. Rep. Progress Geol. Survey of Wisconsin for 1859. 1860.

This species is proportionally longer than the preceding, less expanded on the anterior margin, and has the beaks elongate and attenuate. In many respects it resembles the *Myalina mytiliformis* of the grey sandstone of the Clinton group.

These species are probably not true Ambonychia, but in the condition in which they occur, we have not sufficient characters remaining, to authorize their separation.

Formation and Locality.—In limestone of the age of the Niagara group, near Milwaukee, and at Wauwatosa and Racine, Wisconsin.

GENUS AVICULA, Klein.

Avicula undata.

Avicula undata, Hall. Palæontology of New York, II, p. 283, Plate lix, fig. 2.

A specimen from Racine, Wisconsin, and another from Bridgeport, Illinois, resemble this species from the Niagara group of New York.

Avicula emacerata, Conrad.

Avicula emacerata, Conrad; in Jour. Acad. Nat. Sci. Phila., VIII, p. 241, Plate xii, fig. 15.
Hall. Geol. Report Fourth District N. Y., p. 109.
Hall. Pal. N. Y., II, pp. 83, 282, Plate lix, fig. 1*a–e*.

This species occurs at Racine, Wisconsin, and at Bridgeport, Illinois.

GENUS PTERINEA, Goldfuss.

Pterinea brisa, n. s.

PLATE XIV, FIG. 1.

Compare *Pterinea striæcosta,* McChesney. New Palæozoic Fossils.

Body of the shell obliquely subovate, extremely inequilateral; anterior wing rather long, distinctly sinuate at its junction with the body of the shell, posterior wing short, not extending so far as the posterior extremity of the shell; umbo prominent, rising a little above the hinge-line. Muscular impression large and nearly round, situated near the middle of the length of the shell. In the cast, beneath the beak or just anterior to it, there is one short curving dental pit, with a smaller accessory one separated by a callosity. The surface of the shell is marked by strong radiating and concentric striæ, which, on the partial decomposition of the shell, present a cancellated texture resembling that of a bryozoan.

In one specimen measured, the width from the two extremities along the hinge-line is nine-tenths of an inch; and from the umbo to the postero-basal margin, in the direction of the umbonal slope, it has the same extent; the length vertically from the hinge-line is six-tenths of an inch.

Formation and Locality.—At Bridgeport, Illinois.

GENUS CYPRICARDINIA, Hall.

PROBABLY = SEDGWICKIA, M'COY.

Cypricardinia arata, n. s.

PLATE XIV, FIG. 6.

Shell subovate, varying from moderately to extremely gibbous; body of the shell subovate, alate posteriorly; beaks near the anterior end, which is short and rounded. Surface marked by strong concentric lamellose ridges.

The species resembles in form the *Modiolopsis* (*Cypricardinia*) *undulostriata* of the Niagara shale of New York; but the concentric ridges are stronger, and the fine undulating striæ are not visible in any of the western specimens.

Formation and Locality.—In limestone of the Niagara group, at Racine, Wisconsin, and Bridgeport, Illinois.

GENUS MODIOLOPSIS, Hall.

Modiolopsis dictæus, n. s.

PLATE XIV, FIG. 7.

Shell broadly subovate, moderately convex, becoming somewhat gibbous on the umbo; beak about one-fifth distant from the anterior extremity; gradually expanding posteriorly so that half way between the beak and the posterior margin it is once and a half as wide as in the line just anterior to the beak. The straight hinge extends about half the length of the shell, and the cardinal margin is thence gradually curved to the posterior end. The cast of the hinge-line shows two narrow lateral folds or teeth. Surface concentrically striated.

The length of a specimen measured is about one inch, with the greatest width seven-eighths of an inch.

The form of this species is very similar to *Modiolopsis modiolaris* of the Lower Silurian rocks; but the hinge-line does not rise so abruptly on the posterior side of the beak, and the contraction below the beaks is not observed.

Formation and Locality.—In limestone of the Niagara group, at Racine, Wisconsin, and at Bridgeport, Illinois.

Modiolopsis rectus, n. s.

PLATE XIV, FIGS. 4, 5.

Shell elongate, narrow, moderately convex, beaks subanterior; hinge-line long and straight; the greatest width of the shell is at the posterior end of the cardinal line, narrowed equally above and below towards the posterior extremity. The anterior muscular impressions large and strongly defined. The casts show that there has been one strong subtriangular tooth beneath the beak of the right valve, with one or two smaller ones, with corresponding pits, in the opposite valves. The lateral teeth are very slender. The surface has been marked by concentric striæ, and a few strong undulations which are preserved in the casts. The length is about one inch with the greatest breadth half an inch.

This species resembles *Modiolopsis* (*Tellinomya*) *machæraformis* of the Clinton group of New York, from which it differs in having the beaks more nearly anterior and in being less narrowed posteriorly; while the greatest width is at the posterior extremity of the hinge-line, instead of at the beaks.

Some specimens, which are scarcely specifically distinct from those described, have proportionally a somewhat greater width, but in other respects are identical.

Formation and Locality.—In limestone of the Niagara group, at Waukesha and Racine, Wisconsin, and at Bridgeport, Illinois.

Modiolopsis subalatus, Hall.

Modiolopsis subalatus, Hall. Palæontology N. Y., II, pp. 84, 285, Plates xxvii, lix.

Some specimens from Racine, Wisconsin, and Bridgeport, Illinois, are apparently identical with this species of the Niagara group of New York. The specimens are casts and more or less crushed and imperfect.

GENUS AMPHICŒLIA, n. g.

The Acephala present great difficulties in the way of satisfactory generic reference; and it is often scarcely possible to arrive at certainty with regard to their true relations.

A single species from Wisconsin, which is somewhat numerous in individuals, has the general exterior aspect of the more elevated forms of LEPTODOMUS of McCOY; but it cannot nevertheless be referred properly to that genus.

The general form of the shell is subrhomboidal, with elevated beaks. The casts present evidence of a large triangular cartilage pit beneath the beaks; and just anterior to this, and separated by a thin process on each valve, is an apparent second pit. No teeth have been discovered on the extension of the hinge-line. The muscular impressions are faint and the shell thin.

It is possible that there may have been a cartilage pit and adjacent tooth, as in MACTRA and AMPHIDISMA—a feature which cannot be satisfactorily determined except from an examination of better specimens than we possess. There is a flattened external ligamental area not unlike that of the Arcacea.

AMPHICŒLIA LEIDYI, N. S.

PLATE XIV, FIGS. 13, 14, 15.

Ambonychia neglecta (?), McCHESNEY. New Palæzoic Fossils, p. 88. 1861.
Amphicœlia neglecta (?) McCHESNEY. Trans. Chicago Acad. Sci., I, p. 41, Plate ix, fig. 2. 1867.

Shell equivalve, inequilateral, somewhat rhomboidal, gibbous except upon the expanded posterior side; height and width subequal; umbones gibbous; beaks much elevated and incurved, pointed, falling from one-fourth to one-third the width within the anterior margin, which declines from the hinge-line at a very obtuse angle; hinge-line equaling somewhat more than half the width of the shell.

The casts show a large triangular pit beneath the beak, and sometimes there is evidence of a thin dividing septum. There are no visible lateral teeth. The surface of the casts is usually smooth, or showing only a few strong lines of growth. In a single specimen preserving a portion of the shell, the surface is marked by fine close radiating striæ.

The height of the shell from beak to base measures in different specimens from two to two and a quarter inches, with a width almost precisely corresponding. The depth of the two valves is about one inch and five-eighths. Some smaller specimens, which may be of this species, have a length and breadth of half these measurements.

Owing to pressure and other causes, the species exhibits great variation in form and proportions. Among the specimens are two with less elevated and more approximate beaks, and less gibbous form, with a greater extension in front and greater width behind; which may prove specifically distinct.

Formation and Locality. In the limestone at Racine and Wauwatosa, Wisconsin, and at Bridgeport and another locality* (unknown) in Illinois.

GENUS CYPRICARDITES, Conrad.

Cypricardites (?) quadrilatera, n. s.

PLATE XIV, FIGS. 8, 9, 10.

Shell somewhat quadrilateral, the angulated umbonal slope dividing the valve into nearly equal areas. Valves inflated, height and depth nearly equal; beaks closely incurved and sharply angulated; the angulation gradually becoming obtuse, and continuing along the umbonal slope to the postero-basal margin. A cast of the right valve shows a conspicuous muscular prominence just anterior to the beak, with two strong lateral folds marking the cardinal line; the entire surface is marked by low concentric undulations. On each side and parallel with the umbonal slope there is an extremely narrow groove and fold, indicating radiating lines upon the surface of the shell. Just posterior to the beak there commences a distinct groove, with a slight ridge on the lower side, which continues about half way between the hinge-line and the umbonal angulation, but not parallel with either, and extending to the posterior margin of the shell.

This species is angulated like many of the extreme forms of Myalina; but the strong muscular marking, with lateral hinge-teeth, prohibit its reference to that genus.

Formation and Locality.—In limestone of the Niagara group, at Bridgeport, Illinois.

Among the collections obtained from Wisconsin, there is a single shell which is not referable to any established genus, though well preserved in its general form and external characters. Although it would be very desirable to know more of its structure before giving a generic name, I shall nevertheless propose a designation. Its general form indicates that it belongs to the Cardiacea, and this is confirmed by all that can be learned of its structure.

* Two specimens were received several years since from Prof. C. U. Shepard, which were credited to Illinois, but the record of the particular locality had been lost.

GENUS PALÆOCARDIA, N. G.

PALÆOCARDIA CORDIIFORMIS, N. S.

PLATE XIV, FIGS. 11, 12.

Shell cordiform; valves obliquely subovate, ventricose; umbones gibbous, with the beaks prominent, attenuate and incurved; hinge-line very short, extending a little in advance of the beaks, and showing the margins separated. The anterior end gradually rounding into the basal margin. In the partial cast the posterior slope shows a ridge on each side rising just behind the beak, and in a line slightly divergent from the cardinal margin, reaching about half way to the posterior extremity, where it becomes obsolete. The surface is marked by fine close radiating striæ.

This species has the general aspect of some of the more gibbous forms of AMBONYCHIA, but the short hinge-line separates it from that genus, while the extreme prominence of the umbones and incurvation of the beaks give it the aspect of a true CARDIUM.

The specimen was given to me by Dr. DAY of Wauwatosa, who informed me that it was found in a quarry a little east of that village.

Formation and Locality.—In limestone of the Niagara group, near Wauwatosa, Wisconsin; in beds which are probably a little below those of Racine and Waukesha.

GASTEROPODA.

The following species have been identified with known forms, or determined as new:

GENUS PLATYCERAS, Conrad.

Platyceras niagarensis, Hall.

Acroculia niagarensis, Hall. Palæontology, N. Y., II, p. 288, Plate 60, fig. 3.

Formation and Locality.—In the limestones of Racine and Waukesha, Wisconsin.

GENUS PLATYOSTOMA, Conrad.

Platyostoma niagarensis, Hall.

Platyostoma niagarensis, Hall. Palæontology, N. Y., II, p. 287, Plate 60, fig. 1.

Formation and Locality.—In the limestones of Racine and Waukesha, Wisconsin.

GENUS STRAPAROLLUS, Montfort.

Straparollus mopsus, n. s.

PLATE XV, FIGS. 21, 22.

Shell discoid; whorls four or more, cylindrical, very gradually enlarging, the outer one sometimes a little flattened on the upper side for a part of its extent; suture line strongly marked; umbilicus very wide, and showing all the volutions. Spire depressed, rising little above the surface of the outer volution. The proportion of height and width is about as one to three. The individuals measure from half an inch to seven-eighths of an inch in diameter. A specimen having the latter measurement is three-tenths of an inch in height. Some fragments of outer volutions indicate specimens of larger size.

Specimens of this species, when compared with the figures of *S. daphne*, Billings, have a very similar aspect on the lower side; but the elevation of the spire, as given in the description, is much too great for our species.

Formation and Locality.—In limestone of the Niagara group, at Racine and Waukesha, Wisconsin.

GENUS CYCLONEMA, Hall.

Cyclonema? elevata, n. s.

PLATE XV, FIG. 4.

Shell conical; spire elevated, gradually tapering, embracing an angle of about forty-five degrees. Volutions rounded, ventricose, about five; gradually enlarging to the aperture, which has been nearly circular.

The cast from which the species is described, possesses evidence of revolving striæ, without indications of a central band.

Height nine-tenths of an inch; width six-tenths of an inch.

Formation and Locality.—In limestone of the Niagara group, at Racine, Wisconsin.

GENUS HOLOPEA, Hall.

Holopea harmonia? Billings.

Holopea harmonia, Billings. New species of Silurian Fossils, p. 158, fig. 142. 1862.

There are several specimens in the collection, so nearly corresponding with the figure given by Mr. Billings, that I must regard them as the same species. In a specimen of the same size as the figure cited, the middle of the last volution is subcarinate and flattened above. The spire is a little more elevated than the figure, and the last volution a little more ventricose below. It may prove to be a distinct species. Another specimen of similar form does not possess the flattened band, while the lower side of the last volution is flattened.

Formation and Locality.—In limestone of the Niagara group, at Racine, Wisconsin.

Holopea guelphensis, Billings.

PLATE XV, FIG. 18.

Holopea guelphensis, Billings. New species of Silurian Fossils, p. 159, fig. 143. 1862.

Several fragments of a species, differing from any other in the collection, resemble the Canadian species; but being all quite imperfect, no full comparisons can be made.

Formation and Locality.—In limestone of the Niagara group, at Racine, Wisconsin.

GENUS PLEUROTOMARIA, De France.

Pleurotomaria occidens, n. s.

PLATE XV, FIGS. 11, 12; PLATE XXV, FIGS. 9, 10.

Pleurotomaria labrosa, var. *occidens*. Twentieth Rep. N. Y. St. Cab., 1st edit., p. 343. 1867.

Shell somewhat rhomboidal-ovate; spire moderately elevated; volutions about three, the last one rapidly expanding, subangular, and marked by a spiral band a little above the middle; upper side somewhat flattened; lower side rounded, and in the last one becoming ventricose. Surface marked by strong revolving and transverse striæ.

An examination of other specimens of this species proves it to be distinct from the *P. labrosa* to which I had heretofore referred it as a variety.

Pleurotomaria halei, Hall.

PLATE XV, FIGS. 13, 14.

Pleurotomaria halei, Hall. Report of Progress Geol. Survey Wisconsin for 1860, p. 34. 1861.

Shell suborbicular, the spire moderately ascending, the height equal to a little more than two-thirds the greatest diameter, consisting of three or four volutions which are rounded on the top, and expanding somewhat rapidly in size; the last one quite ventricose, and in the cast is subangular on the periphery; the under side of the last volution is rounded from the edge into the rather large umbilicus. The surface, as preserved in a mould of the exterior in the stone, is marked on the upper side of the volution by ten or twelve moderately strong revolving ridges, which are smaller and more closely arranged towards the suture, where there is a slightly depressed or flattened space. These are crossed by numerous less strong, closely arranged transverse striæ, which bend backwards from the suture, and have a strong retral curve on the narrow concave band of the periphery. Surface characters of under side undetermined.

This species is so entirely distinct in its form and surface characters from any other species yet known in our Silurian rocks, that it can be readily distinguished. It is more nearly allied with forms such as *P. lucina* of the Upper Helderberg and Hamilton groups of New York.

Formation and Locality.—In limestone of the age of the Niagara group at Racine, Wisconsin and Bridgeport, Illinois.

Pleurotomaria (Trochonema) hoyi, Hall.

PLATE XV, FIG. 10; PLATE XXV, FIGS. 11, 12.

Pleurotomaria hoyi, Hall. Report of Progress Geol. Survey Wisconsin for 1860, p. 35. 1861.

Shell broadly depressed-conical, the spire moderately elevated, consisting of about four volutions which are gradually enlarged from the apex, the last becoming slightly ventricose towards the aperture. Volutions flattened upon the upper side, and the entire height of each one showing above the other; periphery somewhat flattened, with a depressed band truncating the upper angle. Lower side of volutions flattened, except the outer half of the last one, which is rounded towards the aperture, and abruptly descending into the wide umbilicus. Surface finely striated on the lower side of the volution, with a deep retral curve on the band, where the striæ are somewhat fasciculate. The periphery of the cast is sometimes marked by three or four strong but obscure striæ below, and parallel to the revolving band.

This species resembles *P. umbilicata* of the Trenton limestone, but the volutions are more elevated above each other, and the upper surface is wide and flat.

Formation and Locality.—Limestone of the Niagara group, at Racine, Wisconsin.

Pleurotomaria idia, n. s.

PLATE XV, FIGS. 15, 16.

Pleurotomaria idia, Hall. Report of Progress Geol. Survey Wisconsin for 1860, p. 35. 1861.

Shell depressed orbicular, moderately convex above, and broadly umbilicate beneath, with four volutions, which are moderately convex above, and gradually increase in size from the apex, the outer half of the last one being more ventricose and regularly rounded on the periphery, and curving into the broad umbilicus; aperture, or section of volution near it, broadly ovate. Surface characters unknown.

This species differs from the last in being less elevated, in its more gradually increasing volutions, broader umbilicus and absence of angularity on the periphery.

Formation and Locality.—In limestone of the age of the Niagara group, at Racine, Wisconsin.

Pleurotomaria axion, n. s.

PLATE XV, FIG. 17.

Shell subconical, volutions about four, the apicial one minute, the first three volutions small, rounded and gradually expanding, while the last one becomes extremely ventricose and evenly rounded; suture line deeply impressed and more than half of the preceding volution exposed above it. The aperture has been subcircular and very large. Surface marked by strong revolving striæ, which are crossed by concentric striæ of less strength, giving a cancellated structure. The middle of the volution is marked by a rather wide and little elevated band, upon which the striæ have a slight retral curve.

The surface characters are very similar to those of *P. lucina* of the Lower Helderberg and Hamilton groups of New York; but the shell is more elevated and attenuate towards the apex, and the suture is more deeply marked. Its form is intermediate between the species just cited and *P. lineata.**

The species described is from a gutta-percha cast and an impression in limestone.

Formation and Locality.—In limestone of the age of the Niagara group, at Bridgeport, Illinois.

GENUS TROCHONEMA, Salter.

Trochonema (Eunema) fatua, n. s.

PLATE XV, FIGS. 7, 8.

Spire elevated; shell turritiform, consisting of about four or five volutions, which gradually increase to the last one which is moderately ventricose; volutions biangular, leaving a flattened space upon the back about equal to the flattened space between the upper angle and the suture line; lower side of the last volution rounded; aperture ovate-elongate.

The specimens are casts of the interior, and in this condition are readily distinguished from any other species of similar form in these rocks.

*See *Fifteenth Report on the State Cabinet of Nat. Hist.*, p. 165, Plate v.

A gutta percha cast shows the surface to be finely striated; the flattened space on the back of the volution is margined on each side by a slender carina, and the striæ between are apparently coarser than those above or below. The height of the specimens varies from less than one inch, to one inch and seven-eighths. The transverse diameter of the last volution is about one inch.

This species has a more elevated spire than *T. umbilicata* of the Trenton limestone, and, so far as can be determined, has had no umbilicus.

Formation and Locality.—In limestone of the Niagara group, at Racine and Greenfield, Wisconsin.

TROCHONEMA (CYCLONEMA?) PAUPER, HALL.

PLATE XV, FIGS. 5, 6, 9; PLATE XXV, FIG. 13.

Pleurotomaria pauper, HALL; in Twentieth Report N. Y. State Cabinet, 1st edit., p. 343. 1867.

Shell small, obtusely conical, the apicial angle from seventy to eighty degrees. Volutions three, four or more, rapidly increasing in size from the apex, rounded above and on the sides, a little flattened on the top below the suture line, the last one subangular below; suture distinct, not channelled. Aperture rounded or slightly elongated, and scarcely subangular above on the inner side. Umbilical cavity rather large, marked by three or four revolving bands. Surface strongly striated; the upper part of each volution marked by five or six revolving cariniform striæ above the stronger carina upon the angle of the outer volution. These are crossed by fine lines of growth, which are not always preserved in the fossil.

Owing to the thickness of the shell, the internal casts do not often preserve more than three or four bands indicating the exterior striæ, and the apicial angle is usually less than that of the exterior shell.

This species has been identified by Prof. WINCHELL as *Pleurotomaria halei;* and two specimens communicated by him under this name, are in all respects identical with the species described by me under the name *Pleurotomaria pauper*, from which genus it must be separated on account of the exterior character of the shell which has since been discovered.

Formation and Locality.—In limestone of the age of the Niagara group, at Racine, Wisconsin, and Bridgeport, Illinois.

GENUS MURCHISONIA, Phillips.

Murchisonia conradi, n. s.

PLATE XV, FIG. 19.

Shell turreted, somewhat rapidly ascending, consisting of about seven volutions which are distinctly carinated on the middle or scarcely above the middle. Above the carina the surface is slightly concave, and below the carina very slightly rounded; while the lower side of the last volution is regularly rounded and somewhat ventricose.

The surface has been finely striated with irregular undulations, corresponding with the lines of growth where the striæ have become crowded. The entire length of shell to the base of the last volution is one inch and nine-tenths, and the diameter near the base nine-tenths of an inch.

This species is described from an impression in the limestone and a gutta percha cast from the same. It is a well marked species; differing from every other in these rocks in the sharply carinate volutions and elevated spire. In some characters it is allied to *M. xantippe*, Billings, but the spire is more elevated: the length of that one, from the carina of the last volution to the apex of the figure, is the same as the length from the same point to the carina of the second volution above, in our specimen; while the diameters of the lower volutions in the two are about equal.

Formation and Locality.—In limestone of the age of the Niagara group, at Racine, Wisconsin.

Murchisonia laphami, Hall.

PLATE XV, FIG. 20.

Murchisonia laphami, Hall. Report of Prog. Geol. Survey Wisconsin for 1860, p. 36. 1861.

Shell turritiform, robust; volutions seven or eight, gradually increasing from the apex, rather ventricose on the exterior, with close sutures; the upper half of the volutions very slightly flattened; giving a perceptible angularity in the region of the revolving band. Section of volution broadly ovate, the breadth equal to four-fifths of the height, and the greatest diameter on the lower third. Surface marked near the middle of the volution by a somewhat broad band, the margins of which are prominent; the upper part of the volutions are marked by fine transverse striæ, which are directed gently backwards from the suture to the revolving band.

This species very closely resembles specimens of the *M. logani* of the Guelph limestone of Canada West, but the volutions of that species are more ventricose, and the spire more rapidly ascending.

Formation and Locality.—In limestone of the age of the Niagara group, at Racine, Wisconsin.

MURCHISONIA HERCYNA? BILLINGS.

Compare *Pleurotomaria gonopleura,* W. & M.; in Mem. Bost. Soc. Nat. Hist., I, p. 98. 1865.

In a paper by Mr. BILLINGS, already cited, he has described *Murchisonia hercyna*, a conical shell with flattened volutions and without a carina. Among the Wisconsin collections from Racine there is a single specimen of similar form, preserving about four or five volutions which are of precisely similar character, except that they are a little more rapidly expanding, and the two lower ones show a slight convexity of the upper part of the volution. The cast of the interior has the volutions subangular above and below.

GENUS EUNEMA, SALTER.

EUNEMA? TRILINEATA, HALL.

PLATE XV, FIG. 3.

Shell turreted; spire ascending, composed of four or five volutions, which are moderately rounded and gradually increasing in size to the last which is somewhat ventricose. Surface of volutions marked by slender revolving lines or ridges, crossed by close concentric striæ which in some places are elevated in bands or fascicles.

The surface characters are remarkable for a shell in this geological position, and more nearly resemble those of the Devonian or Carboniferous fauna.

Formation and Locality.—In limestone of the age of the Niagara group, at Racine, Wisconsin.

GENUS LOXONEMA, Phillips.

Loxonema leda, n. s.

PLATE XV, FIG. 2.

Loxonema —— sp., Hall; in Twentieth Report of N. Y. State Cab., 1st edit., p. 346. 1867.

Shell turreted. Spire rapidly ascending, composed of eight or more volutions, which are moderately convex on their surfaces, a little more abruptly rounded below the middle, and very gradually increasing in diameter; suture close, not very distinctly marked; apicial angle about twenty degrees; columellar side of aperture elongated or pointed. Other characters of aperture unknown. Surface characters obscure; faint indications of transverse ridges crossing the larger volutions exist in the matrix.

This species was originally compared by me (loc. cit.) with *L. fitchi*, to which its imperfect cast bears some resemblance; but a critical examination shows it to be a very distinct species. The species referred by Prof. Winchell to *L. subulata* is apparently identical with *L. leda*, judging from a cast of the upper volutions communicated by him. It is, at any rate, very distinct from *L. subulata*, the spire being much less rapidly ascending.

Formation and Locality.—In limestone of the age of the Niagara group, at Wauwatosa, Wisconsin, and Bridgeport, Illinois.

GENUS SUBULITES, Conrad.

Subulites ventricosus, Hall.

PLATE XV, FIG. 1.

Subulites ventricosa, Hall. Palæontology of New York, II, p. 347, Pl. 83, fig. 7.
Subulites brevis, W. & M.; in Mem. Bos. Soc. Nat. His., I, p. 100, Pl. ii, fig. 19. 1865.

This species occurs at Wauwatosa; received from Dr. H. Day; and also at Bridgeport, Illinois.

GENUS BUCANIA, Hall.

Bucania angustata, Hall.

Bucania angustata, Hall. Palæontology of New York, II, p. 349, Pl. 84, fig. 6.

A specimen undistinguishable from the species occurring at Galt, Canada West, has been found at Racine, in Wisconsin.

GENUS PORCELLIA (Leveille).

SUBGENUS TREMANOTUS (N. S.-G).

Volutions apparently in the same plane; umbilicus on both sides; aperture expanded: the dorsal line pierced by several oblong perforations.

Tremanotus alpheus (n. s).

Shell subdiscoid, making several volutions, which are rotund, wider than deep, slightly embracing, rounded exteriorly, and very abruptly curving into umbilicus.

The specimen is a cast of the interior of the shell, and along the periphery presents a range of elongated oval prominences which have apparently been perforations in the shell, arranged at equal distances from each other; or they may have been flattened, hollow nodes which have left these marks, and which originally communicated with the interior of the shell.

The surface has been marked by coarse longitudinal striæ or ribs, the traces of which are shown in the cast.

This species bears some resemblance to *Bucania angustata*, but differs in the more rotund volutions, and in the interrupted oblong nodes representing the perforations on the periphery, while that species is free from nodes or carina. From the subcarinate character of the specimen figured as *B. angustata* in the Geology of Canada, page 334, I am led to infer that it is rather identical with the species here described than with the typical forms of the species to which it has been referred.

Formation and Locality.—From the Niagara limestone of Illinois, Prof. C. U. Shepard.

Among the collections from Wauwatosa, Waukesha, Racine and other localities of the Niagara group, in Wisconsin, there are remains of other species of Gasteropoda than those here described; but their condition is such that, for the most, their description or illustration would add little to our positive knowledge of the subject. The description of the interior casts of species of this class of fossils is usually even less satisfactory than that of other fossils in a similar condition; but as it seems unlikely that we shall get them in any other form, we are compelled to make such use of them as will aid in further comparisons of these fossils with those from other localities.

CEPHALOPODA.

GENUS NAUTILUS, Breyn.

Nautilus occidentalis, Hall.

Cyrtoceras giganteum, McChesney. Descrip. New Palæozoic Fossils, p. 67. Jan., 1860.
Lituites occidentalis, Hall. Rep. Prog. Geol. Survey Wisconsin for 1859, p. 31. Feb., 1860.
Lituites cancellatum, McChesney. Descrip. New Palæozoic Fossils, p. 96. 1861.
Nautilus (*Lituites*) *occidentalis*, Hall. Geological Report of Wisconsin, p. 441. 1862.

Shell very large, subdiscoidal. Volutions two or more, rapidly expanding, contiguous, the outer portion of the last volution becoming free and extending in a nearly straight line, while the earlier portions are compressed on the ventral side by the dorsum of the preceding volution; septa distant; section ellipitical; siphuncle small, subcentral. Surface marked by regular equal fillet-like striæ or ridges, which are curved backwards on the dorsum; and in more perfect individuals, these are cancellated by finer longitudinal or revolving striæ.

Specimens sometimes measure twelve inches in the greatest diameter of the disc.

This fossil was published by me, under the name *occidentalis*, in 1860. The name *giganteum*, given by M'Chesney, being preoccupied, the name *cancellatum* was given a year later by that author. It appears to me that these forms are not true Lituites, and that they should be referred to the Genus Nautilus; therefore since there is already a *Nautilus giganteus*, the name *occidentalis* has precedence of *cancellatus*.

Formation and Locality.—In limestone of the age of the Niagara group, near Milwaukee, Wisconsin, and at Joliet, Illinois.

Nautilus capax, Hall.

Lituites capax, Hall. Report of Progress Geol. Survey Wisconsin for 1859, p. 3. 1860.

This species differs from *N. occidentalis* in its more rotund form, the section of the outer volution being very broadly elliptical or nearly circular, and showing rapid expansion towards the aperture.

The materials possessed by me are fragmentary, but sufficient to leave no doubt of specific distinction between it and the preceding species.

Formation and Locality.—In limestone of the age of the Niagara group, at Waukesha and Racine, Wisconsin. I also have seen some large fragments of the same species in the collection of Prof. Marcy from Bridgeport, Illinois.

GENUS TROCHOCERAS, Barrande, Hall.

Trochoceras desplainense, M'Chesney.

PLATE XVI, FIGS. 8, 9, 10.

Trochoceras desplainensis, M'Chesney. New Palæozoic Fossils, p. 68, Plate viii, fig. 1. 1860.

Shell dextral, trochiform, making a little more than two volutions, the apex rising to about the same plane with the top of the adjacent volution, gradually expanding, and the other chamber continued in a more nearly direct line. Section of the volutions essentially circular; siphuncle small, central. The three outer septa measure on the dorsum seven-eighths of an inch. Surface marked by strong oblique angular ridges, which are curved backward on the dorsum, gradually increasing in distance, and finally there is a considerable space below the aperture, marked only by lines of growth. The intervals between the annulations are regularly concave.

I have identified this form with *T. desplainense*, M'C.; having before me a cast of the specimen described and figured by that author, in which about two volutions can be distinguished. The original of the cast had apparently been a little flattened from pressure; and I have a specimen, not figured, presenting a similar aspect. Another specimen, having its natural proportions preserved, is more rotund. It does not appear that there have ever been much more than two volutions in the full grown shell, and the section is essentially circular, though the lateral diameter may be a little greater when the dorso-ventral diameter is measured to the bottom of the depression between the annulations, but not otherwise. The differences indicated in the distance of the septa do not seem to be important. This species bears considerable resemblance to *Trochoceras trochoides* of Barrande, Plate xxix, figs. 16–21.

Formation and Locality.—In limestone of the age of the Niagara group, Racine, Wisconsin.

TROCHOCERAS COSTATUM, HALL.

PLATE XXV, FIG. 15.

Trochoceras costatum, HALL. Report Progress Geolog. Survey of Wisconsin for 1860, 1861.

Shell depressed trochiform, sinistral, greatest diameter about two and a quarter inches; spire depressed convex; volutions about one and a half to two,* gradually expanding from the apex; section subcircular; umbilicus broad and shallow. Siphuncle undetermined. Surface marked by strong sharply elevated annulations, which increase in distance and regularity with the growth of the shell, gradually diminishing on the last volution and becoming more or less obsolete, or appearing as gentle undefined elevations towards the aperture. Near the apex of the shell there are about twelve of these annulations in the space of half an inch, and on the outer volution, opposite the same point, there are barely six in the same space.

This species is a little less in size than the *T. desplainense;* the annulations are more numerous and more sharply elevated, not increasing in size on the outer volution beyond the point opposite the apex of the shell. Taking a single volution from near the apex, there are nearly twice as many annulations as in the species cited. The sinistral direction of the volutions is, however, a conspicuously distinguishing feature.†

The species was originally described from imperfect material, and the figure given is from a gutta-percha cast in a well preserved impression of the exterior of the lower or umbilical side of the shell.

This species may be compared with *T. pulchrum* of BARRANDE, Plate xvii, figs 8 – 16, but is more finely costate.

Formation and Locality.—In limestone of the age of the Niagara group, at Racine and near Milwaukee, Wisconsin.

* Originally stated as three or four by mistake.

† Since it sometimes happens that the *Trochoceras desplainense* is quite flat upon the upper side, or that the inner volutions are a little depressed below the outer one, it might perhaps be suspected that the *T. costatum*, of which the umbilical side is represented in the figure, is an exaggerated condition of the former species, with the inner volution still more depressed. This, however, is not true, for the volutions are clearly sinistral, and as represented are in their natural relations. It is, perhaps, the first American species of this character that has been recognized, but M. BARRANDE distinctly describes the two forms, and has figured several species with sinistral spires. In his generic description, he says, "the shell consists of several turns of the spire or of a single volution more or less complete, but exhibiting almost always a marked defect of symmetry. The enrolment is sometimes dextral and sometimes sinistral according to the species, but the dextral forms greatly predominate. In *T. asperum* we find both modes, varying in individuals, and the same in *T. sandbergeri*."

Trochoceras notum, n. s.

PLATE XVI, FIGS. 1, 2.

The entire shell unknown; a fragment of the outer volution shows it to have been strongly annulated, with the annulations bending backward on the dorsal side. The transverse diameter is greater than the dorso-ventral diameter, and the direction of the volutions has been dextral. The siphuncle is subcentral and small.

It is distinguished from *T. costatum* by the dorso-ventral compression of the volutions, and by the dextral direction of the spire. The volutions have been in contact, and their number, though unknown, is probably about two.

It differs from *T. desplainense* in the dorso-ventral compression of the volutions, and less conspicuous and more closely arranged annulations.

Formation and Locality.—In limestone of the age of the Niagara group, at Bridgeport, Illinois.

Trochoceras (Gyroceras) bannisteri, Winch. and Mar.

PLATE XXV, FIG. 17.

Gyroceras bannisteri, Winchell and Marcy; in Mem. Bost. Soc. of Nat. Hist., I, p. 102.

Shell consisting of about one and a half volutions, which increase in size somewhat rapidly: spire gently ascending; umbilicus broad and comparatively deep, the lateral diameter of the volutions being greater than the dorso-ventral diameter. Surface marked by low subangular annulations, which, turning gently backwards on the sides of the shell, are more abruptly bent into a shallow sinus on the dorsum. These annulations apparently become obsolete towards the aperture; on the other parts of the shell, there are about six or seven in a space equal to the dorso-ventral diameter.

This species differs from either of the species described, in its more rapid enlargement from the apex, and in the finer annulations.

These observations are made upon a cast in gutta-percha, sent to me by Prof. Winchell, under the name of *Gyroceras bannisteri.* The cast has the appearance of a very pretty species of Trochoceras, of more delicate proportions than those described in this paper.

Formation and Locality.—In limestone of the age of the Niagara group, at Bridgeport, Illinois.

GENUS LITUITES, Breyn.

Lituites marshii, n. s.

PLATE XVI, FIGS. 6, 7.

Shell of medium size, consisting of three or more closely enrolled volutions, which increase in size very gradually from the apex: section circular or subcircular; slightly flattened on the dorsum, and marked on the sides by sharp, strong, oblique annulations with regularly concave spaces between. These ridges, rising on the ventral margin, are directed obliquely backward as they cross the sides of the volutions, reaching the centre of the dorsum at a point opposite the origin of the second preceding one, having their greatest elevation on the sides of the shell, and making a somewhat abrupt retral curve, become nearly obsolete on the dorsum. Septa moderately distant, deeply and uniformly concave; the chambers regularly increasing in depth with the diameter of the shell. The space of three chambers, measured on the side of the shell, are equal to the dorso-ventral diameter of the volution. The dorsal margins of the septa are directed forward, giving a broad retral curvature on the sides of the volution. Siphuncle small, subcentral. Surface of shell and form of aperture unknown.

This beautiful species is readily distinguished by its slender volutions, and the strong oblique ridges, which in the outer part of the shell are a little more distant than the septa, while on the inner volutions they are nearer to each other, the increase in the distance of the annulations being a little more rapid than that of the septa. Owing to the retral curving of the annulations, and the advancing curvature of the septa, the ridges are cut by the latter near the dorso-lateral angle of the volution, throughout the greater part of the extent of the shell. The specimen preserves a little more than two volutions, and we have no portion of the chamber of habitation. Inferring from the prevailing characters of similar forms of this genus, there has probably been nearly or quite another volution at the apex, which is not preserved.

Formation and Locality.—In limestone of the Niagara group, at Kankakee, Illinois.

GENUS PHRAGMOCERAS, Broderip.

Phragmoceras nestor, n. s.

A fragment preserving the outer chamber and several of the septa, is ventricose, broadly expanded in the dorso-ventral direction, and measuring from the extreme limits of the apertures, which are marginal, more than two and a half inches; the length of the narrow constriction between them being one inch and a quarter. Both the dorsal and ventral apertures are marginal and expanded.

The length of the outer chamber along the middle is an inch and three-fourths, and the dorso-ventral diameter in the middle of the length is two and a quarter inches. The septate portion has been abruptly arcuate, the length of the part remaining being four times as great on the outer as on the inner side of the curve. The greater and lesser diameters of the septa are about as seven to ten. The siphuncle is submarginal.

The cast of the outer chamber is marked by what appears to be regular vascular impressions extending outwards from the first septum.

In fig. 3 a lateral view is given of the specimen described, and in fig. 4, a view of the aperture.

Fig. 3.

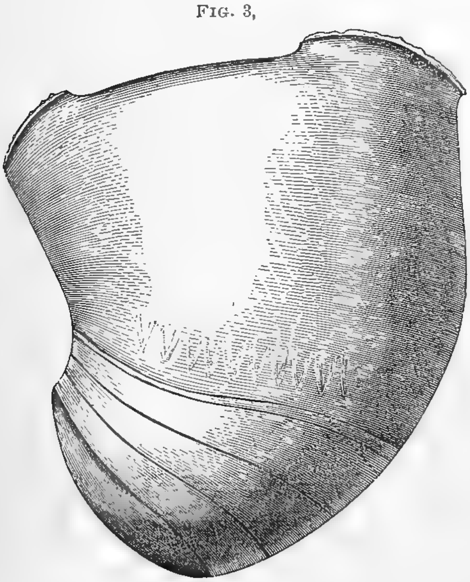
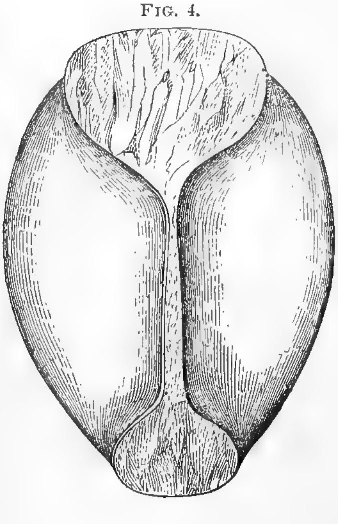


Fig. 4.



This species differs from the *P. hector*, Billings, of the Guelph limestone of Canada, in being more narrowly elliptical in section, and much more expanded in the dorso-ventral direction at the aperture, as well as in the greater length and more extreme constriction of the intermediate portion of the aperture.

This species should be compared with *P. ventricosum* and *P. arcuatum*, MURCHISON, *Silurian System and Siluria.*

Formation and Locality.—In limestone of the Niagara group, at Wauwatosa, Wisconsin.

GENUS CYRTOCERAS, GOLDFUSS.

CYRTOCERAS LUCILLUM, N. S.

PLATE XVIII, FIG. 7.

Shell arcuate, gradually expanding towards the aperture, section elliptical, a little narrower on the inner side of the curve; septa moderately convex, closely arranged; siphuncle small, submarginal on the outer side of the arch. Surface marked by regular, equal, neatly defined annulations, which have a slight retral arch on the exterior curve, indicating a similar sinuosity in the margin of the aperture. The annulations are closely arranged; on the smaller parts of the shell, they are in the proportion of twenty in the space of an inch; while on the inner side of the curve they are more approximate, and on the outer side more distant. On the larger part of the shell the annulations number five or six in the space occupied by seven in the smaller parts.

Formation and Locality.—In limestone of the Niagara group near Wauwatosa, Wisconsin.

CYRTOCERAS FOSTERI, HALL.

PLATE XVI, FIGS. 11, 12, 13.

Cyrtoceras fosteri, HALL. Report Progress Geol. Survey Wisconsin for 1860, p. 43. 1861.

This species is known to me only in the Niagara limestone near Chicago.

CYRTOCERAS DARDANUS, HALL.

PLATE XVII, FIGS. 3, 4, 5.

Cyrloceras dardanus, HALL. Report Progress Geol. Survey Wisconsin for 1860, p. 43. 1861.

This species was originally described from fragments, which in all the specimens seen can be readily identified. Some other imperfect specimens which have come under my notice since the publication of the original description, have induced me to suppose that the fossil may belong more properly to the Genus GYROCERAS. The species occurs at Waukesha and Wauwatosa, Wisconsin.

CYRTOCERAS BREVICORNE, N. S.

PLATE XVIII, FIGS. 8, 9; PLATE XXV, FIG. 14.

Shell small, gently curving and very rapidly expanding from the apex, the diameter of the outer chamber nearly equaling one half of the entire length of the shell; septa somewhat closely arranged, curving upward on the dorsum, moderately concave, the four outer ones measuring five-eighths of an inch on the back and less than half an inch on the ventral side. Siphuncle small, and lying close to the dorsal margin. Surface of shell unknown.

This species is the most rapidly expanding form of any yet discovered in these rocks, and may be easily distinguished by this feature alone. The specimen figured retains a single chamber besides the outer one, the remaining portions being restored from the impression in the adhering stone. Another fragment retains the chamber of habitation, and six of the septa below. The fossil is associated with a smaller species of CYRTOCERAS (*C. pusillum*), and a TROCHOCERAS; and is not an abundant form, so far as known.

Formation and Locality.—In limestone of the age of the Niagara group, at Racine, Wisconsin.

CYRTOCERAS PUSILLUM, N. S.

Shell small, slender, making half a volution, somewhat rapidly expanding near the aperture; section broadly elliptical; the length of the chamber of habitation, as preserved, about equal to once and a half its lesser diameter. Septa moderately concave, arching forward on the back so as to give a depth once and a half as great as on the sides. Siphuncle dorsal. Surface unknown.

Formation and Locality.—In limestone of the age of the Niagara group, at Racine, Wisconsin.

CYRTOCERAS LATERALE, N. S.

PLATE XVIII, FIGS. 4, 5, 6.

Shell rather above the medium size, very gently curving, and the sides abruptly expanding above the middle, the ventral line being nearly straight, dorsal line more strongly arcuate; shell more rapidly expanding transversely than in the opposite direction, giving to the middle of the shell a broad and somewhat flattened appearance. The outer chamber gently converges again above the last septum, and is broadly constricted below the aperture, where it is nearly straight for a short distance. Section transversely oval, and a little flattened on the ventral border in the middle portion of the shell, while in the lower or smaller part it is circular. Septa distant about one-sixth the transverse diameter of the shell, moderately concave, their margins directed slightly upwards on the lateral portions of the shell, giving a broad shallow sinus on the dorsal and ventral sides. Siphuncle small, situated near the dorsal margin. Surface of the shell marked by obscure longitudinal ridges, distant from each other from a sixteenth to a tenth of an inch in different individuals and on different parts of the shell. The impressions of these ridges are distinctly seen on well-preserved casts of the interior.

This species is readily distinguished from the others of the genus associated with it, by the slight curvature and the greater transverse diameter; the relative diameters of the specimens figured, in its larger part, being as four to five. The relative distance of the septa may vary somewhat in different individuals, judging from other specimen before me, but not materially affecting characteristic features of the species. The outer two septa, next the chamber of habitation, are often crowded closely together.

Formation and Locality.—In limestone of the age of the Niagara group, at Racine, Wisconsin.

Cyrtoceras rigidum, Hall.

PLATE XVI, FIGS. 3, 4, 5.

Shell small, consisting of about one volution, gradually expanding to a diameter of three-fourths of an inch with a height of two inches. Septa unknown; outer chamber deep. Siphuncle apparently dorsal. Surface of cast marked by strong obliquely transverse annulations which become gradually stronger from the concave side, and are gently curved backward on the middle of the dorsum. Spaces between the annulations concave, without any evidence of intermediate smaller ridges. Exterior surface unknown, the specimen being a cast of the interior.

The figures referred to are the dorsal and lateral views of a fragment, with a transverse section. The accompanying outline, fig. 5, shows the form of the entire cast of the interior, as nearly as can be given with the materials in my possession.

FIG. 5.

This species, in the external markings of the cast, is quite similar to *Trochoceras notum*, and not very unlike *T. costatum;* but the enrollment of the shell in the same plane is a distinguishing feature.

Formation and Locality. — In limestone of the age of the Niagara group, at Bridgeport, Illinois.

CYRTOCERAS HERCULES, WINCH. AND MAR.

PLATE XVII, FIGS. 6, 7.

Lituites hercules, WINCHELL & MARCY; in Mem. Bost. Soc. N. H., I, p. 102, Plate iii, fig. 9.
Cyrtoceras (Phragmoceras ?) amplicorne, HALL; in 1st edit. Twentieth Rep. N. Y. State Cab. N. H., p. 358. 1867.

Shell large, strongly curved, making an entire volution, rapidly expanding toward the outer chamber, which is less arcuate than the septate portions of the shell; transverse section broadly elliptical, becoming a little flattened on the sides towards the outer chamber. Septa rather deeply concave and comparatively distant; three of them, measured on the dorsum, being nearly equal to the diameter of the outer part of the largest one measured. The dorsal margins of the septa are advanced so that a direct transverse section would cut the ventral margin of the next preceding one. Siphuncle small, central or subcentral. Entire form of aperture unknown. Surface finely striated, with the striæ curving backward to the dorsum.

This is one of the most robust species of the genus known in our rocks, and, were the outer chamber entire, would measure full seven and a half inches in height, with a transverse measurement of more than five and a half inches. The dorso-ventral diameter of the base of the chamber of habitation is two inches and eight-tenths, with a transverse diameter at the same point of two inches and three-tenths. It is likewise remarkable for its great curvature and central siphuncle.

The flattening of the sides gives the shell in some respects the aspect of PHRAGMOCERAS; but the curvature is so broad and regular, and the outer chamber so extended and gradually expanding, that it presents an aspect more like CYRTOCERAS.

Formation and Locality.—In limestone of the age of the Niagara group, at Waukesha, Wisconsin.

GENUS ONCOCERAS, HALL.

ONCOCERAS ORCAS, HALL.

PLATE XVII, FIGS. 1, 2.

Cyrtoceras orcas, HALL. Report Progress Geol. Survey of Wisconsin for 1860, p. 42. 1861.

This species should properly be referred to the Genus ONCOCERAS, of which it is the only representative at present known to me in this formation in Wisconsin.

GENUS GOMPHOCERAS, SOWERBY.

GOMPHOCERAS SEPTORIS, N. S.

The outer chamber of a GOMPHOCERAS, including the first septum, shows a submarginal siphuncle, with broad sub-elliptical section. The lateral aperture extends to a point nearly have way from the apex to the first septum, and is continued in a narrow constriction nearly to the apex, where it is united wlth the larger aperture: the margin of this is contracted into tubular folds, so narrow as to present the appearance of three small rounded lateral apertures, with a similar one on the dorsal side.

FIG. 6.

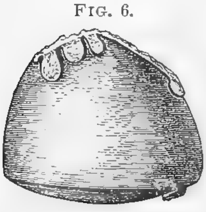
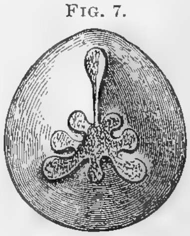


FIG. 7.



This peculiarity of the aperture is sufficient for specific determination, when compared with any species known to me.

Fig. 6 is a lateral view of the outer chamber, and fig. 7 represents the form of the aperture.

Formation and Locality.—In limestone of the Niagara group, at Wauwatosa, Wisconsin. Dr. H. DAY.

GOMPHOCERAS SCRINIUM, N. S.

PLATE XVIII, FIGS. 1, 2, 3.

Gomphoceras marcyæ, WINCHELL & MARCY; in Memoirs Boston Society Nat. Hist., Vol. I, p. 100, Plate iii, fig. 8.

A specimen consisting of the outer chamber and first septum, is of moderate size, transversely subcircular, with a very slight angularity on the ventral side. Outer chamber rapidly contracting from near the last septum to the aperture, giving it a somewhat conical form, the length being less than the transverse diameter of the septum. Aperture trilobed, the ventral opening small; dorsal opening moderately large and subtriangular; the proportions of the transverse and axial diameters are as three to four. Septa moderately deep, with a very regular convexity. Siphuncle situated at one-third the distance from the ventral margin to the centre. Surface marked only by irregular lines of growth.

Formation and Locality.—In limestone of the Niagara group, at Bridgeport, Illinois.

GENUS ORTHOCERAS, Breyn.

Orthoceras annulatum, Sowerby.

PLATE XX, FIGS. 4, 5, 6; PLATE XXIV, FIGS. 2, 3, 4.

Orthoceras annulatum, Sowerby. Mineral Conchology, II, p. 77, Tab. cxxxiii. 1818.
Orthoceratites undulatus, Hisinger. Anteckn. V, Tab. iv, fig. 6. Vet. Akad. Handlingar, Tab. vii, fig. 8. 1826.
Orthoceratites undulatus, Hisinger. Lethea Suecica, p. 28, Tab. x, fig. 2. 1827.
Orthoceras annulatum, Murchison. Silurian system and Siluria.
Orthoceras undulatum, Hall. Pal. New York, II, p. 293, Plates lxiv, lxv.
Orthoceras nodocostum, M'Chesney. New Palæozoic Fossils, p. 94, Plate 9, fig. 5. 1861.
Orthoceras nodicostatum, M'Chesney. Chicago Academy of Sciences, Vol. i, p. 53, Plate ix, fig. 5.

This species is of common occurrence in the shales of the Niagara group in New York. It is found in the lower beds exposed at Waukesha and near Wauwatosa, in Wisconsin. The specimens are casts, usually preserving only the marks of the strong annulations, which vary considerably in their sharpness and degree of elevation; but there is no evidence of specific distinction among the forms of this character. The fine undulating transverse striæ are preserved in the impressions of the exterior surface, associated with the casts.

Orthoceras columnare, Hall.

PLATE XIX, FIGS. 4-6, 8.

Orthoceras columnare, Hall. Rep. Progress Geol. Survey Wisconsin for 1859. Feb., 1860.
Compare *O. canaliculatum,* Sowerby, Silurian System, T. 13, fig. 26.

The species described by me from Wisconsin is elongate cylindrical, very gradually tapering. The siphuncle is central, of medium size, and not expanded between the septa. The septa are distant about one half the diameter.

The surface is longitudinally fluted by low ridges which are about one-sixth of an inch distant from each other. This feature is of course variable upon specimens of different size. The intermediate striæ are not preserved in the casts, in which condition the species is usually found.

In the typical specimens, the septa are very distant, and in this respect it is conspicuously different from *O. loxias*, which has a very similar external character. This character may be subject to some variation.

Formation and Locality.—This species occurs in strata below the Racine and Waukesha beds proper, and in the same horizon with *O. annulatum.**

Orthoceras medullare, Hall.

PLATE XX, FIGS. 1, 2.

Orthoceras medullare, Hall. Rep. Prog. Geol. Survey Wisconsin for 1859, p. 4. Feb., 1860.
Orthoceras striœlineatum, M'Chesney. New Palæozoic Fossils, p. 94. Feb., 1861.

Shell cylindrical, often a little compressed, gradually, and in some specimens more rapidly tapering. The septa are distant nearly half the diameter, but are subject to considerable variation in the same individual, so that nearly three chambers are sometimes included in a length equal to the diameter. The siphuncle is large and slightly expanded between the septa.

The surface is marked by strong, sharp, subequal longitudinal striæ, which are cancellated by fine transverse striæ. The longitudinal striæ are often alternated by finer sharp striæ in the same direction. Surface of the cast smooth, and by this character it is distinguished from the casts of *O. columnare* and *O. angulatum.*

Formation and Locality.—In limestone of the Niagara group, at Waukesha and Wauwatosa, Wisconsin.

* The *Orthoceras scammoni*, M'Chesney, *New Palæozoic Fossils*, is probably identical with this species. Two specimens received from Prof. Marcy offer some elucidation of the characters of the fossils not before understood. A single specimen combines in itself characters of *O. columnare* and *O. scammoni;* and unless we can find sufficient differences, on a further examination of collections, to sustain the separation, the *O. scammoni* and others, as well as that referred by me to *O. angulatum,* will fall under *O. columnare,* which has pr.ority in time over those described by M'Chesney. The cancellated figs. 10 and 11, of Plate xix, are apparently only the well preserved impressions of the external surface markings of the same species. It is probably also the same species which has been described by Mr. Billings, in 1866, as *Orthoceras cadmus.*

ORTHOCERAS ANGULATUM, WAHL.

PLATE XIX, FIGS. 10, 11; PLATE XXIV, FIG. 1.

Orthoceras angulatum, WAHLENBERG. Nova Acta Soc. Sci. Upsal, p. 90. 1827.
Orthoceras angulatum, HISINGER. Lethea Suecica, p. 28, Tab. x, fig. 1.
Orthoceras virgatum, SOWERBY; in MURCHISON'S Silurian System, p. 622, Tab. ix, fig. 4.
Orthoceras virgatum? HALL. Palæontology N. Y., II, p. 291, Plate lxiii, figs. 2, 3.
Compare *O. canaliculatum*, SOWERBY; in MURCHISON'S Silurian System, p. 632, Tab. xiii, fig. 26.

Specimens from Wisconsin are apparently identical with those of New York referred as above; the former being casts of the interior, while the latter are preserved in a soft calcareous shale, and have the surface markings more or less obscured.

The septa are distant about one-fourth the diameter of the shell. The siphuncle is central or subcentral, with scarcely an apparent expansion between the septa.

The longitudinal ridges are angular, and about one line distant when the shell is an inch in diameter. The finer surface striæ are but imperfectly preserved on the cast, and it is only in the impressions of the exterior that these markings become conspicuous.

This is probably the species described by Mr. M'CHESNEY, in a paper published in 1861, under the names *O. scammoni*, *O. hoyi*, *O. lineolatum*, *O. irregulare* = *O. woodworthi*. The last one figured in a fragment less than an inch in length. A gutta-percha cast sent by Prof. WINCHELL under the name *O. scammoni*, corresponds very well with specimens referred by me to *O. angulatum*. Should the species prove distinct from the European one, we may select a name from among those above cited. The comparison of a considerable collection of specimens from Bridgeport and the various localities in Wisconsin has not convinced me that we have so large a number of species of a character so similar as those above cited.

Formation and Locality.—In limestone of the age of the Niagara group, at Racine, Wisconsin, and Bridgeport, Illinois.

ORTHOCERAS CREBESCENS, N. S.

PLATE XIX, FIGS. 1, 2, 3.

Shell large, rapidly tapering; transverse section circular; septa deeply concave, four and a half of the intervals being equal to the diameter of the shell. Siphuncle moderately large, central or subcentral, strongly constricted at its junction with the septa, and expanded between. Surface of cast (the usual condition in which the specimens are found) obscurely marked by longitudinal ridges in the most perfectly preserved individuals, their distance varying from a sixteenth to an eighth of an inch; but these are usually so inconspicuous as not to be observed.

In one specimen, preserving a portion of the outer chamber (fig. 1), the septa become much crowded in the upper part; but whether this is a constant feature, or only exceptional, cannot be determined. In specimen figure 2, the septa are oblique to the axis of the shell, caused by the eccentricity of the siphuncle.

This species is easily distinguished from the others with which it is associated, by its large size, rapidly increasing diameter, circular section and large siphuncle. The exterior surface characters have not been determined.

Formation and Locality.—In limestones of the Niagara group, at Racine, Wisconsin.

Orthoceras alienum, n. s.

PLATE XXIV, FIGS. 5, 6, 7.

Shell cylindrical, very gradually tapering, a broad constriction of the outer chamber a little below the aperture; septa deeply concave, about four or five in the diameter of the outer one measured; the length of the outer chamber equal at least to twice the diameter of the shell. Siphuncle central, moderate in size, scarcely constricted at the junction of the septa. Surface of the cast smooth; exterior surface unknown.

This species is only known in the form of casts of the interior, and is distinguished from the others described by its very gradual enlargement towards the aperture, below which it is broadly constricted. The shell tapers at the rate of a line in an inch of the length. The siphuncle is a cylindrical tube, which is scarcely constricted at the junction of the septa, and has a diameter of five-sixteenths of an inch where the shell is one inch and three-eighths in diameter.

Formation and Locality.—In limestone of the Niagara group, at Racine, Wisconsin.

ORTHOCERAS ABNORME, N. S.

PLATE XVIII, FIG. 10; PLATE XXV, FIG. 18.

Shell large, gently curving and rapidly expanding from the apex; transverse section circular; septa distant, the space of three measured on the convex side nearly equal to the diameter of the outer margin of the larger one measured, their distance gradually increasing with the diameter of the shell. Siphuncle central or subcentral, very large, its diameter nearly equaling one-half the diameter of the shell, greatly constricted at its junction with the septa.

The siphuncle is partially occupied by a central core, or a replacement of organic deposition, with radiating ramifications which reach the outer walls of the siphon, and are connected with the filling between the septa. Surface characters, form of outer chamber and aperture unknown.

The peculiar features of this species are the curving form, giving somewhat the aspect of CYRTOCERAS with the character of septa and siphuncle of ORTHOCERAS. The distant septa and extremely large siphuncle, with the partial filling observed in numerous specimens, are distinguishing features. It is a large rapidly expanding form, the specimen figured measuring about five inches in length with the outer chamber preserved, having a diameter of two inches and three-tenths, the greatest curvature being in the lower part.

Other fragments identified with this species, show the same curvature as the one figured; while as they increase in size towards the outer chamber, the curvature diminishes, and the extreme portion is probably quite straight.

The organic deposition in the centre of the siphuncle has the aspect of a shrunken flexible or sub-elastic tube, with slender tubular ramifications which extend to the exterior walls, and appear as if they might have communicated to the chamber without, since the slender rami are now continuous with the matter filling these chambers.

This central deposition of matter, with radiating rami, presents characters identical with those on which the Genus ACTINOCERAS of BRONN was founded. I have heretofore indicated their irregularity and want of symmetry as an argument against their organic structure. M. BARRANDE regards these features as due to an organic deposition within the siphuncle. Such an origin would account for their generally characteristic features and their absence of structure, which would certainly be indicated in some specimens, had the parts been at all shelly in texture. At least one other species in the same formation preserves a similar feature in the siphuncle.

Formation and Locality.—In limestone of the age of the Niagara group, at Racine, Wisconsin.

Orthoceras niagarense, n. s.

PLATE XX, FIG. 3.

Shell elongate, gradually tapering; section broadly elliptical; septa deeply concave, depth of chamber about five lines where the diameter is one and a half inches; siphuncle eccentric. Surface annulated by low rounded undulations which are from one to two lines distant, according to the size of the shell; intermediate spaces regularly concave. In the larger parts of the shell there are about three annulations to each chamber. The finer surface markings unknown.

This species in its young state is rather slender and very gently tapering, and, though attaining a pretty large size, is not as robust as most of the associated forms. It bears considerable resemblance to the Niagara shale species which I have referred with doubt to the *O. imbricatum*, Wahl.; but the annulations are not so sharply elevated, and the septa are comparatively more distant. The section, in all the specimens examined, is elliptical. It is possible that this may be the species described by Mr. Billings under the name *O. oberon*, the principal difference being in our specimens the prevailing elliptical form of the tube.

The specimen figured is about nine inches in length, and is represented of the natural size.

Formation and Locality.—In limestone of the age of the Niagara group, at Waukesha and Pewaukee, Wisconsin.

Orthoceras loxias, n. s.

PLATE XIX, FIG. 7.

Shell of medium size, elongate, somewhat rapidly enlarging from the apex; section circular; siphuncle central or subcentral, scarcely constricted at the junction of the septa; septa distant about one-fourth the diameter; chamber of habitation unknown. Surface marked by sharply angular longitudinal carinæ with regularly concave interspaces, which, on the larger part of the shell, are distant fully three-sixteenths of an inch and gradually converge towards the apex. The shell is silicified so that the finer markings are obscured, but there are indistinct transverse striæ crossing the spaces between the ridges. No fine longitudinal striæ have been observed, though they may have existed on the shell in its original condition.

The similarity of this species to *O. columnare* is obvious, but it tapers more rapidly, and the septa are less distant. The length of the specimen figured is about eight and a half inches.

The species has been illustrated in this connexion from its general external similarity to figs. 4, 6, 8 and 9, and from a belief, originally, that it was from the same horizon, or not far removed therefrom. The specimen has been a long time in my possession, and was obtained in the northwestern lake region many years since, but I have no means of ascertaining the particular locality. The weathered surface of the limestone has the aspect of the Niagara limestone; but the fresh fracture more resembles some beds of the Clinton group, in the vicinity of Green-bay. A critical examination of the rock, the nature of the crystalline filling of some of the cavities, together with the silicification of the exterior shell and the principal part of the interior, septa, &c., induces me to refer the species, with some hesitation, to the Lower Silurian age.

CRUSTACEA.

In the *Annual Report on the Geology of Wisconsin for* 1860 (published in 1861), I described two new species of Illænus, a new Calymene, and a species of Dalmanites,* and in the list of species appended to the *Geology of Wisconsin*, Vol. i, p. 423, I noticed a species of Acidaspis (*A. danai*) from the limestone of the Niagara group.

A farther study of the collections in my possession, from the limestones of Racine, Waukesha, and from near Milwaukee, with a few from Illinois, has shown several other trilobites; among which the following may be noticed.

GENUS ILLÆNUS, Dalman.

Illænus armatus, n. s.

PLATE XXII, FIGS. 1-3; PLATE XXV, FIG. 22.

Head short and gibbous, varying in its proportions from nearly twice as wide as long, to length equalling two-thirds the width; elevated in the centre. The dorsal furrow makes a short rounded arch from the base of the shield, and terminates in a perceptible impression, on a line with the base of the eye and half way between it and the anterior margin. Eyes very prominent, situated close to the posterior margin; palpebral lobe short; furrow above it scarcely longer than the sinus below the eye. Cheeks small, making not more than one-fourth of the width of the head, and the suture coming to the anterior margin a little in advance of the eye. The posterior angles prolonged into short spines which extend directly backwards. The pygidium in several specimens has the proportions of length and breadth as 5 to 7, 6 to 8, and 7 to 10. The largest head identified as belonging to this species has a length of about one inch.

Fig. 8.

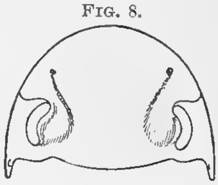
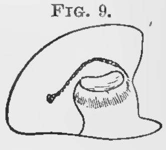


Fig. 9.



In fig. 8, the head is represented of the natural size, and fig. 9 is a profile view of the same.

Compared with *Illænus* (*Bumastus*) *barriensis*, the head is more prominent in the middle, more produced in front, and the eyes

* *Illænus imperator* of the Niagara group, *I. taurus* of the Trenton limestone, *Calymene mammillata* of the Hudson river group, and *Dalmanites vigilans* of the Niagara group.

are more prominent. The more conspicuous difference, however, is the prolongation of the posterior angle of the cheek into a short strong spine, a feature which I have not observed in *I. barriensis*. The pygidium is also more nearly semicircular, being broader in proportion to its length.

Formation and Locality.—In limestone of the Niagara group at Bridgeport, Illinois, and at Grafton and Racine, Wisconsin.

ILLÆNUS INSIGNIS, N. S.

PLATE XXII, FIGS. 13, 14.

Head large; glabella prominent and somewhat regularly arcuate from front to base; anterior border with the margin a little recurved. Dorsal furrows distinctly marked from the base of the head for three-fourths the distance to the anterior margin, where they terminate in a distinct rounded pit; palpebral lobe large, elongate, the eye being situated at some little distance from the posterior margin of the head. Facial suture running out on the anterior border within the line of the eye. The full extent of the cheek is not known. The form of the glabella and the convexity of a single articulation of the thorax indicate the general form to have been very convex.

The pygidium is parabolic, very convex; about as long as wide or a little longer. Anterior margin nearly straight along the middle for about half the width, for the attachment of the axis of the thorax, and abruptly receding towards the sides.

FIG. 10.

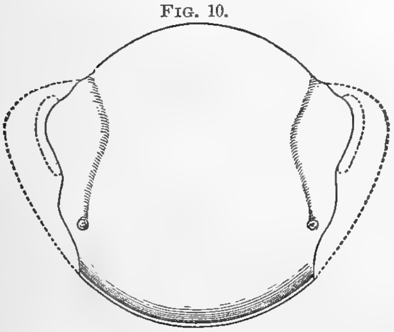
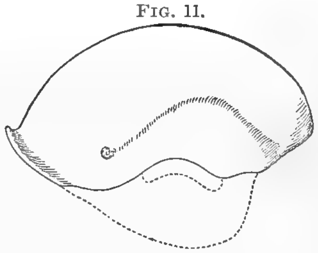


FIG. 11.



The specimens are mostly casts of the interior, but the species is readily recognized by the elongate and regularly arcuate form of the glabella, and the strongly marked dorsal furrows, and in these respects it differs conspicuously from any other species in the formation. A single specimen partially preserving the crust does not show the glabellar furrows so distinctly as the casts.

In fig. 10, the head is represented showing the dorsal furrow and direction of the facial suture, and in fig. 11, a profile view is given of the same.

I received several years since a specimen of this species from Prof. C. U. Shepard, who collected it with other Niagara fossils in Illinois, but the record of the particular locality had been lost.

Formation and Locality.—In the limestone of the Niagara group at Waukesha and Milwaukee, Wisconsin, and from a similar horizon in Illinois.

Illænus imperator, Hall.

PLATE XXII, FIGS. 15-17; PLATE XXIII, FIGS. 2, 3.

Illænus imperator, Hall. Report Progress Geol. Survey Wisconsin for 1860, p. 49. 1861.

This species, which was originally described from some large caudal shields with a few of the articulations of the thorax, has proved to be not rare.

The head is large and broad, moderately convex, and pretty regularly arching from the base to front; the glabella occupies about one-third the entire width; dorsal furrows wide, extending about half the entire length of the head, and curving outwards at the anterior extremity.

One large head has a length of three inches and a half, with a width between the facial sutures of four and a quarter inches. The eyes and cheeks are but partially known.

The caudal shields present gradations in size, from a length of half an inch by a width of seven-eighths of an inch, to those of less than three inches long with a width of four and a half inches. The proportions of length and breadth of the pygidium are not constant, though its wide and very depressed form is always characteristic.

The position of this species is somewhat lower in the group than the Racine and Waukesha beds.

Illænus (Bumastus) ioxus, Hall.

PLATE XXII, FIGS. 4-10.

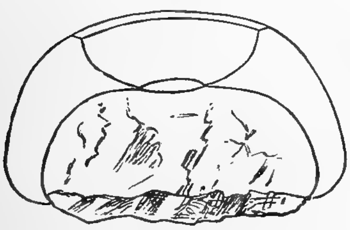
Compare *Bumastus barriensis*, Murchison. Silur. Syst., p. 656, Pl. vii, bis, fig. 3a–d. 1839.
Bumastus barriensis, Hall. Palæontology N. Y., II, p. 302, Plate lxvi, figs. 1–15.

There are several slight differences between the American (Wisconsin) specimens referred to this species, and the figures and descriptions of the English form of *I. barriensis*, as given in the *British Decade* 2, Plates 3 and 4. None of these differences, however, appear to be very important or strongly marked. On the head the eye is placed a little more obliquely; the movable cheek is comparatively longer from the posterior angle to its anterior margin; the facial suture lines unite with the rostral suture, forming an abrupt angle instead of a rounded one; the rostral shield is proportionally narrower from side to side, especially on the inner margin, where it unites with the hypostoma.

The differences in the pygidium are not readily observed. We have no means of comparing the articulations of the thorax in the Wisconsin specimens.

The New York specimens usually referred to *I. barriensis* have the same form of head and pygidium as those of Wisconsin, and differ from the figures of the British species in the direction of the terminations of the pleura. Notwithstanding the differences are not conspicuous, I am inclined to regard them as of the same importance as those which distinguish closely allied species.

FIG. 12.



The form of the rostral shield and the direction of the suture lines are shown in the accompanying fig. 12.

This species is of common occurrence in the Niagara group of Wisconsin, at Racine, Waukesha, Wauwatosa, and other places.

It usually occurs as separated heads and pygidia, with detached portions of the thorax. It has sometimes attained a very large size, the head being two and a half inches in length; equalling in size the largest head figured from the Niagara shale of New York.

ILLÆNUS CUNICULUS, N. S.

PLATE XXII, FIG. 12.

Glabella subquadrangular in outline, broadly rounded on the anterior margin, with the edge sharply recurved; general surface regularly convex, a little more arcuate transversely than in a longitudinal direction; length and breadth very nearly equal. Palpebral lobes moderately elevated, somewhat triangular in form, and laterally produced; situated very near the occipital border. Suture line reaching the posterior margin of the head, a little within the outer angle of the eye lobe, and slightly indented in front of the eye; thence directed toward the anterior margin with a slightly sigmoid curve; the distance between the sutures on the anterior margin but little less than in front of the eyes.

This species, in comparison with *I. armatus*, *I. barriensis* and *I. imperator*, has the glabella more elongated, while it is less convex than *I. insignis*, with shorter, and laterally more produced, palpebral lobes. The posterior position of the eye lobe is likewise a distinguishing feature.

Formation and Locality.—In limestone of the Niagara group, at Wauwatosa; and a single specimen of doubtful locality, received from Mr. I. A. Lapham, has the aspect of the Bridgeport rock.

GENUS BRONTEUS, Goldfuss.

Bronteus acamas, n. s.

PLATE XXI, FIGS. 19, 20; PLATE XXV, FIG. 21.

Bronteus occasus, Winch. & Marcy. Mem. Bost. Soc. of Nat. Hist., I, p. 104, Plate iii, fig. 12.

A cast of the head is broad; depressed convex; the anterior portion plain; dorsal furrow extending a little more than one-third the entire length. A single glabellar furrow, with a distinct anterior lobe, are visible. The palpebral lobe is comparatively broad and moderately elevated.

The pygidium is somewhat semi-elliptical or parabolic, wider than long; the axis is short, somewhat semi-oval, with one or more transverse furrows near the anterior margin, while the terminal portion is marked by two faint longitudinal depressions, which are scarcely defined grooves. The median rib, at its origin, is about twice as wide as the lateral ones, increasing gradually, and below the middle of its length more rapidly, to the margin; where it is four or five times as wide as at its origin, and entirely simple. There are seven lateral ribs on each side, which are very slightly elevated, and the four anterior ones curve gently forward.

The specimens are for the most part casts of impressions, so that the entire surface characters cannot be ascertained. The head is imperfect, the occipital ring and cheeks being broken off; but there are several nearly entire pygidia in the collection.

The pygidium of this species resembles the *Bronteus planus* of Corda, as illustrated by Barrande (*Système Silurien du centre de la Bohème*, Pl. xlii, fig. 34, and Pl. xxxviii, fig. 3), and it is difficult to point out distinguishing characters. The head associated with these pygidia is more nearly like that of *Bronteus tenellus* (Barrande, *ut sup.*, Pl. xlvii, figs. 36, 37); but it differs from that in some important particulars.

This species has the pygidia more elongate than *B. niagarensis* of New York. (*Pal. N. Y.*, Vol. ii, p. 314, Pl. lxx, fig. 3.) The figure given on Plate xxv, fig. 10, is made from a specimen communicated by Prof. WINCHELL under the name of *Bronteus occasus.*

Formation and Locality.—In limestone of the Niagara group, at Racine, Wisconsin.

GENUS ACIDASPIS, MURCHISON.

ACIDASPIS DANAI, HALL.

PLATE XXI, FIGS. 8, 9.

Acidaspis danai, HALL; in Catalogue of Fossils, Geol. Wisconsin, I., p. 423. 1862.
A. *ida*, WINCH., MAR.; in Mem. Bost. Soc. N. H., I, p. 106, Plate iii, fig. 13. 1865.

Head transverse, somewhat quadrangular, about twice as wide as long; anterior and antero-lateral border ornamented with nodes and short spines. Glabella strongly defined by the dorsal furrows, narrower in front than at the base; distinctly lobed, the middle lobe larger than the others, separated by deep, strong furrows. A strong, slightly diverging spine from each side of the base of the glabella, with a strong node or short spine in the centre. The ocular ridges rise a little in front and one side of the glabella, and continue in a nearly direct line to the base of the eyes which are in a line with the front of the anterior lobes of the glabella.

This species more nearly resembles *Acidaspis vesiculosus*, BEYRICH, as illustrated by BARRANDE (Pl. xxxviii, fig. 13). It differs from that one in being more transverse, in the narrower front of the glabella, and in the straight instead of curving ocular ridges. We have not ascertained whether this species has spines from the posterior borders of the cheeks, which is probable, as in the allied European species. Fig. 9 is from a specimen communicated by Prof. WINCHELL, but I am not able to detect the crenulations on the anterior border, as shown in the figure given by him.

Formation and Locality.—The original specimen is marked as from Bridgeport, near Chicago.

GENUS LICHAS, Dalman.

Lichas breviceps? Hall.

PLATE XXI, FIGS. 12 13, 14.

Lichas breviceps, Hall; in Transactions Albany Institute, IV, p. 222. 1862.

The specimens figured are a head, which in all important characters corresponds with *L. breviceps* as described by me. The pygidium, fig. 14, occurs on the same specimen of rock, and corresponds in size to the head, both figures being enlarged two diameters.

The pygidium differs from the pygidia associated with the head of *L. breviceps* in the Waldron locality only in the central posterior indentation, and in this respect corresponds with *L. nereus*, which it otherwise closely resembles. It is therefore unnecessary to propose any other name until we have better material. Figs. 12 and 14 are from Bridgeport, Illinois. The specimen fig. 13 is from Grafton, Wisconsin, and is represented of the natural size, the terminal portion having been restored to correspond with fig. 14.

Lichas ——— (sp.).

The pygidium of a species of this genus in limestone from Grafton, Illinois, has a strong rounded axis, with four rings besides the terminal one. The lateral lobes are somewhat convex, but the extremities are broken off, so that its entire form cannot be determined.

Lichas pugnax, Winch. and Mar.

PLATE XXV, FIG. 20.

Lichas pugnax, Winch. & Marcy, Mem. Bost. Soc. Nat. Hist., I, p. 103, Plate iii, fig. 10. 1865.

The figure given is of the pygidium of the original specimen in the collection of Prof. Marcy.

Formation and Locality.—In the Niagara limestone at Bridgeport, Illinois.

Lichas obvius, n. s.

PLATE XXV, FIG. 19.

Glabella gibbous, broad in front, length equal to the width between the eyes; occipital and dorsal furrows sharply defined; lateral lobes simple, of nearly equal width throughout, suddenly contracting near the base; surface finely pustulose.

Formation and Locality.—In limestone of the Niagara group, at Lyons, Iowa. From Dr. Farnsworth.

GENUS SPHÆREXOCHUS, Beyrich.

Sphærexochus romingeri, Hall.

PLATE XXI, FIGS. 4-7.

Sphærexochus mirus, of authors; not *S. mirus* of Beyrich.
Sphærexochus romingeri, Hall. Geological Report of Wisconsin, p. 434. 1862.
Sphærexochus mirus, Hall; in Twentieth Rep. State Cab., 1st edit., p. 334. 1867.

This species was at first supposed by me, to be identical with the *S. mirus* of Europe, but a farther careful study of it with larger collections for comparison, has shown certain differences in the form and proportions of the head, size of the cheek, etc., warranting its separation from the European species. The annulations on the axis of the pygidium are not so abrupt, nor the posterior extension so great; while the lateral lobes are more free at their extremities, giving a very different aspect to this part of the fossil.

This fossil is pretty widely distributed, occurring at nearly all the localities of the Niagara group in Wisconsin and Illinois.

GENUS CALYMENE, Brongniart.

Calymene niagarensis, Hall.

Calymene niagarensis, Hall. Geological Report, 4th District, N. Y., p. 101, fig. 3.
Calymene blumenbachii var. *niagarensis,* Palæontology of New York, vol. ii, p. 307.

This species occurs in nearly all the localities of the Niagara group in Wisconsin. Its most common condition is that of impressions of the exterior crust, while casts of the interior are less frequently obtained.

GENUS ENCRINURUS, Emmerich.

Encrinurus nereus, n. s.

PLATE XXI, FIG. 15.

Pygidium triangular; length and breadth about equal. Axis sharply elevated and marked by about eighteen rings, with a farther extension upon which no markings are distinguishable. The lateral lobes are marked by eight or nine distinct costæ, which, in the cast, are not tuberculated.

This species differs from the one in the Clinton group of New York, in the greater number of ribs on the lateral lobes of the pygidium, while there are fewer annulations on the middle lobe.

Formation and Locality.—In limestone of the age of the Niagara group, at Racine, Wisconsin.

GENUS DALMANIA, Emmerich.

Dalmania vigilans, Hall.

PLATE XXI, FIGS. 16, 17, 18.

Dalmanites vigilans, Hall. Rep. Progress Geol. Survey of Wisconsin for 1860, p. 51. 1861.

General form of body not determined. Cephalic shield convex, semi-elliptical, the breadth about twice as great as the length (exclusive of the frontal projection); the border is extended in front into a triangular flattened process, the base of which is little less than one-half as wide as the width of the anterior portion of the glabella. In older individuals this projection becomes more obtuse and sometimes rounded; the lateral borders are broad, flattened, separated from the cheeks by a distinct groove, extended posteriorly into spines which are equal in length to the glabella. Glabella large, depressed convex, widening in front to twice its width at the posterior margin, divided into lobes by three pairs of transverse furrows exclusive of the occipital furrow, which is distinct and continuous. The two posterior furrows are distinct at the sides, but do not extend entirely across the glabella except in very faint depressions. The anterior furrows are deep, very distinct, situated a little anterior to the eyes, extending each about one-third across the glabella, and giving to the frontal lobe a transversely elliptical outline. The occipital ring is narrow, ornamented on the middle by a single short sharp spine. Eyes very prominent, short reniform, containing about thirty-five vertical ranges of lenses, the middle ones of which have nine each. Cheeks small, prominent on the anterior portion, marked near the posterior margin by a deep groove, the continuation of the occipital furrows. Thoracic segments unknown. Pygidium somewhat elongate triangular, extended posteriorly into an acute spine; central lobe or axis marked by ten or twelve narrow rings; the lateral lobes less prominently marked by ten flattened ribs, which terminate in a narrow flattened margin. Eight of these ribs are double throughout their entire length; the posterior ones are directed obliquely backwards.

This species somewhat resembles *D. limulurus* (*Phacops limulurus*, Palæontology N. Y., II, Plate 67, fig. 1); but differs in the proportionally larger glabella, the larger and more prominent eyes, and the extension of the anterior border. The pygidium is less rounded on the anterior margin, the spine is more obtuse, the flattened margin outside of the ribs is narrower, and the number of ribs on the lateral lobes is greater. In figs. 13 and 14, the head and pygidium of this species are represented.

Fig. 13.

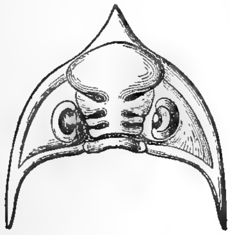
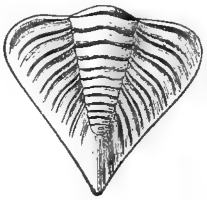


Fig. 14.



Geological Formation and Location.—In Niagara limestone, at Waukesha, Wisconsin.

GENUS CERAURUS, Green.

CHEIRURUS, Beyrich.

Ceraurus niagarensis, n. s.

PLATE XXI, FIGS. 10, 11.

Compare *Cheirurus insignis*, Beyrich. Ub. Bohm, Tril. p. 12, fig. 1.
Compare *Cheirurus insignis*, Barrande. Syst. Sil. du Centre de la Bohème, p. 782, Plate 41.
Compare *Cheirurus insignis*, Corda. Prod., p. 133, Plate vi, fig. 70.
Ceraurus insignis, Hall. Palæontology N. Y., II, pp. 300, 306, Plate 67, figs. 9, 10.
Ceraurus insignis, Hall; in Twentieth Rep. State Cab., 1st edit., p. 335. 1867.

A careful comparison of our specimens with the figures of *C. insignis*, given by Barrande, shows certain differences in the general form of the glabella, the direction of the furrows and form of posterior lobes, which I am inclined to regard as of specific importance, and therefore propose another specific name. The New York and Wisconsin specimens of this species preserve the same characteristics.

In the collection loaned to me for examination by Prof. Winchell, I have discovered the hypostoma of a Ceraurus attached to the front of an imperfect glabella, which I infer belongs to this species. This appendage differs from the hypostoma of *C. insignis* in being more rounded anteriorly, and not so deeply notched at the sides, while the border just anterior to the notch is not expanded as in the European species.

This species was, I believe, first identified with the European *C. insignis* by M. E. DeVerneuil, in his memoir on the parallelism of the European and American palæozoic formations.* A comparison with the figures of Beyrich then satisfied me that our species was identical with the Euro-

* *Bulletin Soc. Géol. de France*, 1847.

pean one, and I expressed this opinion in Vol. ii, *Palæontology N. Y.* The species occurring in Tennessee, which is probably the same as ours, has been identified by Dr. Rœmer with *Ceraurus bimucronatus* of Murchison, which he regards as synonymous with *Calymene speciosa* of Hisinger, not of Dalman. Our species bears as close a resemblance to *C. quenstedti* and *C. obtusatus* of Barrande as it does to *C. insignis.*

GENUS LEPERDITIA, Roualt.

Leperditia fonticola, n. s.

PLATE XXI, FIGS. 1, 2, 3.

Obliquely ovate or subreniform, gibbous in the middle; hinge-line straight, and equalling two-thirds the entire length, and about equalling the greatest width. Valves equal or subequal; posterior side rounded, wider than the anterior; base broadly rounded, and somewhat abruptly contracted towards the anterior end; greatest gibbosity in the middle; eye tubercle nearer the cardinal margin than the anterior extremity, with a distinct depression between it and the gibbous centre.

The specimens are casts of the interior, and occur in considerable numbers in some of the beds where there are few or no other fossils. It has a length of .47 of an inch, and the cardinal line is .29 of an inch. The greatest width is .30 of an inch. Some individuals are larger, while the greater number are smaller than the dimensions here given.

Formation and Locality.—In limestone of the Niagara group, near Fond du Lac, Wisconsin.

SUPPLEMENTARY NOTES.

The following notes are mainly in reference to species described in a paper by Profs. ALEXANDER WINCHELL and OLIVER MARCY, published in Vol. I, No. 1, of the *Memoirs of the Boston Society of Natural History*, entitled "An Enumeration of Fossils collected in the Niagara Limestone at Chicago, Illinois."

HOLOCYSTITES, HALL.

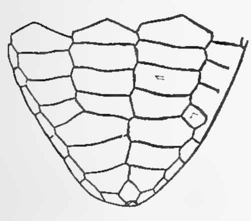
(Page 353.)

I had overlooked the fact that the name HOLOCYSTIS had been proposed by LONSDALE for a genus of corals. The difference of the terminal syllable has in many cases been regarded as a sufficient distinction, and is perhaps preferable to adopting a new name. Should it be objected to, however, I propose the name MEGACYSTITES.

ICHTHYOCRINUS SUBANGULARIS, HALL.

(Page 367.)

The following figure, from a specimen kindly loaned me by Prof. MARCY, and which I suppose to have been used in the description of *I. corbis*, shows the form and arrangement of the plates of the base and



and lower parts of the rays, differing in no essential particular from specimens I have identified with *I. subangularis*.* The suture lines of this specimen had been marked with pencil, previous to coming into my hands, and it shows distinctly the *series of three radial plates as well as subradials.* The specimen from which my description and figure of *I. subangularis* was made (Plate xi, fig. 15, of this paper), is from Bridgeport. It preserves the substance of the plates, and is more fit for comparison of external characters than internal casts alone.

Besides the specimen used for the diagram, there is, in the collection of Prof. MARCY, another one which equally shows the structure of the

* The basal plates proper of ICHTHYOCRINUS have heretofore been shown by me to be undeveloped externally, or are covered by the summit of the column; and the lower plates, shown on the exterior of the calyx, are properly subradials, the basals being too minute for representation.

base, first and second radials. Both specimens are casts of the interiors of the fossil, and show not only the real structure, but the obscurely angular form of the lower part of the body.

Actinocrinus (Saccocrinus) whitfieldi, Hall.

(Page 370.)

An examination of the figure, and a subsequent examination of a specimen labelled *Megistocrinus marcouanus*, in Prof. Marcy's collection, and which appears to have been the original of the figure given, leaves no doubt regarding its identity with *A. whitfieldi*. The bifurcations of the rays take place in precisely the same manner in the two individuals; and differences as great as those indicated in the plates and form of the body, can be detected between many of the individuals from Waldron, and are of no specific importance. Prof. W. points out a difference in the number of interradial plates, stating that they are always less than fifteen. But in the two interradial areas of his specimen which show plates, on either of them can be counted fifteen plates, or even more than this number, if we enumerate the smaller ones in the upper part of the area. In one of the areas, sixteen plates can be distinctly counted.

Megistocrinus infelix, W. & M., is only a smaller individual of the preceding species, possessing all the characters of the Waldron specimens and none others. The number of interradial plates may appear less, as those of the upper part of the area are too small to be counted in a cast of the interior, especially since this cast is very indistinctly preserved in some of its parts. The constrictions of the interradial and anal areas between the arm-bases is a character common to all the Waldron specimens, when preserving the margin of the dome. This feature is well shown in *Saccocrinus speciosus*,* figured by Rœmer. The bifurcation of the rays take place at the same height as in the Waldron species of the same size; the ridges along the radial series are subject to much variation, but these differences are of no specific value. Both Prof. Winchell's figure and specimen leave no doubt of the identity of this form with *Actinocrinus whitfieldi*.

Megistocrinus necis, W. & M. The specimen communicated by Prof. Winchell, under this name, I should regard as *A.* (*S.*) *whitfieldi* with the summit unusually constricted, but showing no marks of specific distinction.

* The fossil referred by Dr. Rœmer to *Saccocrinus speciosus* is probably not of that species, but more likely identical with the Waldron species.

Pentamerus (Pentamerella) ventricosus, Hall.

(Page 382.)

I am inclined to regard the *P. chicagoensis* of W. & M., as only an extravagant form of the above species. Their figure gives five plications on each side, while the specimen (quite imperfect) shows two strong ones in the centre, a much smaller one adjacent on the side; and outside of this a broad, low elevation, while the third one is not defined by any depression between it and the margin of the shell.

Avicula undata, Hall.

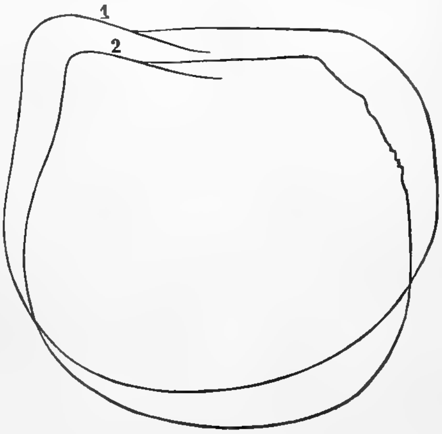
(Page 384.)

This is not to be regarded as a true Avicula, but as having characters so nearly identical with those of that genus, that this reference seemed more proper than any other. The species is *not* a Pterinea. It has one small anterior tooth in each valve; and an oblique posterior tooth, with a second shorter one in the right valve. The muscular scar is large and subcentral. These characters appear to me more nearly those of Avicula than of Pterinea. The teeth are correctly described by Prof. Winchell as "posterior, linear, diverging teeth," which are quite oblique at the posterior extremity.

Amphicœlia leidyi, Hall.

(Page 387.)

The hinge structure of this species will not sanction its reference to Pterinea, made by Profs. Winchell and Marcy. The striated hinge-plate mentioned by them, and which I have seen through the kindness of Prof. Marcy, appears as if oblique or expanding outward, giving space for a strong external ligament, while the large pit beneath the beaks does not ally it very nearly with Pterinea; and until we know more about it, I shall leave it under its proposed generic name of Amphicœlia, though it is scarcely worth while to seek any relation to Leptodomus. In regard to identity with *P. neglecta*, I have been inclined to the opinion that there may be two species of this genus in



the rocks of Wisconsin and Illinois; numerous specimens presenting differences of outline, which are easily recognizable. The accompanying outline figures are, 1, copied from the figure given by M'Chesney of *Ambonychia neglecta;* and 2, from *Amphicœlia leidyi.* It may require farther comparison, with larger collections, to demonstrate the identity or difference of these forms.

Platyostoma niagarensis, Hall.

(Page 390.)

Platyceras campanulatum, W. & M., seems to be only one of the many phases assumed by the above species, in its wide geographical distribution.

Porcellia senex, Winch. and Mar.

"Shell small, consisting of one and a half or two very rapidly enlarging, detached whorls, which are somewhat oblique in the young shell, but afterwards continue very nearly in one plane. Toward the aperture the shell is flattened and subnodulous on the dorsum."

The specimen is a cast of the interior of a Platyceras, closely allied to *P. niagarensis;* and the spire is oblique throughout its entire extent, the two sides of the shell being nowhere symmetrical. There are a few undulations on the back, from inequalities of growth at the aperture, which has been deeply sinuate; but there is no evidence of the narrow carina on the dorsum, or slit at the aperture, characteristic of Porcellia.

Pleurotomaria halei, Hall.

(Page 392.)

Notwithstanding the fact that Prof. Winchell has identified *P. axion* as the species he referred to *P. halei*, the specimens which he sent to me under the latter name are not of that species, but of *Pleurotomaria* (*Trochonema?*) *pauper*. In Prof. Marcy's collection there are numerous specimens of the latter species, and one fine cast of *P. halei;* but neither in this collection, nor in that sent by Prof. Winchell, is there any specimen of *P. axion.*

Subulites ventricosus, Hall.

(Page 398.)

Subulites brevis, W. & M., may prove a distinct species. Should the want of symmetry be found a constant feature, the specific distinction should be maintained.

Orthoceras annulatum, Sowerby.

(Page 411.)

Prof. Winchell, in referring specimens of the above species to the *O. nodocostum* of M'Chesney,* says, "No annular striæ can be seen on our specimens. The longitudinal ridges are barely discernible on the shell, and leave no trace upon the cast." The figure of Mr. M'Chesney represents annular striæ upon his specimens, and I have never seen the shell without these markings; and the casts, or partial casts, usually show the longitudinal ridges more distinctly than the shell.

I have received from Prof. Winchell a gutta-percha cast, under the name *O. nodocostum;* and I have likewise had an opportunity of examining, in Prof. Marcy's collection, the matrix from which this cast was taken. This matrix, although obscured by the crystalline matter which has taken the place of the shell, nevertheless preserves the marks of annular striæ, quite as distinctly as it does the longitudinal ridges or nodes.

Illænus armatus, Hall.

(Page 418.)

Specimens communicated by Prof. Winchell under the name of *Illænus worthenanus*, are the glabellæ of the above species, and one part of a glabella of Ceraurus with hypostoma attached, which is probably the hypostoma described on page 105, vol. i, *Mem. Bost. Soc. Nat. Hist.* The pygidium accompanying these, under the same name, is apparently the one described on page 105, and belongs to *I. armatus.* In the collections of Prof. Marcy there are several glabellæ and imperfect heads of *I. armatus*, and a very good head of *I. insignis;* all of which were communicated under the name *Illænus worthenanus.*

Lichas pugnax, Winch. and Mar.

The representation of the pygidium by Prof. Winchell is very unfortunate. The third or posterior annulation of the figure is the anterior

* *O. nodicostatum*, as corrected in Transactions of the Chicago Academy of Sciences.

one of the axis. The two anterior annulations of the figure do not belong to the pygidium, and do not exist in the specimen ; nor is there anything resembling them. The anterior margins of the lateral lobes, as well as the anterior border of the single annulation, clearly show the limits of the pygidium in that direction. The left lateral lobe should be carried a little higher at the axial furrow, and the right side be continued in a similar manner, leaving off the two anterior rings of the axis. This condition is clearly shown in the original specimen.

III. LIST OF FOSSILS OF THE NIAGARA GROUP, OCCURRING IN THE WISCONSIN, ILLINOIS AND IOWA LIMESTONES.

FORAMINIFERA.

Receptaculites hemisphæricus, HALL. Geolog. Report of Wisconsin. 1861.
R. infundibulus, HALL. Id. pa. = *Ischadites tessellatus*, WINCH. & MAR.†

ZOÖPHYTA.

Diplophyllum cæspitosum, HALL. Pal. N. Y., II, p. 116, pl. 33, fig. 1.
Favosites favosa, GOLD. Pal. N. Y., II, p. 126, pl. 34 bis., fig. 5.
F. gothlandica ? = F. niagarensis, HALL.
F. niagarensis, HALL. Pal. N. Y., II, p. 125, pl. 34 bis., fig. 4 a, b.
F. striata, SAY, in Amer. Jour. Sci., VII., p. 381 = ? F. favosa, GOLD.
F. venusta (HALL), WINCH. & MAR.
Halysites catenulatus, LINN.
H. macrostylis, HALL. Pal. N. Y., II, p. 135, pl. 362, fig. 2.
Heliolites pyriformis, GUETT. Pal. N. Y., II, p. 133, pl. 36 A, fig. 1.
*Petraia calicula (HALL) = *Streptelasma calicula*, HALL. Pal. N. Y., II, p. 111, pl. 32, fig. 1.
Stromatopora concentrica, GOLDF.
*Zaphrentis turbinatum (HALL) = *Polydilasma turbinatum*, HALL. Pal. N. Y., II, p. 112.

BRYOZOA.

*Cladopora fibrosa, HALL. Pal. N. Y., II, p. 139.
*C. lichenoides, WINCH. & MAR.
C. reticulata, HALL. Pal. N. Y., II, p. 141, pl. 39, fig. 3.
*C. seriata, HALL. Pal. N. Y , II, p. 137.
*C. verticillata, WINCH. & MAR.
Fenestella elegans, HALL. Pal. N. Y., II, p. 164.
*Lichenalia concentrica, HALL. Identified by WINCH. & MAR.
Polypora incepta, HALL. Pal. N. Y., II, p. 167.
*Stictopora punctipora, HALL. Identified by WINCH. & MAR.

ECHINODERMATA.

Actinocrinus (Saccocrinus) semiradiatus, HALL.
A. (Saccocrinus) whitfieldi, HALL, = *Actinocrinus christyi*, HALL.
Apiocystites imago, HALL.
Caryocrinis ornatus, SAY. (Pl. xi, fig. 17 of this Report.)
Crinocystites chrysalis, HALL.
Cyathocrinus cora, HALL.
C. pusillus, HALL, = *Lecanocrinus pusillus*, WINCH. & MAR.
C. waukoma, HALL.
Echinocystites nodosus, HALL.
Eucalyptocrinus cælatus, HALL. Pal. N. Y., II, p. 210, pl. 47, fig. 4.
*E. chicagoensis, WINCH. & MAR.
E. cornutus, HALL.
E. cornutus var. excavatus, HALL.
E. crassus, HALL.
Eucalyptocrinus obconicus, HALL.
E. ornatus, HALL.

* Species which have not come under the observation of the writer.
† In the *Memoirs of the Boston Society of Natural History*, vol. i, 1865; as also the subsequent citations of same authors.

Glyptaster occidentalis, HALL.
G. pentangularis, HALL.
Glyptocrinus armosus (M'CHESNEY), = *G. siphonatus*, HALL.
*G. carleyi, HALL. Trans. Alb. Ins., IV, p. 203. Identified by WINCH. & MAR.
G. nobilis, HALL.
Gomphocystites clavus, HALL.
G. glans, HALL.
G. tenax, HALL.
Hemicosmites subglobosus, HALL.
Holycystites abnormis, HALL.
H. alternatus, HALL.
H. cylindricus, HALL.
H. ovatus, HALL.
H. scutellatus, HALL.
H. sphæricus, WINCH. & MAR.
H. winchelli, HALL.
Ichthyocrinus subangularis, HALL, = *I. corbis*, WINCH. & MAR.
Lampterocrinus inflatus, HALL.
Macrostylocrinus striatus, HALL.
Megistocrinus marcouanus, WINCH. & MAR., = Actinocrinus (Saccocrinus) christyi, HALL.
M. infelix, WINCH. & MAR., = *M. marcouanus*, WINCH. & MAR.
M. necis, WINCH. & MAR = Actinocrinus (Saccocrinus) christyi, HALL.
Melocrinus verneuili (TROOST), HALL, = *Actinocrinus obpyramidalis*, WINCH. & MAR.
Rhodocrinus? rectus, HALL, = *Crinocystites? rectus*, HALL.
R. (Lyriocrinus) sculptilis, HALL.
Turbinocrinus verneuili, TROOST, = Melocrinus verneuili (TROOST), HALL.

BRACHIOPODA.

Atrypa nodostriata, HALL. Pal. N. Y., II, p. 272.
A. reticularis, LINN.
Meristina nitida (HALL), = *Atrypa nitida*, HALL. Pal. N. Y., II, p. 268.
Obolus conradi, HALL.
Orthis elegantula, DALMAN.
O. flabellites, HALL.
O. hybrida, SOWERBY.
Pentamerus arcuosus,† M'CHESNEY, = ? P. ventricosus, HALL.
*P. crassoradius,† M'CHESNEY. New Pal. Fossils, p. 87. 1861.
P. multicostatus, HALL.
P. oblongus, SOWERBY, Silurian System, = *P. bisinuatus*, M'CHESNEY.
P. occidentalis, HALL. Pal. N. Y., II, p. 341.
P. trisinuatis, M'CHESNEY. New Pal. Fossils, = Athyris ? p. 86.
P. (Pentamerella) ventricosus, HALL, = ? *P. chicagoensis*, WINCH. & MAR.
Rhynchonella cuneata, DALMAN.
R. neglecta, HALL. Pal. N. Y., II, pp. 70, 274.
*Spirifera crispa, SOWERBY.
S. eudora, HALL.
S. gibbosa, HALL.
S. meta, HALL.
S. niagarensis, CONRAD; in Jour. Acad. Nat. Sci. Phil., VIII, p. 261.
S. nobilis, BARRANDE, = *S. inconstans*, HALL; *S. racinensis*, M'CHESNEY.
S. plicatella var. radiata, SOWERBY.
S. similior, WINCH. & MAR., = Pentamerus.
Strophomena rhomboidalis, WAHL.
Strophodonta profunda, HALL. Pal. N. Y., II, p. 61, = *Strophomena niagarensis*, W. & M.
S. semifasciata, HALL; in Trans. Alb. Ins., IV, p. 210, = *Strophomena macra*, W. & M.
Trematospira matthewsoni, M'CHESNEY; New Pal. Fossils, p. 71. 1860.

† In a revision of his paper, Mr. M'CHESNEY has omitted these two species of Pentamerus as well as others of his previously described forms, without giving any explanation for so doing.

LAMELLIBRANCHIATA.

Ambonychia acutirostra, HALL, = *A. mytiloides*, HALL.
A. aphea, HALL.
Amphicœlia leidyi, HALL = ? Ambonychia neglecta, M'CHESNEY.
Avicula emacerata, CONRAD. Pal. N. Y., II, p. 282.
A. undata, HALL. Pal. N. Y., II, p. 283.
Conocardium niagarensis, WINCH. & MAR.
C. ornatum, WINCH. & MAR.
Cypricardinia arata, HALL.
Cypricardites ? quadrilatera, HALL.
Edmondia nilesi, WINCH. & MAR., = ? Modiolopsis nilesi.
Modiolopsis dictæus, HALL.
M. rectus, HALL, = *Cleidophorus macchesneyanus*, WINCH. & MAR.
M. subulatus, Hall.
Palæocardia cordiiformis, HALL.
Pterinea brisa, HALL.
*P. cyrtodontoides, WINCH. & MAR.
*P. revoluta, WINCH & MAR., = ? P. striæcosta, M'CHESNEY.
P. volans, WINCH. & MAR.

GASTEROPODA.

Bucania angustata, HALL.
B. chicagoensis, M'CHESNEY, New Pal. Fossils, p. 69. 1860.
B. crassolare, M'CHESNEY, New Pal. Fossils, p. 91. 1861.
B. pervoluta, M'CHESNEY, New Pal. Fossils, p. 91. 1861.
Cyclonema ? elevata, HALL.
Eunema ? trilineata, HALL.
*Holopea chicagoensis, WINCH. & MAR.
H. guelphensis, BILLINGS.
H. harmonia ? BILLINGS.
*H. niagarensis, WINCH. & MAR.
Loxonema leda, HALL.
Murchisonia conradi, HALL.
M. hercyna ? BILLINGS.
M. laphami, HALL.
**Platyceras campanulatum*, WINCH. & MAR., = Platyostoma niagarensis, HALL.
*P. niagarensis, HALL, = *Acroculia niagarensis*, HALL. Pal. N. Y., II, p. 288.
Platyostoma niagarensis, HALL. Pal. N. Y., II, p. 287.
Pleurotomaria axion, HALL.
P. gonopleura, WINCH. & MAR.
P. halei, HALL.
P. ***halei***, WINCH. & MAR., = Trochonema (Cyclonema ?) pauper, HALL.
P. (Trochonema) hoyi, HALL.
P. idia, HALL.
*P. sigaretoides, WINCH. & MAR.
Porcellia senex, WINCH. & MAR., = Platyceras.
Straparollus mopsus, HALL.
Subulites ventricosus, HALL, = ***S. brevis***, WINCH. & MAR.
Tremanotus alpheus, HALL, = ***Bellerophon*** (***Bucania***) ***perforatus***, WINCH. & MAR.
Trochonema (Eunema) fatua, HALL.
T. (Cyclonema ?) pauper, HALL.

CEPHALOPODA.

Cyrtoceras brevicorne, HALL.
C. dardanus, HALL.
C. fosteri, HALL.
C. hercules (WINCH. & MAR.) = ***Lituites hercules***, WINCH. & MAR.

Cyrtoceras laterale, HALL.
C. lucillum, HALL.
C. pusillum, HALL.
C. rigidum, HALL.
Gomphoceras scrinium, HALL, = *G. marcyæ*, WINCH. & MAR.
G. septoris, HALL.
Lituites marshii, HALL.
Nautilus capax, HALL, = *Lituites capax*, HALL.
N. occidentalis, HALL.
Oncoceras orcas, HALL.
Orthoceras abnorme, HALL.
O. alienum, HALL.
O. angulatum, HALL.
O. annulatum, SOWERBY.
*O. cameolare, M'CHESNEY. New Pal. Fossils. 1861.
O. columnare, HALL, = *O. scammoni*, M'CHESNEY. New Pal. Fossils. 1861
O. crebescens, HALL.
*O. hoyi, M'CHESNEY. New Pal. Fossils. 1861.
*O. laphami, M'CHESNEY. New Pal. Fossils. 1861.
*O. lineolatum, M'CHESNEY. New Pal. Fossils. 1861.
O. loxias, HALL.
O. medullare, HALL.
O. niagarense, HALL.
*O. woodworthii, M'CHESNEY, = *O. irregulare*, M'CHESNEY.
Phragmoceras nestor, HALL.
Trochoceras (Gyroceras) bannisteri, WINCH. & MAR.
T. costatum, HALL.
T. desplainense, M'CHESNEY. New Pal. Fossils. 1860.
T. notum, HALL.

CRUSTACEA.

Acidaspis danai, HALL.
Bronteus acamas, HALL, = *Bronteus occasus*, WINCH. & MAR.
Calymene blumenbachii var. niagarensis, HALL.
Ceraurus niagarensis, HALL.
Dalmania vigilans, HALL.
Encrinurus nereus, HALL.
Illænus armatus, HALL.
I. cuniculus, HALL.
I. imperator, HALL.
I. insignis, HALL, = ? *I. worthenanus*, WINCH. & MAR.
I. (Bumastus) ioxus, HALL.
Lichas breviceps? HALL.
*L. decipiens, WINCH. & MAR.
L. obvius, HALL.
L. pugnax, WINCH. & MAR.
Sphærexochus romingeri, HALL.
Leperditia fonticola, HALL.

INDEX.

INDEX

TO FOSSILS DESCRIBED OR NOTICED IN THIS VOLUME.

[The heavier figures indicate a description or figure; the lighter, a notice or reference.]

ERRATA.

Page 65, line 7, for HAYDON read HAYDEN.
Page 143, line 1, for (G) read (*Ga.*)
Page 164, line 33, for *Euursalicis-nodus* read *Euura salicis-nodus.*
Page 174, line 16, for *melia* read *melie.*
Page 175, line 5, for *similis* read *semele.*
Page 195, line 22, for *ræmingeri* read *ræmingeri.*
Page 213, line 18, for cforms, read forms.
Page 220, line 14, for *atennarius* read *antennarius.*
Page 224, line 6, for *clitonensis* read *clintonensis.*
Page 226, line 22, for *anttennarius* read *antennarius.*
Page 258, line 1, for GRAPTOLITDÆ read GRAPTOLITIDÆ.
Page 261, line 20, for *clintoni* read *clintonensis.*
Page 282, line 1, insert a comma after STROPHALOSIA.
Page 300, line 26, for *globistriata* read *glabristria.*
Page 300, line 26, for *deroissyi* read *deroysii.*
Page 309, line 25, for *nigrescens* read *nigricans.*
Page 339, lines 22, 28, for PALECHINUS r'd PALÆCHINUS.
Page 367, line 26, for *Icthyocrinus* read *Ichthyocrinus.*
Page 371, line 19, dele *Saccocrinus christyi* =.
Page 378, line 34, for LINDSTROM read LINN.
Page 380, line 29, for PLATE VIII read PLATE XIII.
Page 395, line 28, *for* identified *read* designated.
Page 444, line 9, *for* L. melia *read* L. melie.
Page 444, line 20, *for* O. similis *read* O. semele.

PLATES AND EXPLANATIONS.

PLATE 1.

[The figures of Plates i, ii, iii and iv, with two exceptions, are taken from Decade ii, of Figures and Descriptions of *Canadian Organic Remains*, and are illustrations of both Canadian and New York species.]

GRAPTOLITHUS CLINTONENSIS, HALL.

(Palæontology of New York, Vol. ii, page 39.)

Figures 1, 2 *and* 4 *are enlarged to six diameters, and fig.* 3 *to nine diameters.*

FIG. 1. A fragment from near the base of the stipe, where the cellules are less developed than those of fig. 2, and of a different form from those of the other specimen figured. The cellules are partially filled with mineral matter and have an angular form.

" 2. A lateral view of a part of a mature stipe, showing the form of the cellules, and the recurved extremities, causing the apertures to open downwards. The specimen is filled with mineral matter.

" 3. A front view of a part of the same stipe, showing the lateral extent of the cell-bases and the expansion at the aperture.

" 4. A dorsal view of the same, showing a groove which indicates the place of the solid axis.

DICTYONEMA GRACILIS, HALL.

" 5. A branch of *Dictyonema gracilis*, showing the serrated margin indicating cell-apertures (enlarged six diameters).

DIPLOGRAPTUS WHITFIELDI, HALL.

Figures 6–10 *are of natural size; fig.* 11 *is enlarged to two diameters.*

FIG. 6. A celluliferous stipe, with a few partially developed reproductive sacs in the upper part.

" 7. A stipe where the sacs are more fully developed.

" 8. A stipe with numerous reproductive sacs, some of which have apparently become dehiscent, and exhibit numerous extremely slender fibres. In connection with one of these sacs there are two minute germs, one of them lying beneath the sac, and the other just beyond its outer margin and barely separated from its fibres. See fig. 11.

" 9. A stipe with a few of the sacs remaining, and the bases of some others which have apparently been broken off. One of these sacs appears to be attached to the axis above the cellules, and lying beneath the axis.

" 10. A stipe from which the reproductive sacs have been removed (by maceration), showing only the marginal fibres by which they were attached to the axis in their extension beyond the cellules.

" 11. An enlargement of a single sac, from fig. 8, showing the position of the two germs.

GERMS OF GRAPTOLITES.

The figures (except 15) *are Germs of Graptolites, enlarged to six diameters.*

FIG. 12. A germ of a biserrate form, before the cellules have assumed distinctive shape. The axis is extended, and the common envelope spreads on both sides in the lower part; the cœnosarc embracing the lateral processes, which are seen at the base of most of the diprionidian forms, and extending along one side of the axis above.

" 13. A form similar to fig. 12, a little further advanced, where the lower cellules have begun to assume their proper form.

" 14. Another form of germ resembling *G. ciliatus;* the ciliated processes are visible beyond the limits of the sac, but the cellules appear not to have assumed definite form.

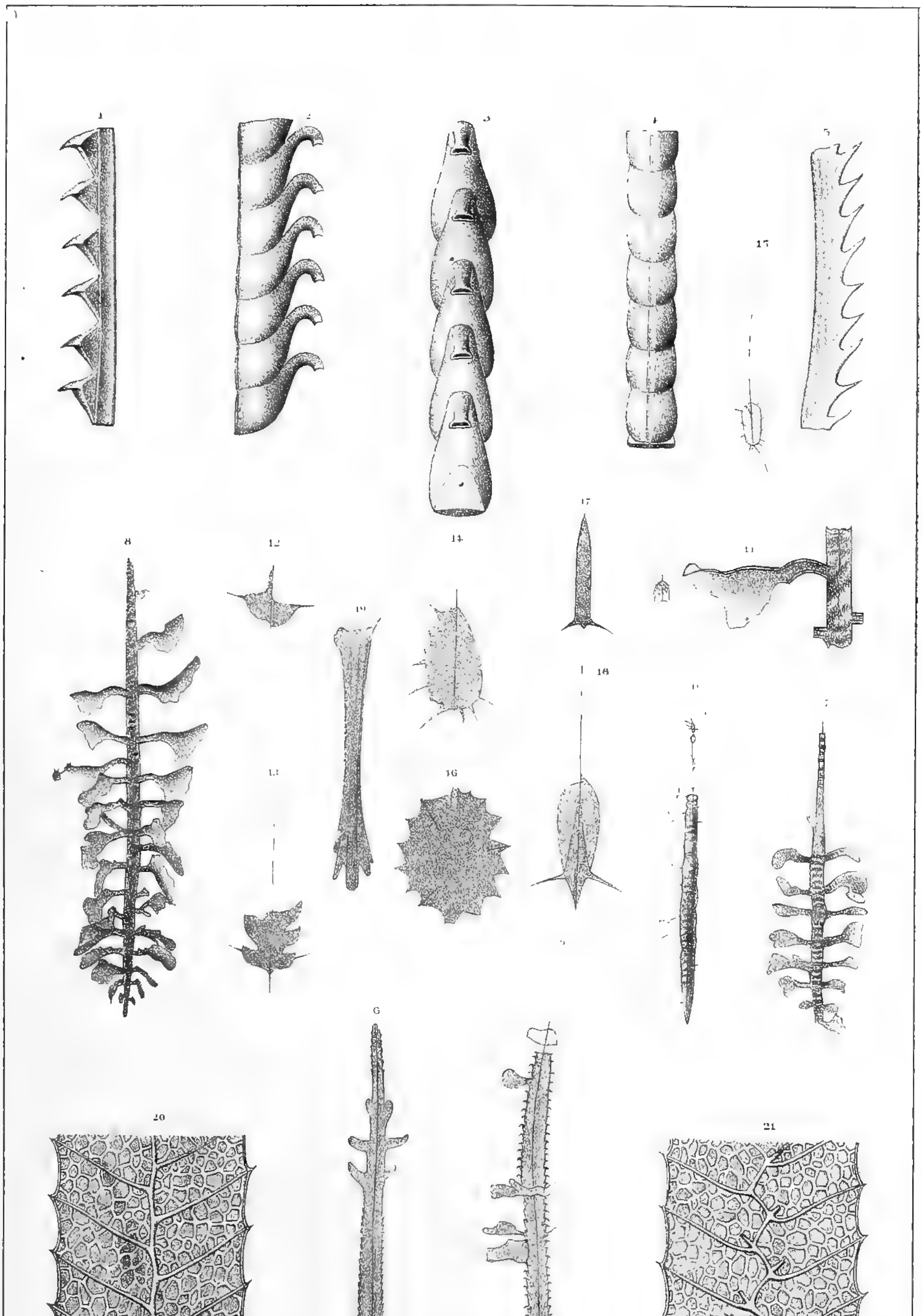
" 15. A young individual of *G. ciliatus* (natural size).

" 16. A discoid germ. This may be the central disc of a compound form of a Graptolite.

" 17. A germ showing the common body extended on the two sides of the axis, but without any visible or apparent cellules.

" 18. A germ where the common body or sac is much expanded on the two sides of the axis, and the central portion is apparently becoming more solid.

" 19. A germ where the solid axis is on one side; the species probably belongs to the monoprionidian type.



R. P. Whitfield, del.

Swinton, lith

PLATE I—Continued.

Retiolites venosus, Hall.

(Palæontology of New York, Vol. ii, page 40.)

Figures enlarged to nine diameters.

Fig. 20. The exterior of the convex? side, showing the external axis and cell partitions, with the intermediate reticulate texture.

" 21. Another view, apparently from the interior, showing an undulating or zigzag axis, with cylindrical processes extending to the margins, and short, apparently broken, processes directed obliquely upwards. The reticulate texture is not essentially different from that of the other side.

PLATE II.

CLIMACOGRAPTUS TYPICALIS, HALL.

Figures 1–8 *are enlarged to six diameters. The specimens have the common canal filled with mineral matter, so that they are fully distended, except fig.* 8, *which is partially flattened by compression.*

FIG. 1. A lateral view of the concave side, with the surface entire, showing the form of the cell-apertures.

" 2. A profile of the same; showing the entire form of the cell-apertures.

" 3. Lateral view of a fragment, where the surface is exfoliated, showing the cell-partitions extending downwards towards the centre.

" 4. A longitudinal section made a little below the exterior surface, showing the cell-partitions extending further towards the interior than in fig. 3.

" 5. A longitudinal section through the centre, showing the cell-partitions reaching to the central axis.

" 6. A transverse section, showing the cell-partitions just within the aperture, and the minute central axis.

" 7. A transverse section made a little lower than in fig. 6, showing the cell-partitions extending across the stipe on one side, and on the other side showing the narrow triangular point near the centre.

" 8. A section made diagonally across a crushed stipe, showing the folding (from pressure) of two cell-divisions on each side of the centre.

" 9. An ideal longitudinal section, showing the form and direction of the cell-partitions and the central axis (enlarged to twelve diameters).

DIPLOGRAPTUS PUTILLUS, HALL.

Figures enlarged to twelve diameters.

FIG. 10. A fragment of a stipe, showing the two ranges of cellules, their form, mode of growth, and the infolding of the exterior test along the line of the central axis.

" 11. A lateral view of the same fragment, showing the cell-apertures, the flattening of the exterior of the base of the next cellules in advance, and the greater breadth of the cellules at the bases.

" 12. A longitudinal section through the centre of the stipe, showing the double cell-partitions and the double central axis.

" 12*a* A transverse section, cutting one cellule near the aperture, and the other near the base.

CLIMACOGRAPTUS BICORNIS, HALL.

(*Graptolithus bicornis*, Palæontology of New York, Vol. i, page 268, and Geology of Canada, page 200.)

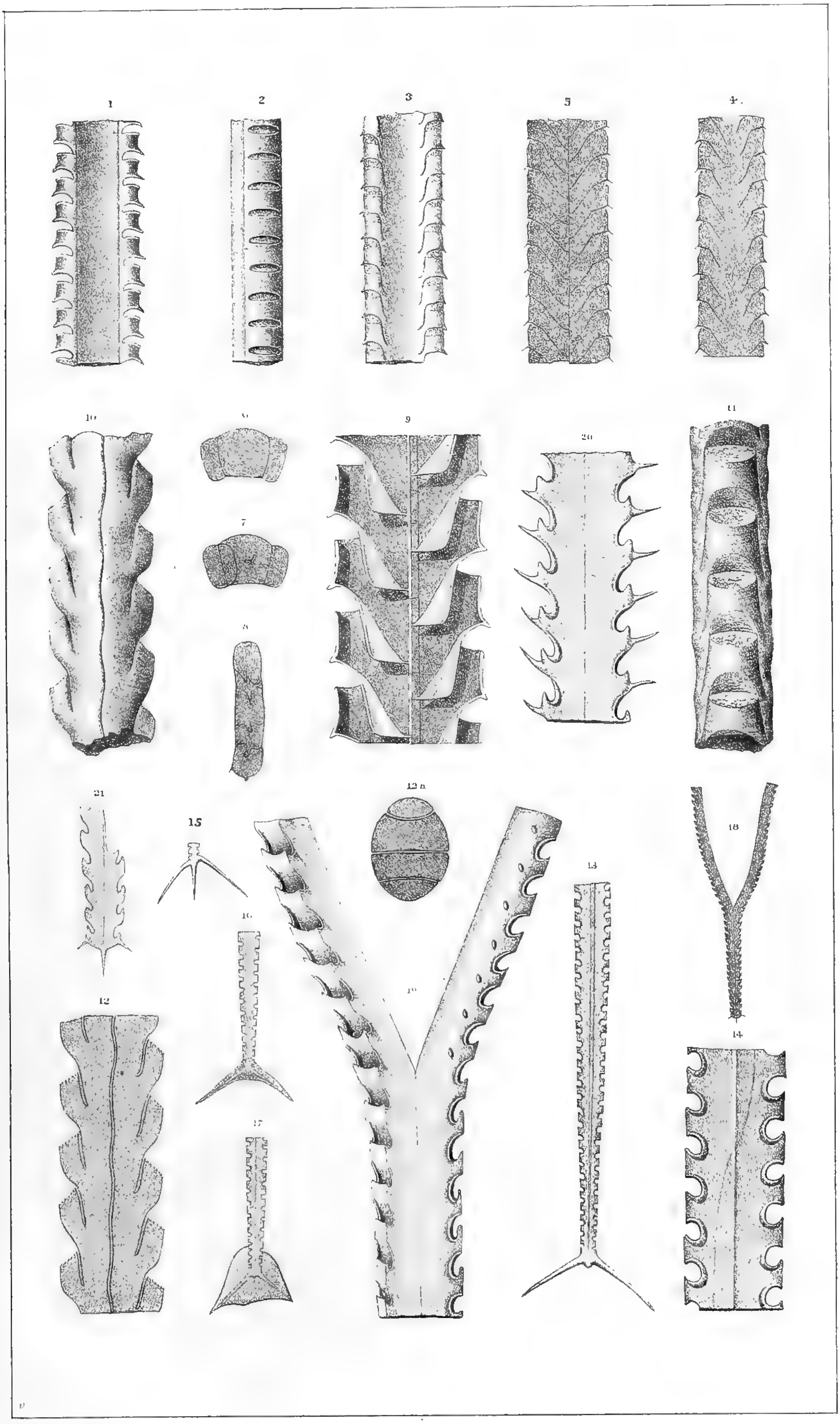
FIG. 13. The lower part of a stipe, enlarged to two diameters, showing the bifurcating process and a central node or initial point.

" 14. An enlargement (to six diameters) of a fragment which preserves in a very perfect manner the borders of the cellules, and shows an undulating central axis as well as the median ridge.

" 15. The base of a specimen, showing three spine-like processes (two diameters).

" 16. The lower extremity of a specimen, showing a partially developed corneous disc (two diameters).

" 17. The lower extremity of another specimen, showing a more complete disc or bulb at the base (two diameters).



R. P. Whitfield, del. Swinton lith.

PLATE II—Continued.

Dicranograptus ramosus, Hall.

(*Graptolithus ramosus*, Palæontology of New York, Vol. 1, page 27, and Geology of Canada, page 200.)

Fig. 18. The lower part of a frond, in which the base is entire, with the bifurcation above (natural size).

" 19. The bifurcating portion, with a part of the simple stipe, showing the cells on one side as they are usually seen when flattened in the slate; or on one portion of this there are oval pustules, a feature sometimes observed in this species. The opposite side gives the appearance of the cellules when flattened and compressed, partially against the aperture (six diameters).

" 20. An enlargement from below the bifurcation, showing the more perfect form of the aperture, with the spines proceeding from the exterior surface above the aperture (enlarged to six diameters).

" 21. A young individual or germ, supposed to be of this species, showing the basal processes and the partially developed cellules at the upper part.

PLATE III.

DIPLOGRAPTUS QUADRIMUCRONATUS, HALL.

FIG. 1. Enlargement of part of a stipe compressed in a slightly oblique direction, still showing the cellules on the two sides.

" 2. Enlargement of a stipe compressed more obliquely, so as nearly to obscure the cellules on one side.

" 3. Enlargement of a specimen compressed vertically to the celluliferous sides of the stipe.

" 4. A diagram representing a theoretical longitudinal section.

" 5. A diagram representing a transverse section of a stipe, with the mucronate extensions of the cell-margins.

DIPLOGRAPTUS AMPLEXICAULE, HALL.

FIG. 6. Enlarged view of the back of a portion of a stipe, showing the form and direction of the cells.

" 7. Enlargement of the inner face, showing the curvature and overlapping of the cells and the quadrangular apertures.

GRAPTOLITHUS NITIDUS, HALL.

FIG. 8. A large specimen, showing the radicle and two stipes, and the pustules at the base of the cellules. The extremities are not quite entire.

" 9. A well preserved small individual, enlarged to three diameters.

GRAPTOLITHUS FLACCIDUS, HALL.

FIG. 10. An enlargement, to three diameters, of the radicle and stipe bases with the cellules.

" 11. A further enlargement of a portion, to show the form of the cellules and the pustuliform appearance at the base of the divisions between them.

GRAPTOLITHUS EXTENSUS, HALL.

FIG. 12. An enlargement of a fragment of a stipe, where the cellules are distended by iron pyrites.

GRAPTOLITHUS BIFIDUS, HALL.

FIG. 13. An individual of ordinary size.

" 14. An enlargement of one of the stipes of another individual, showing the form of serratures, and minute pustules at the base of the cell divisions.

GRAPTOLITHUS FRUTICOSUS, HALL.

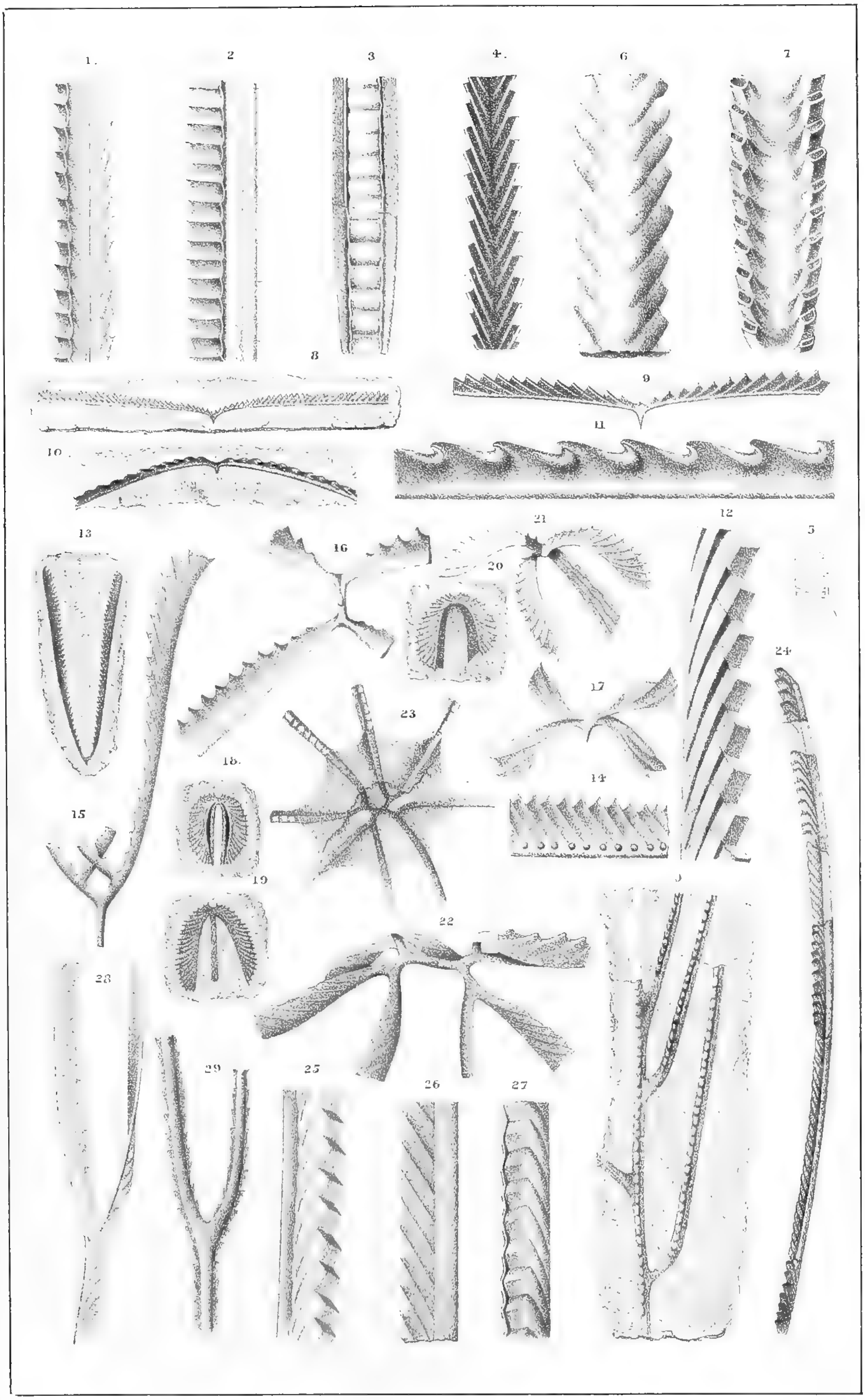
FIG. 15. An enlargement of one stipe, with the bases of the other three, showing the form of cellules and mode of bifurcation in this species.

GRAPTOLITHUS BRYONOIDES, HALL.

FIG. 16. An enlargement of the base of a specimen, showing the initial point, the cell-denticles on one of the stipes, and a proportionately longer funicle than usual.

" 17. An enlargement of a young individual, showing the initial point, funicle, and origin of the four stipes, with a few of the earlier cellules.

GRAPTOLITES.



R. P. Whitfield, del. Swinton, lith

PLATE III—Continued.

GRAPTOLITHUS BIGSBYI, HALL.

These figures are given to illustrate the phases assumed by a four-striped species (TETRAGRAPTUS) *in its different positions and manner of imbedding in the shale.* (*See page* 241.)

FIG. 18. Shows a close arrangement of the parts and the contiguity of the non-celluliferous edges at the apices, which are scarcely separated in the shale.

" 19. Illustrates a common condition of this species, where two of the divisions show the lateral faces, while the non-celluliferous edge of a third division is seen lying nearly vertical in relation to these. The fourth division has been broken off in the separated film of slate.

" 20. A specimen showing the lateral faces of two divisions. Below these, in the shale, are seen the non-celluliferous edges of the two other divisions.

" 21. An enlargement of an individual where the divisions are equally spreading; one of them preserving only the base of the stipe.

GRAPTOLITHUS OCTONARIUS, HALL.

FIG. 22. An enlargement of a specimen much broken and distorted from pressure, showing the mode of bifurcation in this type, where there is no central disc.

GRAPTOLITHUS (LOGANOGRAPTUS) OCTOBRACHIATUS, HALL.

FIG. 23. The central disc and bases of the stipes of a large individual of this species. The original preserves two of the stipes to the length of eight inches, and another to nearly the same extent, while the rest are broken off at less distances from the disc. The figure shows that the bifurcations of the stipes take place within the limits of the disc, and become celluliferous just beyond its margin; also that the disc is composed of two separable layers of substance, enclosing the bases of the stipes between them.

" 24. The extension of one of the stipes of the specimen, fig. 23.

" 25. An enlargement from the stipe, fig. 24, where the substance is obliquely compressed at *a*.

" 26. An enlargement from the same stipe at the point where the substance is laterally compressed at *b*.

" 27. An enlargement from the same stipe at the lower point, looking upon the apertures of the cellules, which are somewhat compressed.

GRAPTOLITHUS FLEXILIS, HALL.

FIG. 28. A portion of a branchlet enlarged, showing one part compressed laterally, with the cellules fully expanded; while the other, on the right hand, is gradually twisted so as to show only the back of the branchlet.

" 29. A bifurcated fragment enlarged; the cellules have been flattened vertically, causing them to be visible in slight indentations on both sides of the axis, giving it the appearance of a DIPLOGRAPTUS. This enlargement is made from a part nearer the centre of the same specimen as fig. 28.

GRAPTOLITHUS RICHARDSONI, HALL.

FIG. 30. The figure shows one of the main stipes of a properly branching species; the original specimen having all the characters of a monoprionidian form of Graptolite, where the stipes are branching and again dichotomous throughout their entire length (= DICHOGRAPTUS, SALTER).

PLATE IV.

PHYLLOGRAPTUS ILICIFOLIUS, HALL.

FIG. 1. An enlarged figure of a compressed specimen, showing the faces of two adjacent folia; the margins being broken away so as to show the cell-openings.

" 2. A specimen of the natural size, where one folium is broken away, not quite so far as the axis, leaving the bases of the cellules visible.

" 3. A specimen compressed in the same manner as figs. 1 and 4; the upper folia have, however, been separated, except the bases of a few of the cellules above the middle of the figure, leaving the other two folia imbedded in the shale, and showing the bases of their cellules ascending from the axis (enlarged to three diameters).

" 4. An enlargement of a specimen which is imbedded obliquely, as in fig. 1, or in a direction as if the theoretical figure 5 were vertically compressed, leaving no visible axis. In the lower half of the specimen the fossil has been separated in the opposite slaty .aminæ, leaving only the impression of that side, which also shows no axis. In the upper half of the specimen the cellules are filled and well preserved, and on the left-hand side the apertures are conspicuous (enlarged to three diameters).

A restoration of the form of ***P. ilicifolius***, showing the four divisions, which are represented as cut through transversely, exhibiting the cell-cavities.

PHYLLOGRAPTUS ANNA, HALL.

FIG. 6. A specimen with the folia obliquely compressed.

" 7. An enlargement of a specimen where the two lateral folia remain, showing the cells of the division which has been broken off in the separated laminæ of the slate. The surface is distinctly striated.

RETIOGRAPTUS TENTACULATUS, HALL.

FIG. 8. An individual of the natural size, with the marginal reticulations nearly entire.

RETIOGRAPTUS EUCHARIS, HALL.

FIG. 9. An illustration of the compound form of the genus, enlarged to four diameters.

DENDROGRAPTUS FRUTICOSUS, HALL.

FIG. 10. A frond which is apparently nearly entire.

DENDROGRAPTUS GRACILIS, HALL.

FIG. 11. An enlargement from one of the branchlets, showing the striate surface and the deep indentation of the cellules.

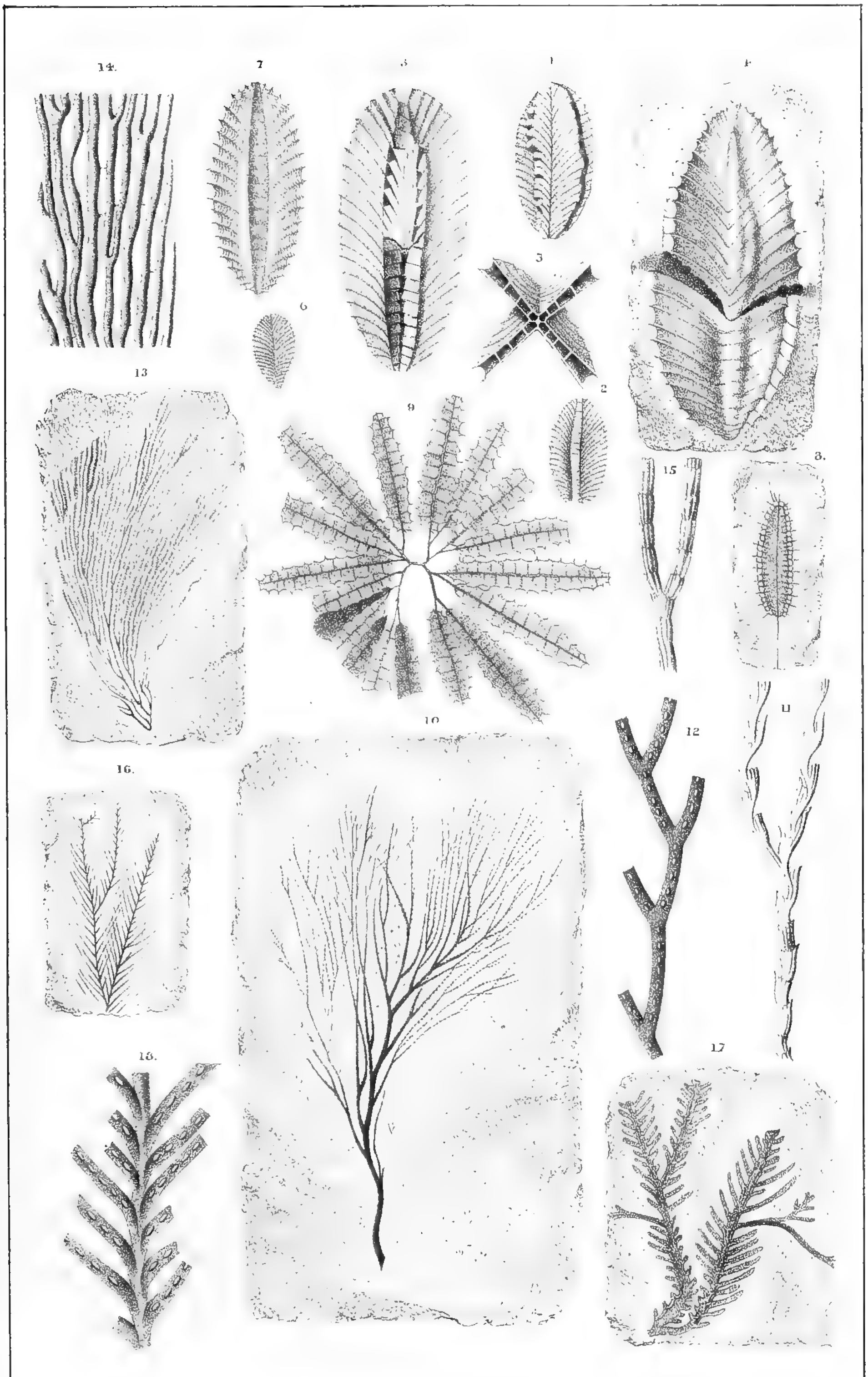
DENDROGRAPTUS ? (CALLOGRAPTUS ?) DIFFUSUS, HALL.

FIG. 12. An enlargement, showing the cell-apertures. All the specimens observed of this species, are extremely compressed.

CALLOGRAPTUS SALTERI, HALL.

FIG. 13. Fragment of frond, showing the non-celluliferous side.

" 14. An enlargement from the non-celluliferous side, showing a few transverse dissepiments at irregular intervals (figure enlarged).



F. P. Whitfield, del. Swinton, lith

PLATE IV—Continued.

Callograptus elegans, Hall.

Fig. 15. An enlargement of the non-celluliferous side of a bifurcating branchlet, showing the striated surface and a semi-articulate structure.

Ptilograptus plumosus, Hall.

Fig. 16. A fragment which is three times branched.

Ptilograptus geinitzianus, Hall.

Fig. 17. A fragment which is irregularly branched, showing the non-celluliferous side.
" 18. An enlargement, showing the cell-apertures.

PLATES V, VI, VII AND VIII.

These plates, intended to illustrate articles V and IX of Contributions to Palæontology, are, together with the papers, omitted from this Report, and will be published in a succeeding one.

PLATE IX.

PALÆASTER SHÆFFERI, HALL.

Page 326.

FIG. 1. Ventral side, showing the ambulacral, adambulacral and marginal ranges of plates.

PALÆASTER MATUTINUS, HALL.

Page 325.

FIG. 2. Dorsal side of a specimen of this species.

PALÆASTER EUCHARIS, HALL.

Page 330.

FIG. 3. Dorsal side of a specimen. *a.* The madreporiform tubercle.
" 3* View of the ventral side.
" 3*a*. An illustration of a single ray, with the centre and bases of the other rays. The letters refer to the parts as follows:
- *a.* Ambulacral plate;
- *p.* The pore;
- *aa.* Adambulacral plate;
- *m.* Marginal plate;
- *tm.* Terminal plate of the marginal series;
- *o.* Oral plates, of which there are five pairs.

" 4. A single ray, deprived of its marginal plates and flattened, showing a great length of the ambulacral plates. In fig. 3*a*, the concavity of the groove produces a shortening of the plates of the ambulacral series. The letters refer to the same parts as those of fig. 3*a*.

PROTASTER FORBESI, HALL.

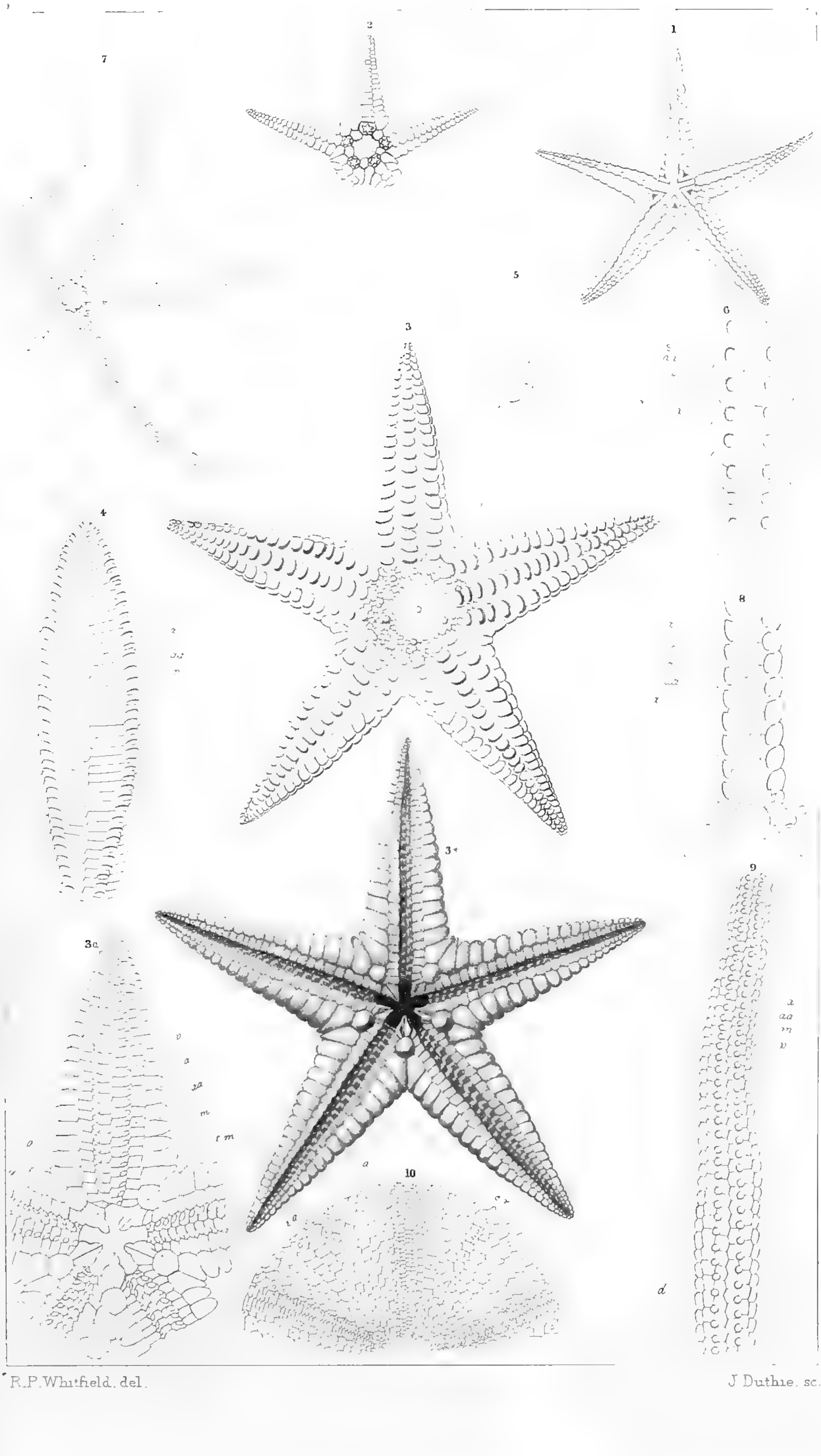
Page 336.

FIG. 5. View of the ventral side in outline; natural size.
" 6 An enlargement of the lower side of a part of one ray, illustrating the parts as follows:
- *o.* Oral plate;
- *p.* The pore;
- *a.* Ambulacral plate;
- *aa.* Adambulacral plate;
- *s.* Spine from anterior end of adambulacral plate;
- *d.* The limit of the circular disc.

EUGASTER LOGANI, HALL.

Page 333.

FIG. 7. Specimen of the natural size.
" 8. A portion of one ray enlarged, with references to the parts as follows:
- *o, o.* The oral plates, of which there are five pairs, the apices of each being apparently joined by a suture to the basal portions.
- *a.* Ambulacral plate;
- *aa.* Adambulacral plate;
- *p.* The pore;
- *s.* The spine;
- *d.* Limit of the disc.



R. P. Whitfield. del. J. Duthie. sc.

PLATE IX—Continued.

Ptilonaster princeps, Hall.

Page 334.

Fig. 9. A part of one ray, showing the ranges of plates, pores, spines, etc.:

d. Limit of the disc;

p. The pore;

a. Ambulacral plate;

aa. Adambulacral plate;

m. Marginal plate with spine attached.

Lepidechinus rarispinus, Hall.

Page 340.

Fig. 10. A portion of a specimen showing three ambulacral areas and two interambulacral areas.

a. The ambulacral area;

ia. The interambulacral area;

cr. Central range of interambulacral plates.

PLATE X.

Actinocrinus (*Saccocrinus*) *semiradiatus*, *Hall.*

Page 370.

Fig. 1. In internal cast of a specimen of this species, showing the characters as described.

Rhodocrinus? rectus, *Hall.*

Page 368.

Fig. 2. View of an interior cast, presenting one of the interradial areas, and two of the radial series.

Glyptaster occidentalis, *Hall.*

Page 369.

Fig. 3. Lateral view of a well preserved cast of this species.

Glyptaster pentangularis, *Hall.*

Page 369.

Fig. 4. An internal cast of this species, preserving the impressions of the plates.

Melocrinus verneuili, *Troost.*

Page 372.

Fig. 5. An internal cast of this species. The constriction between the arms is not quite so deep as in some examples.

Lampterocrinus inflatus, *Hall.*

Page 374.

Fig. 6. Lateral view of a well preserved cast of this species, which preserves the markings of the plates in an unusual degree.

Macrostylocrinus striatus, *Hall.*

Page 371.

Fig. 7. External characters of this species, taken from a gutta-percha cast in the natural mould.
" 8. The internal cast of the same individual.

Glyptocrinus nobilis, *Hall.*

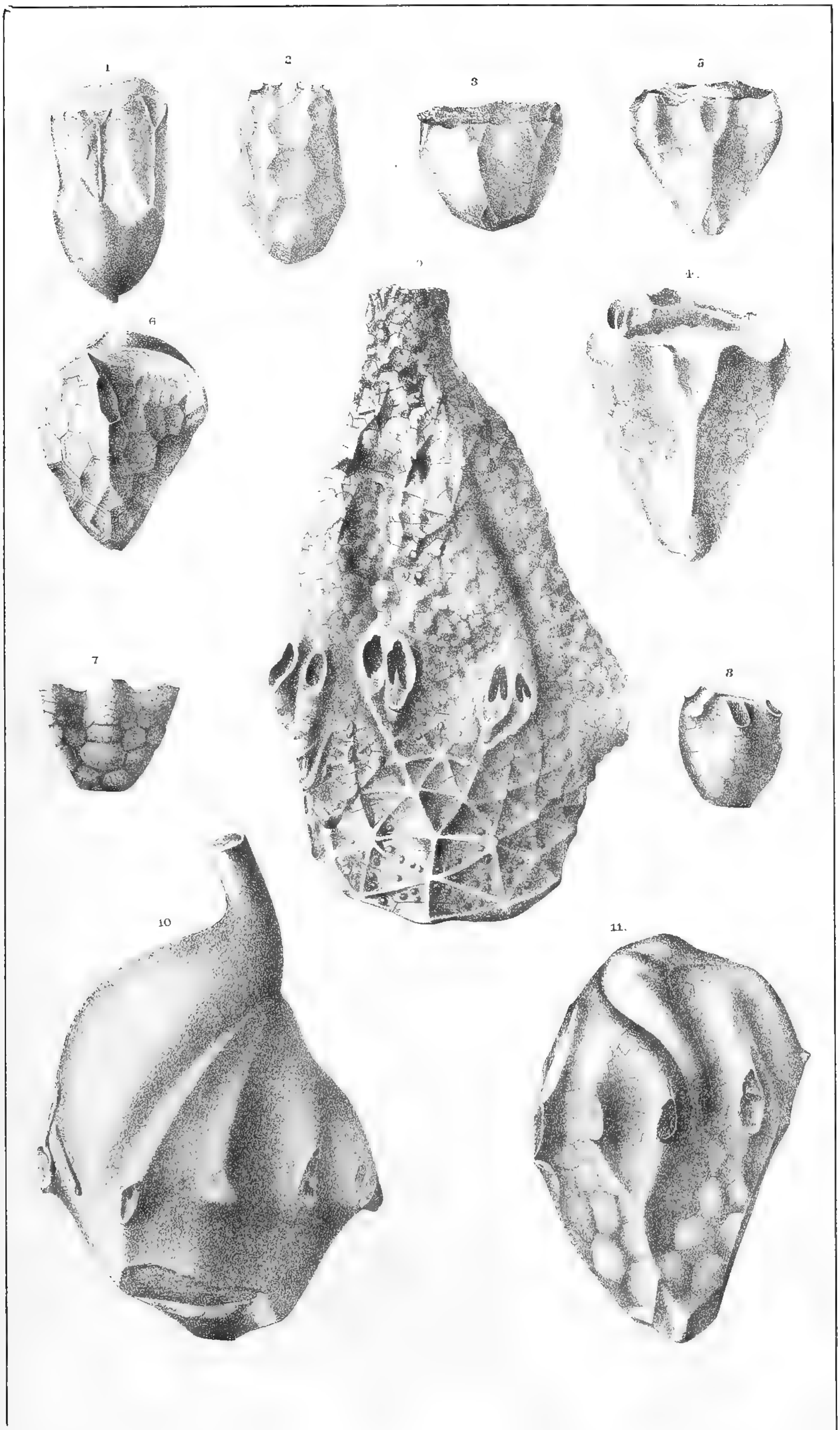
Page 372.

Fig. 9. A view of the external surface as obtained from an impression in the natural mould.
" 10. Lateral view of an internal cast of this species. The base has been broken off.

Glyptocrinus armosus, *M'Chesney.*

Page 373.

Fig. 11. Lateral view of an unusually well preserved internal cast, on which the boundaries of the plates are well marked. The similarity in general form between this species and *G. nobilis* is very remarkable, the conspicuous difference in the cast being the strong elevated proboscis in the latter; while in the former the organ occupying this position curves backwards, lying close upon the summit, and is directed downwards to the line of the arm-bases.



R.P. Whitfield, del Swinton, lith

PLATE XI.

Eucalyptocrinus obconicus, Hall.

Page 365.

Fig. 1. Lateral view of a specimen of this species, showing the structure of the body and first bifurcation of the rays.

Eucalyptocrinus crassus, Hall.

Page 365.

Fig. 2. Lateral view of a well preserved cast of this species, which shows the structure of the body in a very satisfactory manner.

" 3. Basal view of the same specimen as fig. 2.

Eucalyptocrinus ornatus, Hall.

Page 366.

Fig. 4. Basal view of the calyx of a specimen of this species. The figure is from a gutta-percha impression taken in the natural mould of the exterior, and shows the surface markings of the plates.

" 5. View of an internal cast of this species, of large size, which preserves the impressions of the lines of growth of the plates.

Eucalyptocrinus cornutus, var. *excavatus*, *Hall.*

Page 364.

Fig. 6. Basal view of an internal cast of this species, showing the deeply excavated base.

" 7. Lateral view of the same specimen as fig. 6.

Eucalyptocrinus cornutus, Hall.

Page 363.

Fig. 8. Shows the cavity left in the rock by the solution of the substance of the crinoid. The inside of the cavity is occupied by the cast of the interior of the cup of the specimen.

Figs. 9, 10. Basal and lateral views of a gutta-percha cast made in the natural mould left by the removal of the substance of the crinoid.

Cyathocrinus waukoma, Hall.

Page 367.

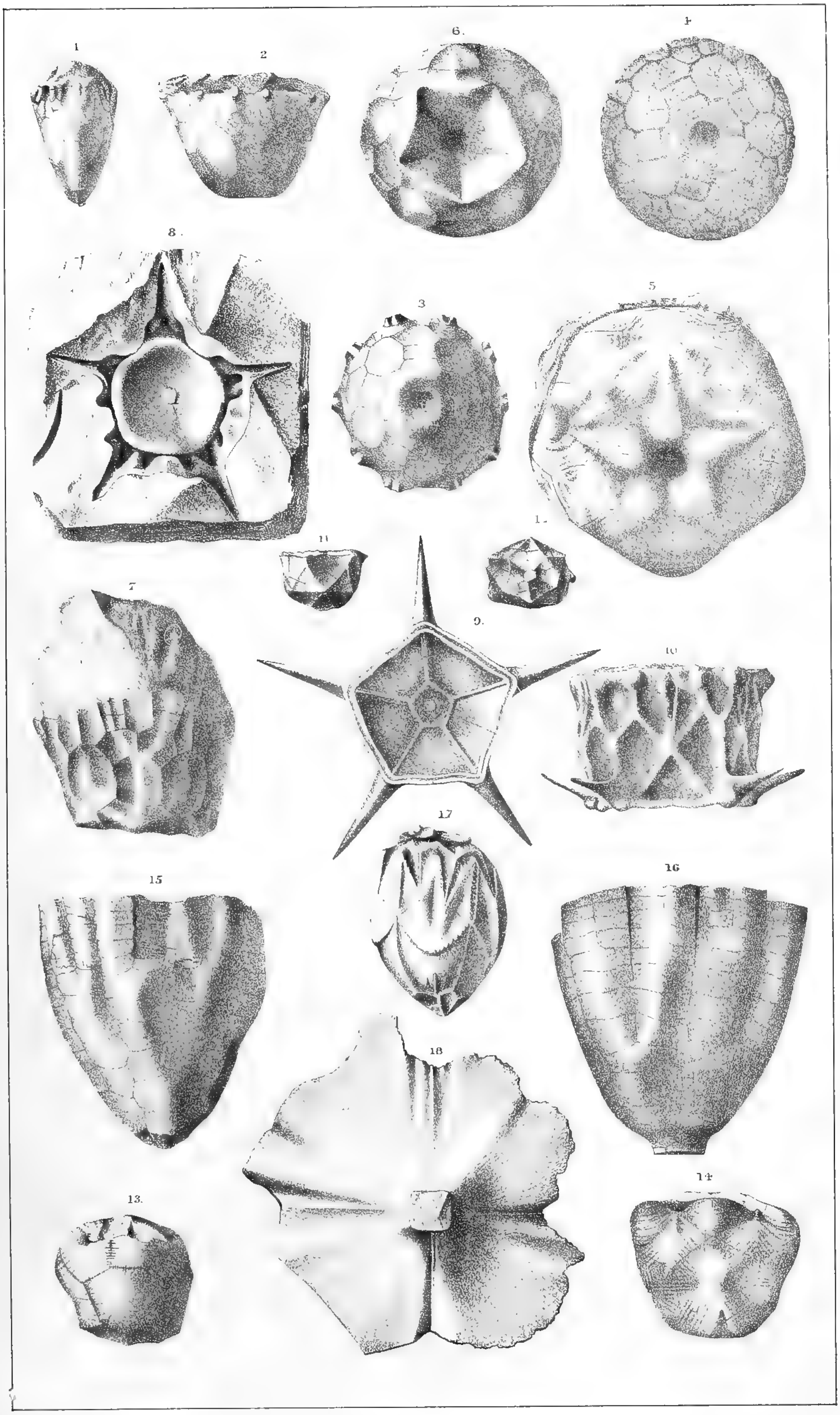
Figs. 11, 12. Lateral and basal views of an internal cast of this species.

Cyathocrinus oora, Hall.

Page 366.

Fig. 13. View of the anal side of a specimen of this species, showing the position of the anal plate.

" 14. Lateral view of a larger individual of the species, showing more distinctly the radiating lines of the plates. (Some larger specimens observed are very decidedly constricted above the base.)



R. P. Whitfield, del.

Swinton, lith

PLATE XI—Continued.

Ichthyocrinus subangularis, *Hall.*

Page 367.

Fig. 15. Lateral view of a specimen from Bridgeport, Illinois, preserving the substance of the plates.

" 16 View of a specimen from Waldron, Indiana, from which the species was originally described.

Caryocrinus ornatus, *Say.*

Fig. 17. Lateral view of an internal cast of a specimen of this species, possessing the usual characters of the species as they occur at these localities.

Cryptodiscus.

Fig. 18. The calyx of a Crinoidean ? of a new and peculiar type, for which the name Cryptodiscus is suggested.

PLATE XII.

Holocystites scutellatus, *Hall.*

Page 357.

Fig. 1. Lateral view of the specimen described. The plates on the left side are obscured by adhering rock.

Holocystites ovatus, *Hall.*

Page 357.

Fig. 2. Lateral view of a specimen of this species.

Holocystites winchelli, *Hall.*

Page 356.

Fig. 3. A view of the specimen described, which is imperfect at the base and summit.

Holocystites cylindricus, *Hall.*

Page 354.

Fig. 4. A view of a well preserved individual of large size, on which the limits of the plates are strongly marked.
" 5. View of a smaller individual.
" 6. View of a small specimen (preserving a portion of the short column), on which the angular prominences of the plates and the surface pustules are well preserved.

Holocystites abnormis, *Hall.*

Page 355.

Fig. 7. Lateral view ot a cast of a large specimen, which preserves the limits of the plates and the minutely pustulose texture of the surface.
" 8. View of a smaller specimen. The peculiar arrangement of the plates in the lower part of the body is seen in both this and the preceding specimen.

Holocystites alternatus, *Hall.*

Page 355.

Fig. 9. View of a very distinctly marked specimen of this species, showing the position of the summit aperture and the arrangement of the plates of the body.

Echinocystites nodosus, *Hall.*

Page 360.

Figs. 10, 11. Lateral and summit views of the specimen described.

Apiocystites imago, *Hall.*

Page 358.

Fig. 12. Lateral view of the specimen, showing the structure of the body and the position of the openings.

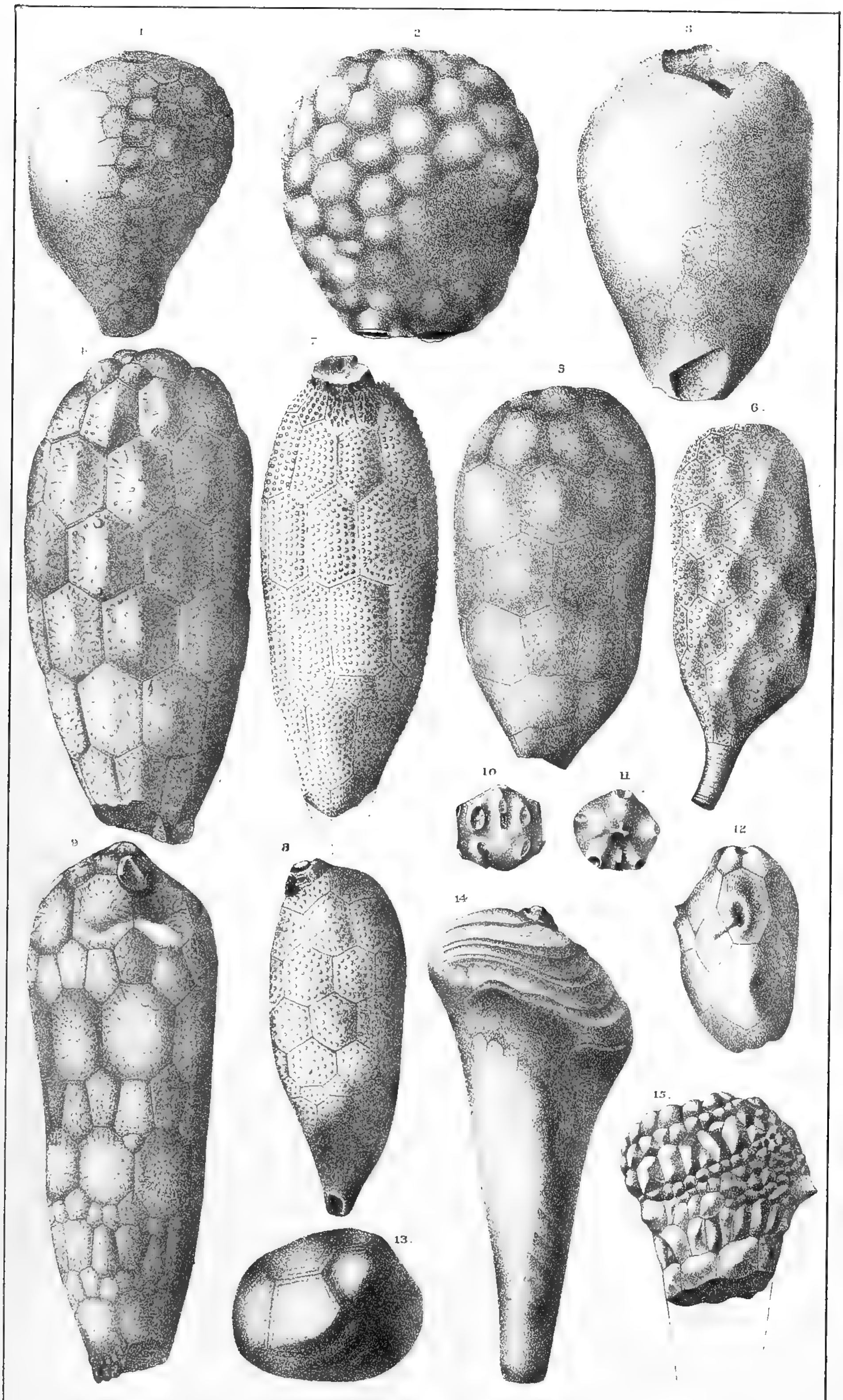
Hemicosmites subglobosus, *Hall.*

Page 359.

Fig. 13. View of a specimen which shows the structure of the body.

NIAGARA GROUP.

CYSTIDEÆ.



R. P. Whitfield, del.

Swinton, lith.

PLATE XII—Continued.

Gomphocystites glans, Hall.

Page 352.

Fig. 14. Lateral view of a cast of a specimen, which shows the general form, the position of the central opening, grooves of the spiral appendages of the dome, and impressions of some of the plates of the dome and body.

Gomphocystites tenax, Hall.

Page 352.

Fig. 15. Enlarged view of a specimen from Lockport, New York, which preserves the plates of the upper part of the body and dome, showing their spiral arrangement and nodose character.

*PLATE XII a.**

Gomphocystites tenax, Hall.

Page 352.

Fig. 1. Lateral view of the upper part of the body, showing the arrangement of plates; the spiral grooves indicating the places of the sessile arms are at the upper margins of the ranges of smaller plates. The plates are more or less irregularly disposed in some parts of the body, but they appear, like others of the genus, to have a generally spiral arrangement. (Enlarged to two diameters.)

" 2. The summit, showing the arrangement of the spiral arms and the central aperture. The diagram is made from an imperfect specimen, and the position of the eccentric aperture could not be ascertained.

Gomphocystites clavus, Hall.

Page 353.

Fig. 3. A fragment (natural size), showing the disposition of the spiral arms and the obtusely angular form of the body below.

Gomphocystites glans, Hall.

Page 352.

Fig. 4. Lateral view of a specimen, showing the entire form and the disposition of the spiral arms.

" 5. The anterior ? view of another individual of the same species.

Holocystites alternatus, Hall.

Page 355.

Fig. 6. A posterior ? view of a specimen (natural size), showing the position of the eccentric aperture, form and relation of plates, etc.

Holocystites cylindricus, Hall.

Page 354.

Fig. 7. View of a nearly entire individual, showing the central aperture in a depression at the summit. The plates of the lower part are broken off.

" 8. A smaller individual, in which the plates have been strongly ridged, preserving a portion of the column. The lower ranges of plates are somewhat obscure, and the dotted lines indicate depressions, which may be sutures or only grooves in the larger plates.

Apiocystites imago, Hall.

Page 358.

Fig. 9. Lateral view of the specimen, showing the ovarian aperture on the left-hand side of the figure, and the right pectinated rhomb. (Figure natural size.)

Crinocystites chrysalis, Hall.

Page 362.

Fig. 10. View of the gibbous side of the specimen.

" 11. Lateral view of the same specimen.

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*This plate accompanied the original paper as Plate I. It is now arranged with the other plates in its order as XII *a*.

NIAGARA GROUP.

(CYSTIDEÆ.)

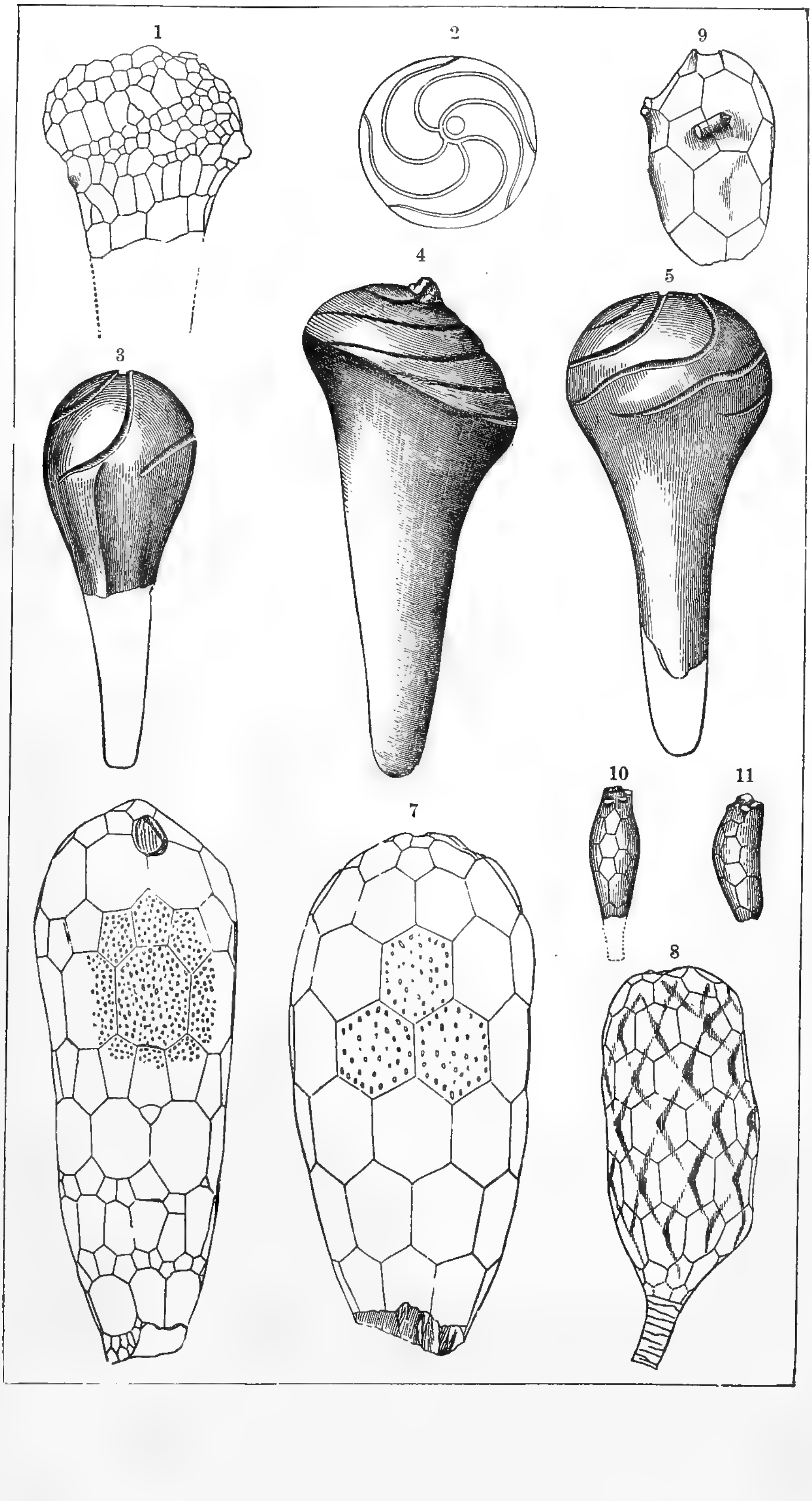


PLATE XIII.

Obolus conradi, Hall.

Page 375.

Fig. 1. View of the cast of the dorsal valve, showing the longitudinal septum and the filling of the cavities beneath the margins of the transverse plate.

" 2. Cast of a ventral valve, showing the impression of the transverse plate, the median depression of the hinge plate, and the cavities left by the teeth-like processes.

Strophodonta profunda, Hall.

Page 376.

Fig. 3. Impression of the surface of the concave valve of a small individual, with a portion of the filling of the cavity between the valves, showing the impression of the ventral valve on the margin.

" 4. Impression of the interior of the ventral valve of a large individual. The muscular imprints in the figure are not represented so long as they are in the original specimen.

Spirifera eudora, Hall.

Page 377.

Fig. 5. Dorsal view of a specimen of this species.

" 7. Profile of the same specimen, showing the gibbosity of the valves, and the height and curvature of the area.

Spirifera gibbosa, Hall.

Page 378.

Fig. 6. View of a dorsal valve of this species.

" 8. Cardinal view of a specimen.

Spirifera plicatella, var. *radiata*, Sowerby.

Page 378.

Fig. 9. Dorsal view of a small individual, showing the extension of the lamellæ in the dorsal valve as seen in young specimens.

" 10. Ventral view of the same individnal, showing the extent of the lamellæ in the ventral valve.

" 11. Profile of the specimen.

Spirifera meta, Hall.

Page 380.

Fig. 12. Ventral view of a specimen.

" 13. Cardinal view of the same individual, showing the height and extent of the straight area.

Spirifera nobilis, Hall.

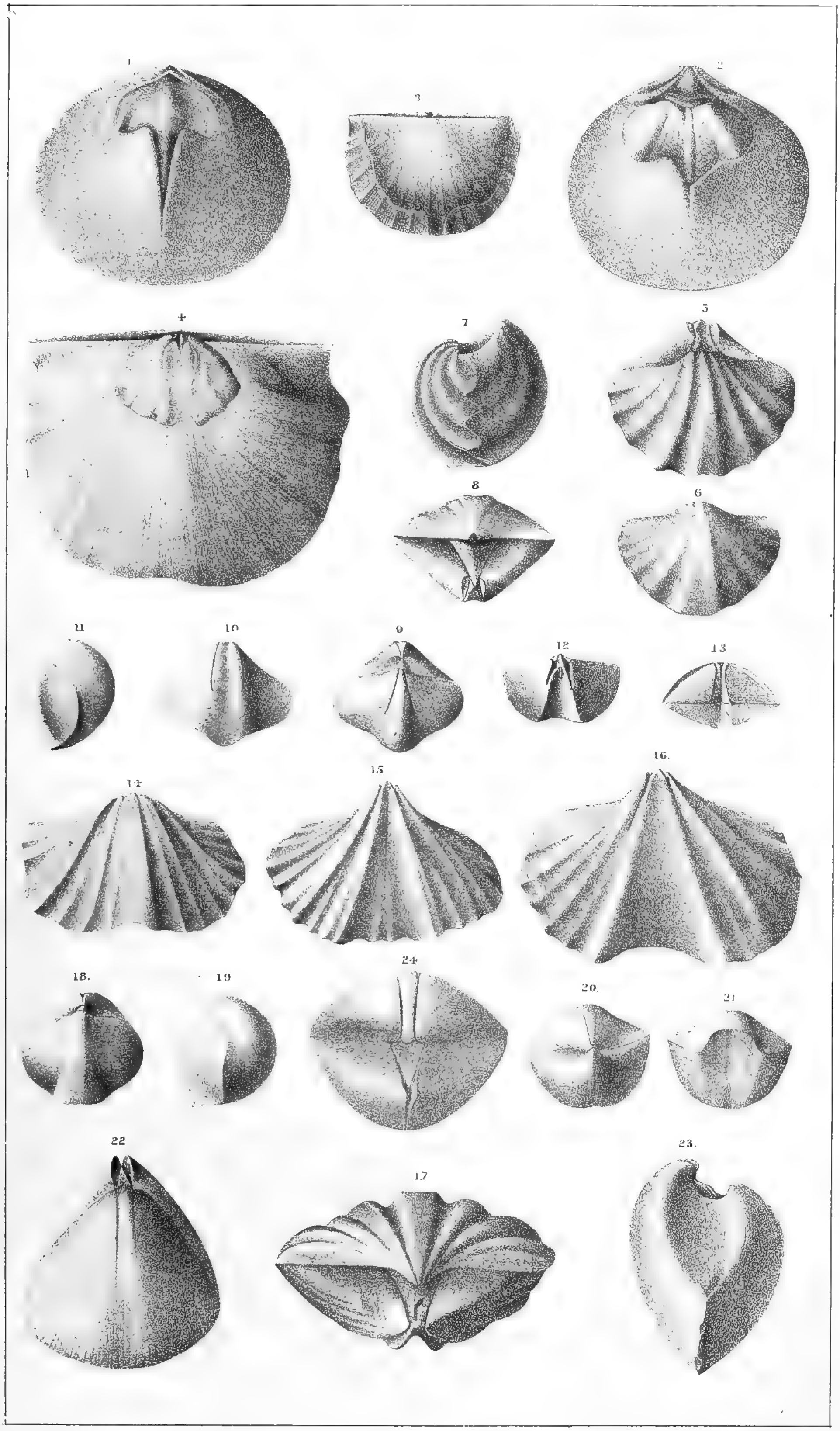
Page 380.

Fig. 14. Dorsal view of an individual of medium size.

" 15. Ventral view of a specimen, showing plications in the mesial sinus.

" 16. Ventral view of a large individual.

" 17. Cardinal view of the specimen fig. 16.



R. P. Whitfield, del. Swinton, lith

PLATE XIII —Continued.

Pentamerus (Pentamerella?) ventricosus, Hall.

Page 382.

Figs. 18–21. Dorsal view, profile, cardinal and front views of a medium-sized individual of the species, showing slight indications of plications on the mesial fold and sinus.

Pentamerus multicostatus, Hall.

Page 381.

Figs. 22–24. Dorsal view, profile, and cardinal views of an internal cast of this species, preserving the impressions of the costæ on the anterior margin.

PLATE XIV.

Pterinea brisa, *Hall.*

Page 384.

Fig. 1. View of the left valve of a specimen of this species partly denuded of the shell. The large quadrangular muscular impression is seen near the posterior wing; the anterior and posterior teeth are also visible.

Ambonychia acutirostra, *Hall.*

Page 383.

Fig. 2. View of the left valve of a full grown individual.

Ambonychia aphæa, *Hall.*

Page 383.

Fig. 3. View of the left valve, showing impressions of the lateral teeth.

Modiolopsis rectus, *Hall.*

Page 386.

Fig. 4. The right valve of a small specimen, showing the muscular impressions.
" 5. The left valve of a larger individual, showing muscular impressions and teeth.

Cypricardinia arata, *Hall.*

Page 385.

Fig. 6. View of the right valve of a specimen of this species, of the natural size.

Modiolopsis dictæus, *Hall.*

Page 385.

Fig. 7. View of a cast of the left valve, showing impressions of the lateral teeth.

Cypricardites ? quadrilatera, *Hall.*

Page 388.

Fig. 8. A cast of the right valve of the species.
" 9. View of the anterior slope, showing the filling of the anterior muscular impression near the beak.
" 10. The posterior slope of the valve, showing the lateral teeth and impression of the elevated muscular scar.

Palæocardia cordiiformis, *Hall.*

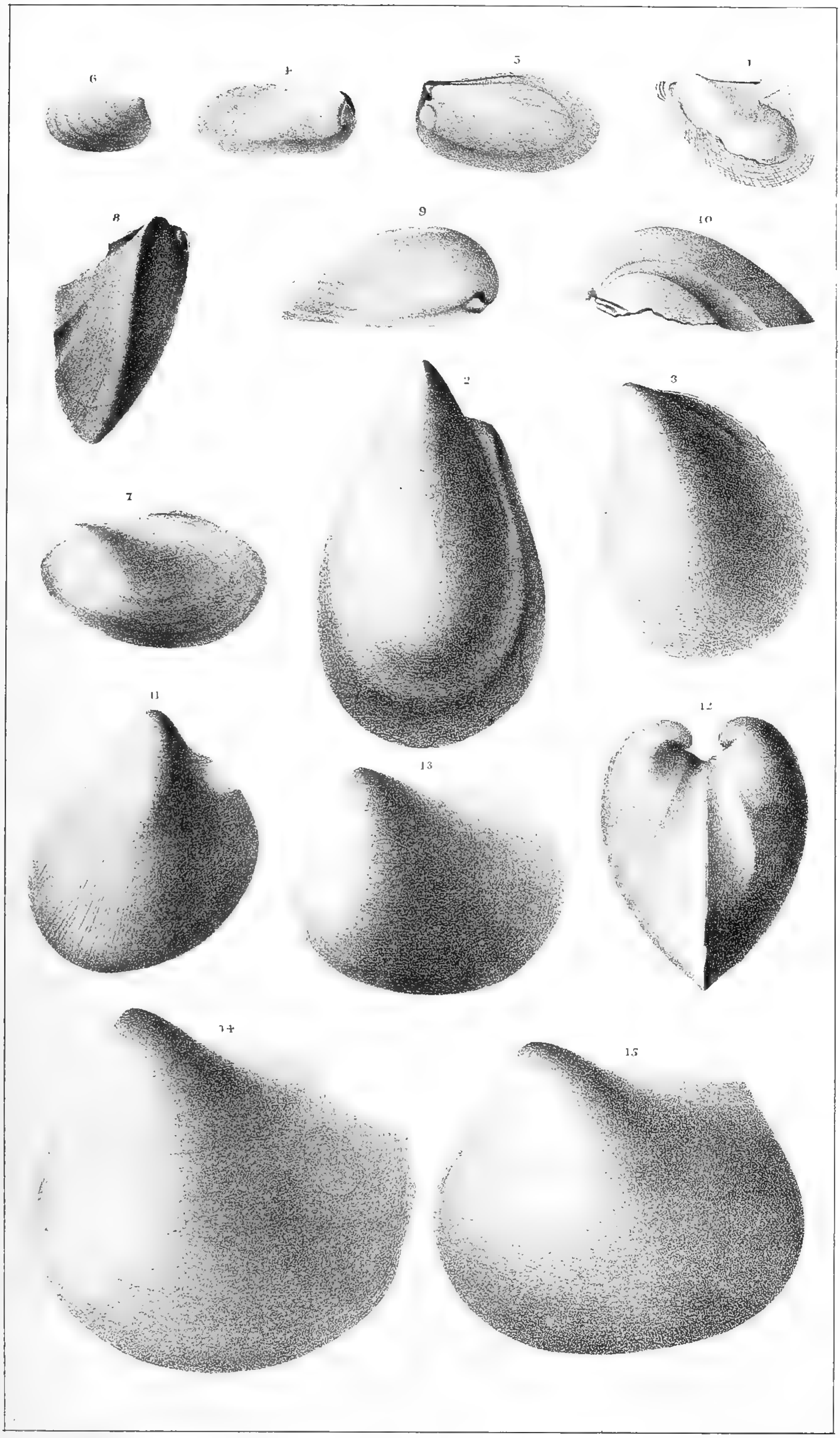
Page 389.

Fig. 11. The right side of the cast, showing the muscular scar.
" 12. Posterior profile of the cast.

Amphicœlia leidyi, *Hall.*

Page 387.

Fig. 13. Cast of a left valve of a small individual.
" 14. Cast of the left valve of a large specimen, in which there are faint traces of muscular impressions.
" 15. Cast of another individual, having somewhat different proportions and a more perfect outline.



Swinton lith

PLATE XV.

SUBULITES VENTRICOSUS, HALL.

Page 398.

FIG. 1. View of an individual of this species, somewhat restored in the upper part.

LOXONEMA LEDA, HALL.

Page 398.

FIG. 2. Figure from a gutta-percha cast taken in the natural mould; faint remains of indistinct transverse striæ are visible.

EUNEMA? TRILINEATA, HALL.

Page 397.

FIG. 3. Figure taken from a gutta-percha cast of the natural mould in the rock.

CYLONEMA? ELEVATA, HALL.

Page 391.

FIG. 4. View of a cast of this species.

TROCHONEMA (CYCLONEMA?) PAUPER, HALL.

Page 395.

FIG. 5. View of the aperture, taken from a gutta-percha cast made in the natural mould.
" 6. Basal view of the same specimen as fig. 5, showing the umbilicus.
" 9. A small internal cast of this species.

TROCHONEMA (EUNEMA) FATUA, HALL.

Page 394.

FIG. 7. View of an internal cast of this species.
" 8. The figure is from a gutta-percha cast, and shows the longitudinal striæ very perfectly.

PLEUROTOMARIA (TROCHONEMA) HOYI, HALL.

Page 393.

FIG. 10. View of a cast of this species.

PLEUROTOMARIA OCCIDENS, HALL.

Page 392.

FIG. 11. Lateral view of a specimen of this species, which preserves a portion of the surface.
" 12. View of the spire, taken from a gutta-percha cast in the natural mould.

PLEUROTOMARIA HALEI, HALL.

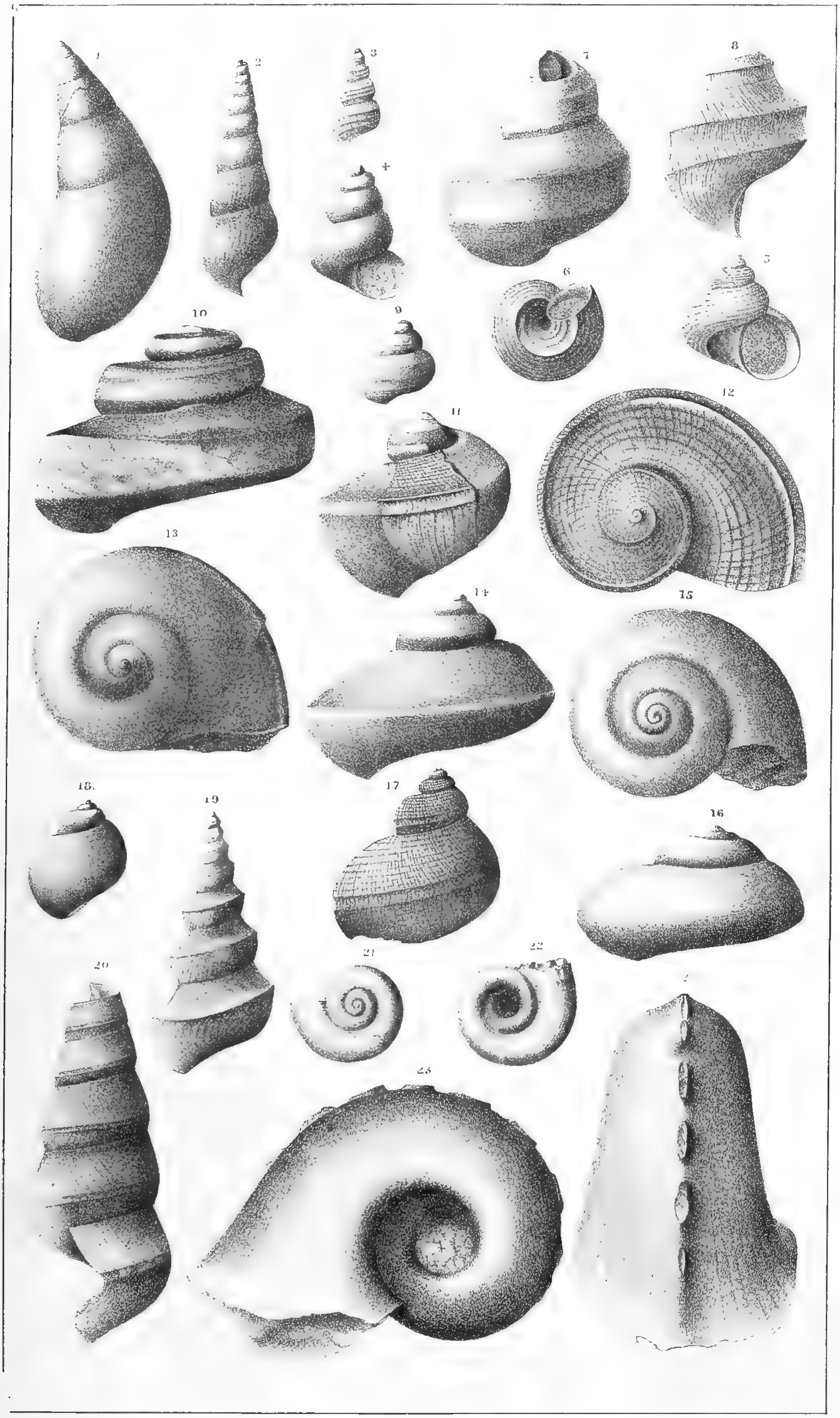
Page 392.

FIG. 13. View of the spire of a cast of this species.
" 14. The elevation of the spire.

PLEUROTOMARIA IDIA, HALL.

Page 393.

FIGS. 15, 16. Vertical and lateral views of a cast of this species.



R. P. Whitfield, del. Swinton, lith

PLATE XV—Continued.

Pleurotomaria axion, Hall.

Page 394.

Fig. 17. View of a specimen of this species taken from a gutta-percha cast.

Holopea guelphensis, Billings.

Page 391.

Fig. 18. View of a cast which has been referred to this species.

Murchisonia conradi, Hall.

Page 396.

Fig. 19. View of a specimen of this species taken from a gutta-percha cast.

Murchisonia laphami, Hall.

Page 396.

Fig. 20. The figure is from an impression taken in the natural mould, and shows the characters of the surface and form of the aperture.

Straparollus mopsus, Hall.

Page 390.

Figs. 21, 22. Upper and lower sides of a specimen of this species.

Tremanotus alpheus, Hall.

Page 399.

Fig. 23. Lateral view of a specimen, showing the umbilicus.
" 24. Dorsal view, showing the filling of the dorsal perforations, and the radiating striæ near the aperture.

PLATE XVI.

Trochoceras notum, *Hall.*

Page 403.

Fig. 1. Dorsal view of a fragment of this species.
 " 2. A septum showing its convexity and the position of the siphuncle.

Cyrtoceras rigidum, *Hall.*

Page 408.

Fig. 3. Lateral view of the outer portion of the cast, showing the curvature of the shell and the character of the undulating ridges.
 " 4. Dorsal view of the same.
 " 5. Transverse section, showing the form.

Lituites marshii, *Hall.*

Page 404.

Fig. 6. Lateral view of a specimen of the natural size, showing the oblique costæ and the outline of the septa.
 " 7. Profile showing the flattened dorsum, the concavity of the septa and the position of the siphuncle.

Trochoceras desplainense, *M'Chesney.*

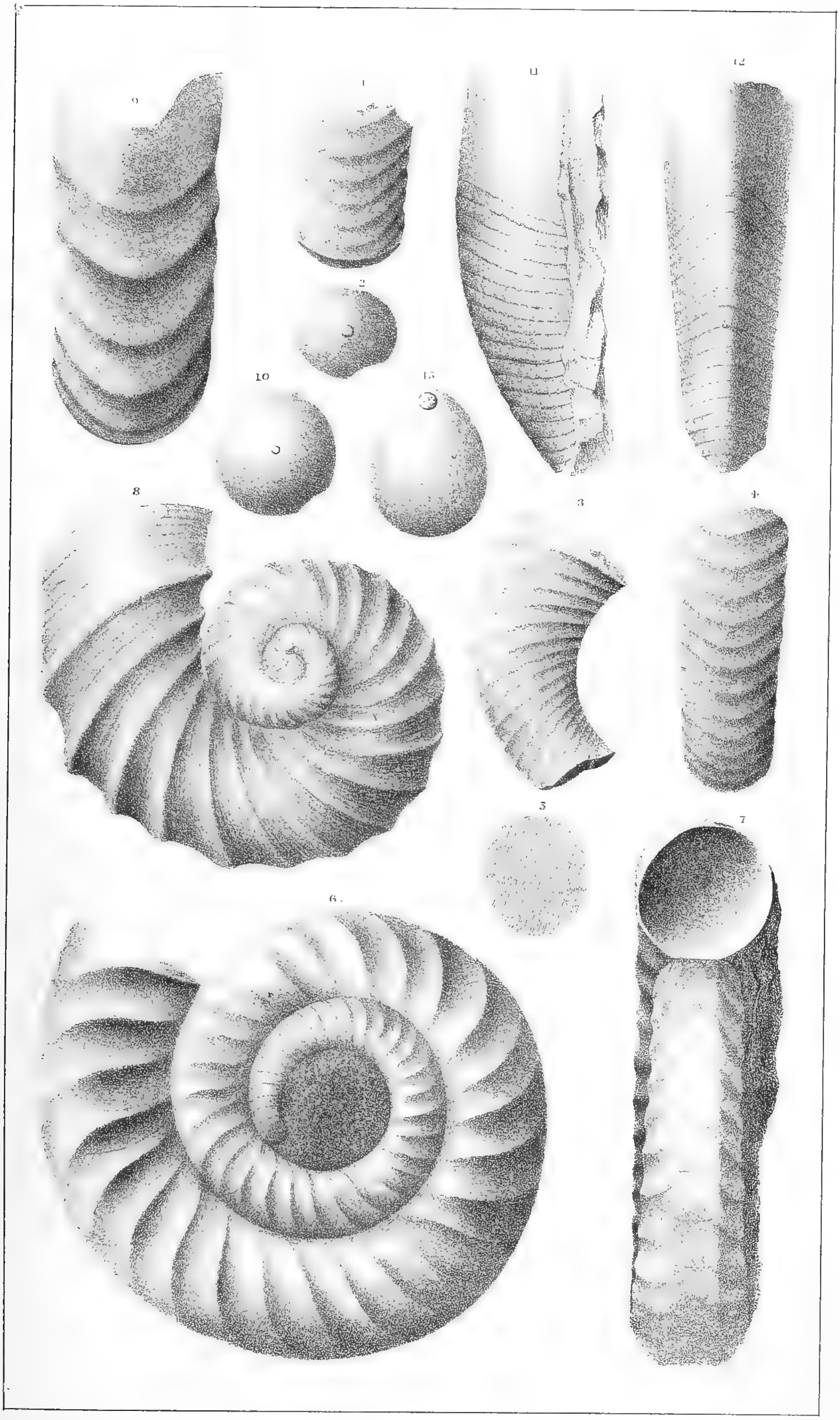
Page 401.

Fig. 8. View of the upper side of spire, taken from an impression in the natural mould in the rock, showing the strong oblique costæ.
 " 9. Dorsal view of the outer part of the last volution, showing the sinus in the margin of the aperture.
 " 10. Transverse section, showing the convexity of the septa and position of the siphuncle.

Cyrtoceras fosteri, *Hall.*

Page 406.

Fig. 11. Lateral view of the specimen described.
 " 12. Dorsal view of the same.
 " 13. Transverse section, showing the convexity of the septa and position of the siphuncle.



R.P. Whitfield, del.

Swinton, lith

PLATE XVII.

Oncoceras orcas, Hall.

Page 410.

FIG. 1. Dorsal view of a large specimen.
" 2. Lateral view of the same. The figures are reduced to two-thirds the natural size.

Cyrtoceras dardanus, Hall.

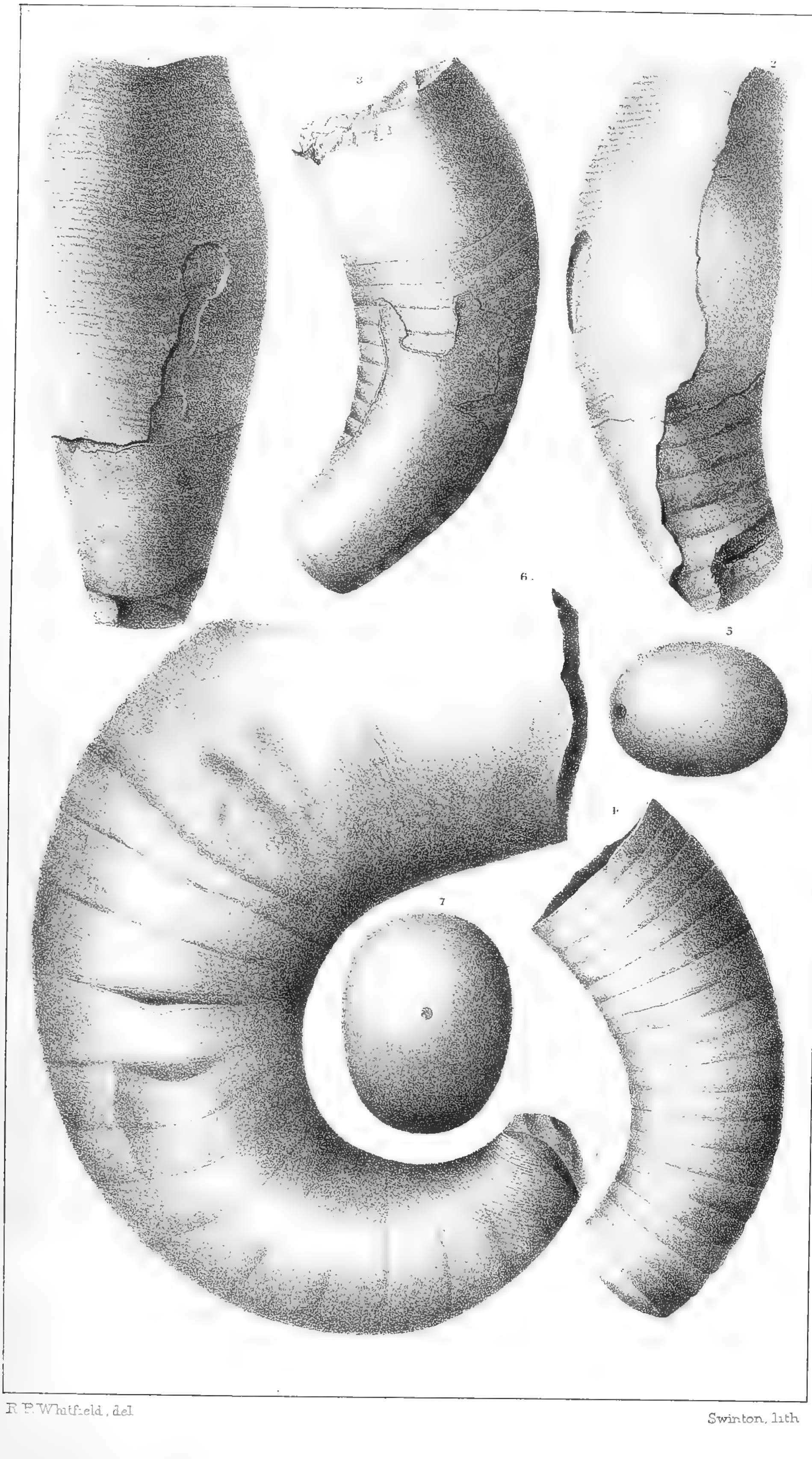
Page 406.

FIG. 3. Lateral view of a specimen which preserves a part of the outer chamber and a small portion of the shell.
" 4. Lateral view of an individual where the septa are not curved upward on the dorsal margin.
" 5. Transverse section of the specimen fig. 4.

Cyrtoceras hercules, Winch. and Mar.

Page 409.

FIG. 6. Lateral view of a large specimen which preserves a portion of the outer chamber, and also some of the surface striæ near the lower end.
" 7. Transverse section, showing the form of the shell. The two figures are reduced one-third in size.



R. P. Whitfield, del.

Swinton, lith.

PLATE XVIII.

Gomphoceras scrinium, Hall.

Page 410.

Fig. 1. Lateral view of the outer chamber, the lower end showing the concavity of the septa.
" 2. View of the aperture of the same individual.
" 3. A transverse section of another individual, showing the size and position of the siphuncle, with muscular or vascular markings at the margin.

Cyrtoceras laterale, Hall.

Page 407.

Fig. 4. Dorsal view of a specimen, showing septa and preserving the remains of faint longitudinal ridges.
" 5. Lateral view of the same individual.
" 6. The outer circle of the figure represents the form of section and the position of the siphuncle of this species,—the inner portion that of *C. lucillum.*

Cyrtoceras lucillum, Hall.

Page 406.

Fig. 7. Lateral view of a specimen of this species. The figure is somewhat restored. See inner portion of figure 6 for transverse section.

Cyrtoceras brevicorne, Hall.

Page 407.

Fig. 8. Lateral view of the specimen described. The specimen consists of the filling of the outer chamber and the matrix of the lower part, which has been represented from a cast in the cavity.
" 9. Dorsal view of the same.

Orthoceras abnorme, Hall.

Page 415.

Fig. 10. View of a specimen of this species having the filling of the chambers in the lower part broken away, showing the siphuncle, and the inner core with its numerous ramifications uniting with the walls of the siphuncle. The view is taken looking obliquely upon the specimen, so that the real amount of curvature is not observable.

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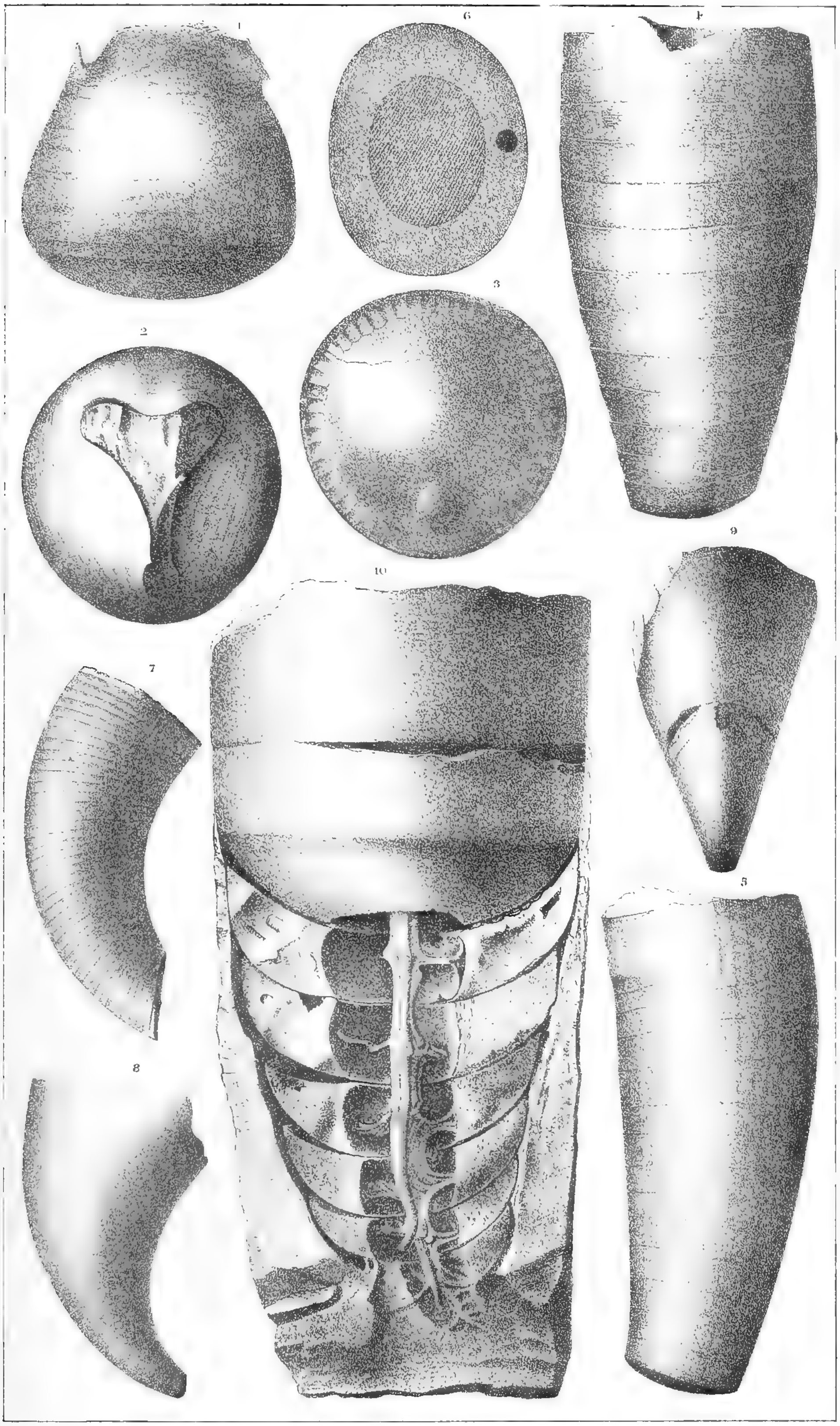
NIAGARA GROUP

CEPHALOPODA.

Plate XVIII.



R. P. Whitfield, del.

Swinton, lith.

PLATE XIX.

ORTHOCERAS CREBESCENS, HALL.

Page 413.

FIG. 1. View of a large specimen, preserving the outer chamber and several of the septa; the lower end showing the depth of the septa.

" 2. View of another individual, having part of the septa in the lower end removed, and exposing the siphuncle.

" 3. A smaller individual, which preserves traces of the longitudinal ridges.

ORTHOCERAS COLUMNARE, HALL.

Page 411.

FIG. 4. A fragment preserving the filling of four chambers, which are very distant.

" 5. A transverse section of the lower end of the preceding specimen.

" 6. View of another specimen, preserving nine chambers, which are very irregular in their distances. In the upper part there is a small piece of the shell represented, showing the surface characters.

" 8. A fragment of this species of smaller size, preserving essentially the same characters.

ORTHOCERAS LOXIAS, HALL.

Page 416.

FIG. 7. Figure of specimen of natural size, preserving about seventeen of the septa, with the shell partially preserved, or replaced by mineral matter on the other parts of the surface. This species is not positively known in the Niagara limestone, and should therefore have been omitted from the index of the fossils of the Niagara group.

ORTHOCERAS ANGULATUM, WAHL.

Page 413.

FIG. 9. A fragment of this species of about six inches in length, preserving above twenty septa and a part of the chamber of habitation; from Racine, Wisconsin.

" 10. From an impression of the exterior of a specimen similar to fig. 9, and from the same locality.

" 11. From an impression of the exterior of a similar form, from Bridgeport, Illinois. The specimen, at a point where it is one inch and five-eighths in diameter, preserves above twenty longitudinal ridges in the semi-circumference, giving more than forty in the entire circumference. The character of surface in these impressions is precisely like that of *O. cancellatum*, HALL, from the Niagara group of New York, and differs in no essential particular from the minute surface markings of *O. columnare*.

PLATE XX.

Orthoceras medullare, *Hall.*

Page 412.

Fig. 1. A fragment of a large individual, preserving several of the septa and a portion of the outer chamber, together with considerable of the shell, showing the character of the exterior surface.

" 2. A section of the same individual, showing its elliptical form and the position of siphuncle.

Orthoceras niagarense, *Hall.*

Page 416.

Fig. 3. A view of the specimen described, showing the oblique undulations and several of the septa.

Orthoceras annulatum, *Sowerby.*

Page 411.

Fig. 4. A natural cast of the interior of a part of the outer chamber. The annulations are very distinct and sharp, while the parallel encircling striæ are very obscure or scarcely distinguishable. The longitudinal ridges are unusually well preserved, and give a nodose character to the annulations.

" 5. A fragment of the septate portion of a specimen of this species, showing the obscure impressions of longitudinal ridges with the annulations not strongly elevated.

" 6. A view of the upper extremity of fig. 5, showing the broadly elliptical form of the section and the position of the siphuncle.

The New York specimens occur in soft calcareous shale, and often preserve the marks of obscure longitudinal ridges, interrupting the parallel transverse striæ, giving a very obscurely nodose aspect to the surface. This is shown in Pal. N. Y., Vol. ii, plate 64, fig. 1 a. The same character is more distinctly shown in Murchison's beautiful figure of this species, which in all its features corresponds with the better preserved specimens in the Niagara group. Those from Illinois and Wisconsin present a great variety in the degree of this marking, owing to the more or less complete solution and removal of the shell and the nature of the enclosing material. In many specimens there are no nodes preserved on the surface. The undulating transverse striæ are rarely well preserved, but they are quite distinct occasionally. Specimens also occur in which the undulating striæ and nodes are both well preserved. The specimen, fig. 4, is quite an extreme one.

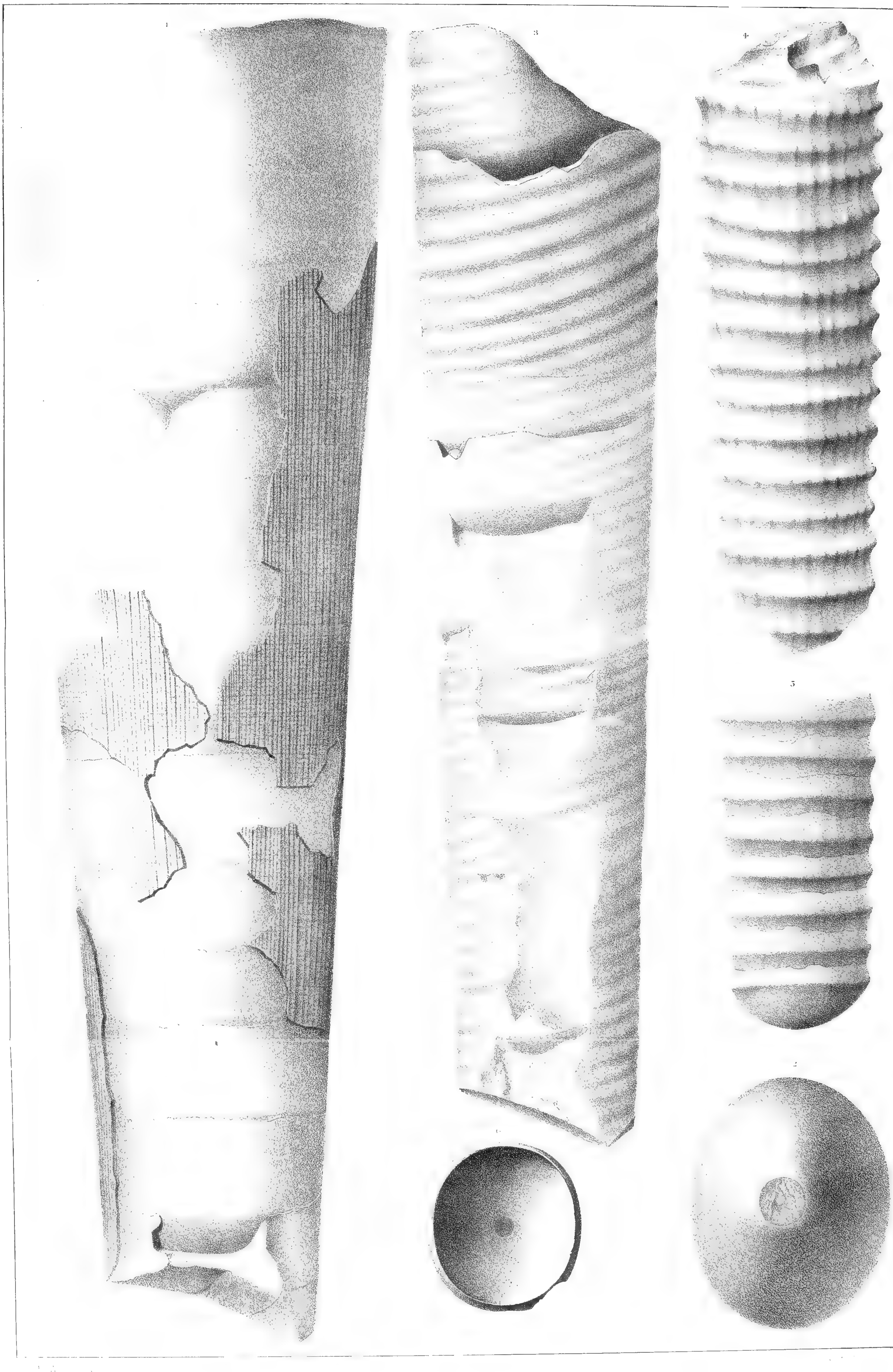

1
3
4
5
6
2

PLATE XXI.

Leperditia fonticola, Hall.

Page 428.

Figs. 1–3. Enlarged views of three different individuals, showing some variations in the proportions and also in the nodes of the surface.

Sphærexochus romingeri, Hall.

Page 425.

Figs. 4, 5. Two views of a glabella of this species, natural size.
" 6. Profile view of the glabella and movable cheek of a small specimen. The figures are enlarged to three diameters.
" 7. The pygidium enlarged to two diameters.

Acidaspis danai, Hall.

Page 423.

Fig. 8. A specimen preserving the glabella and portions of the movable cheeks. The figure is of the specimen originally described.
" 9. Figure of another individual, showing some modifications in the lateral lobes of the glabella.

Ceraurus niagarensis, Hall.

Page 427.

Fig. 10. The glabella and part of one of the fixed cheeks of a specimen of this species.
" 11. The hypostoma of this species? from a specimen in the collection of Prof. Winchell.

Lichas breviceps? Hall.

Page 424.

Fig. 12. The glabella and movable cheek of a specimen, enlarged to two diameters.
" 13. Figure of the internal cast of a pygidium; natural size.
" 14. An enlarged figure of the lower surface of a pygidium.

Encrinurus nereus, Hall.

Page 425.

Fig. 15. Figure of the pygidium of this species enlarged to two diameters.

Dalmania vigilans, Hall.

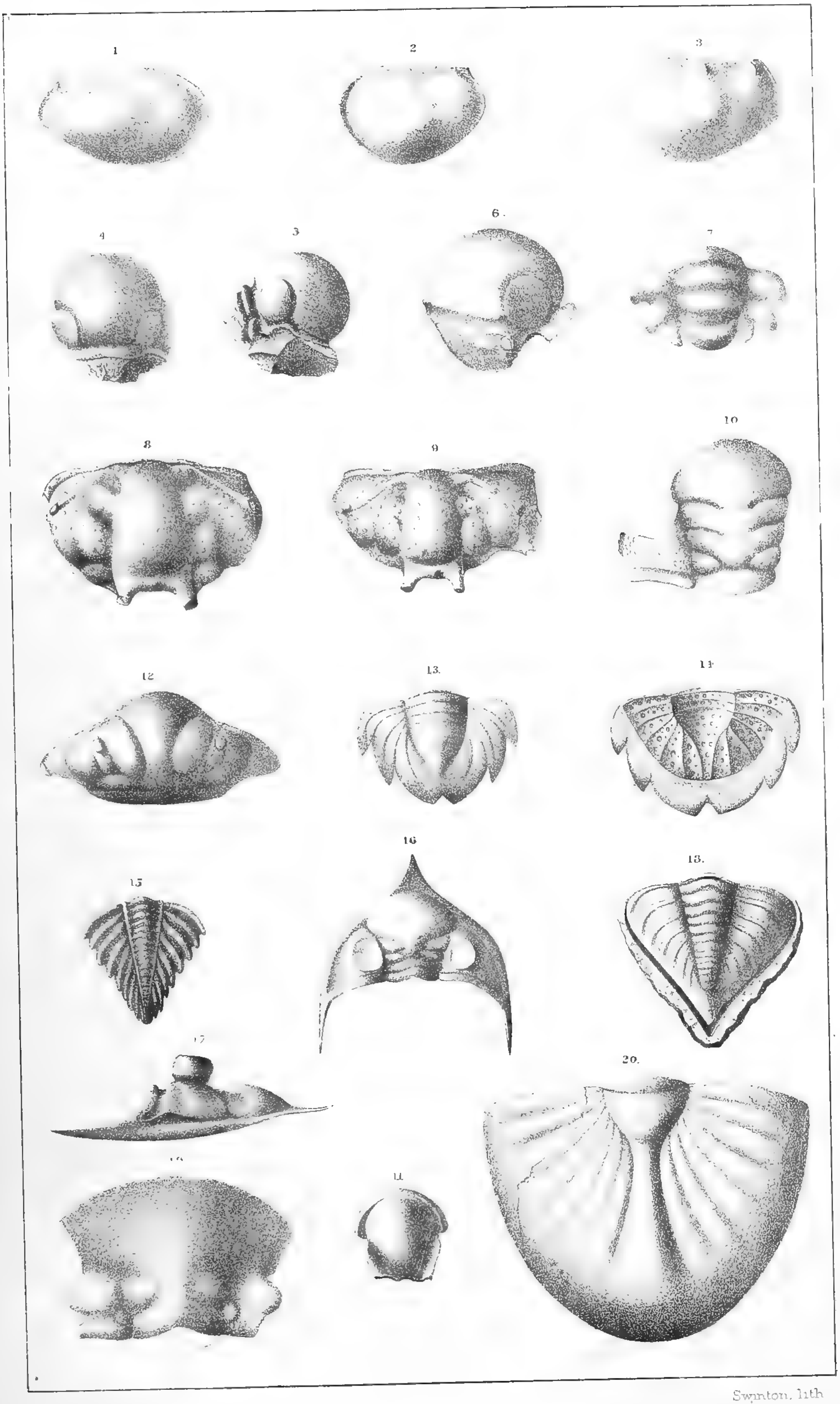
Page 426.

Fig. 16. View of the head of a specimen denuded of the eyes.
" 17. Profile view of another specimen, preserving the cast of the eyes, the crust having been dissolved.
" 18. Cast of a pygidium of this species.

Bronteus acamas, Hall.

Page 422.

Fig. 19. Cast of the glabella of this species, natural size.
" 20. The pygidium natural size, but slightly restored on one margin.



Swinton, lith

PLATE XXII.

ILLÆNUS ARMATUS, HALL.

Pages 418, 433.

FIG. 1. Upper view of the head of a well preserved individual.
" 2. Profile view of the same.
" 3. The pygidium and last thoracic segment, found associated with the head and supposed to be of the same species.

ILLÆNUS (BUMASTUS) IOXUS, HALL.

Page 420.

FIG. 4. Upper view of the head of a small individual.
" 5. Profile view of the same.
" 6. Upper view of a medium sized individual.
" 7. Lower view of the same, showing the extent of the infolding of the border, and the direction of the suture on the under surface.
" 8. Profile view of the same individual.
" 9. The movable cheek of a large specimen.
" 10. A pygidium of the form commonly found associated with the other remains referred to this species.
" 11. A small glabella, referred with doubt to this species.

ILLÆNUS CUNICULUS, HALL.

Page 421.

FIG. 12. View of the glabella of this species.

ILLÆNUS INSIGNIS, HALL.

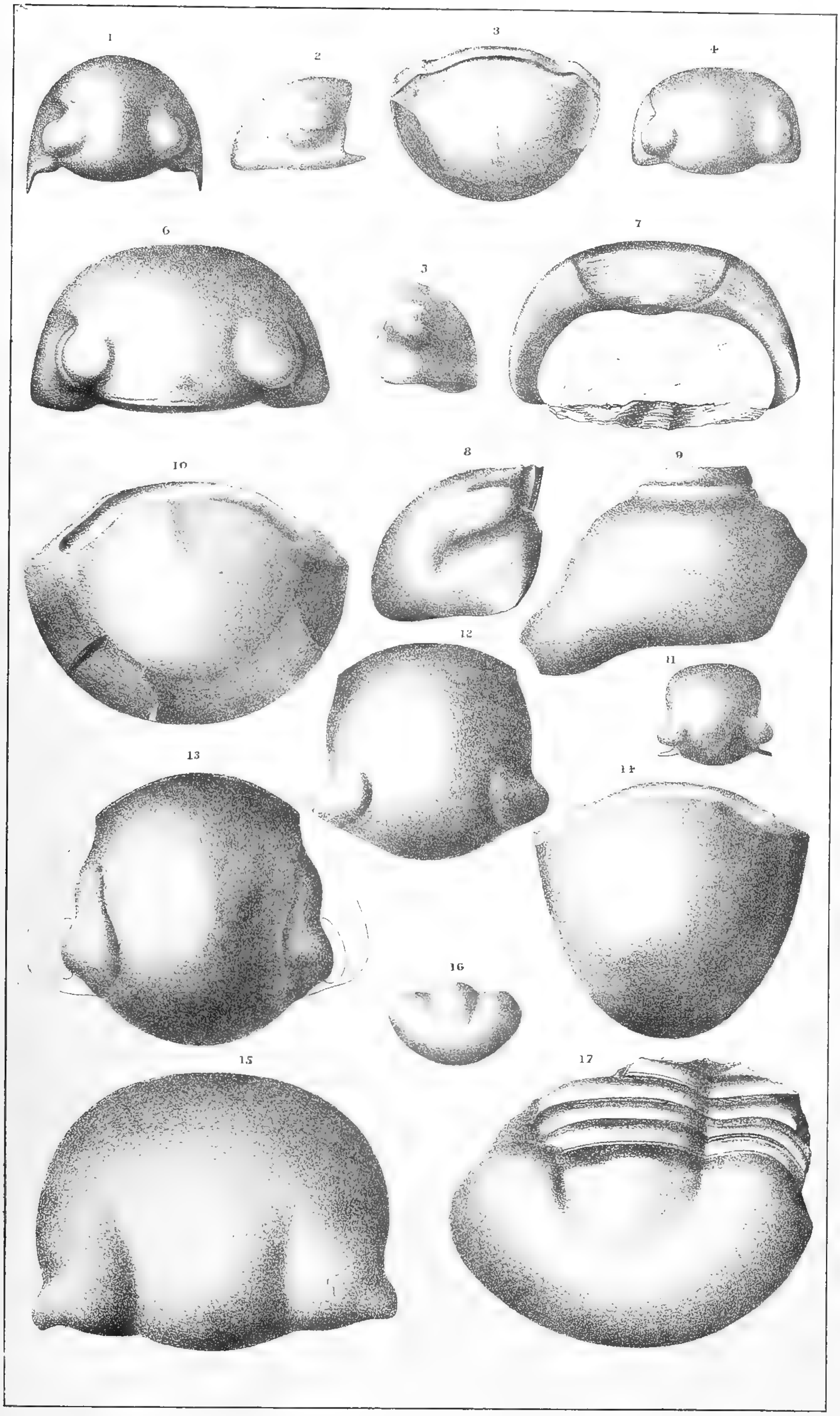
Page 419.

FIG. 13. The glabella and fixed cheeks, with the movable cheeks restored in outline.
" 14. The pygidium referred to this species.

ILLÆNUS IMPERATOR, HALL.

Page 420.

FIG. 15. The head of a large individual. The figure is reduced to one-half the natural size.
" 16. The pygidium of a very small specimen of the species.
" 17. The pygidium and parts of four of the thoracic segments, reduced in size one-half.



R. P. Whitfield, del. Swinton, lith.

PLATE XXIII.

ILLÆNUS (BUMASTUS) IOXUS, HALL.

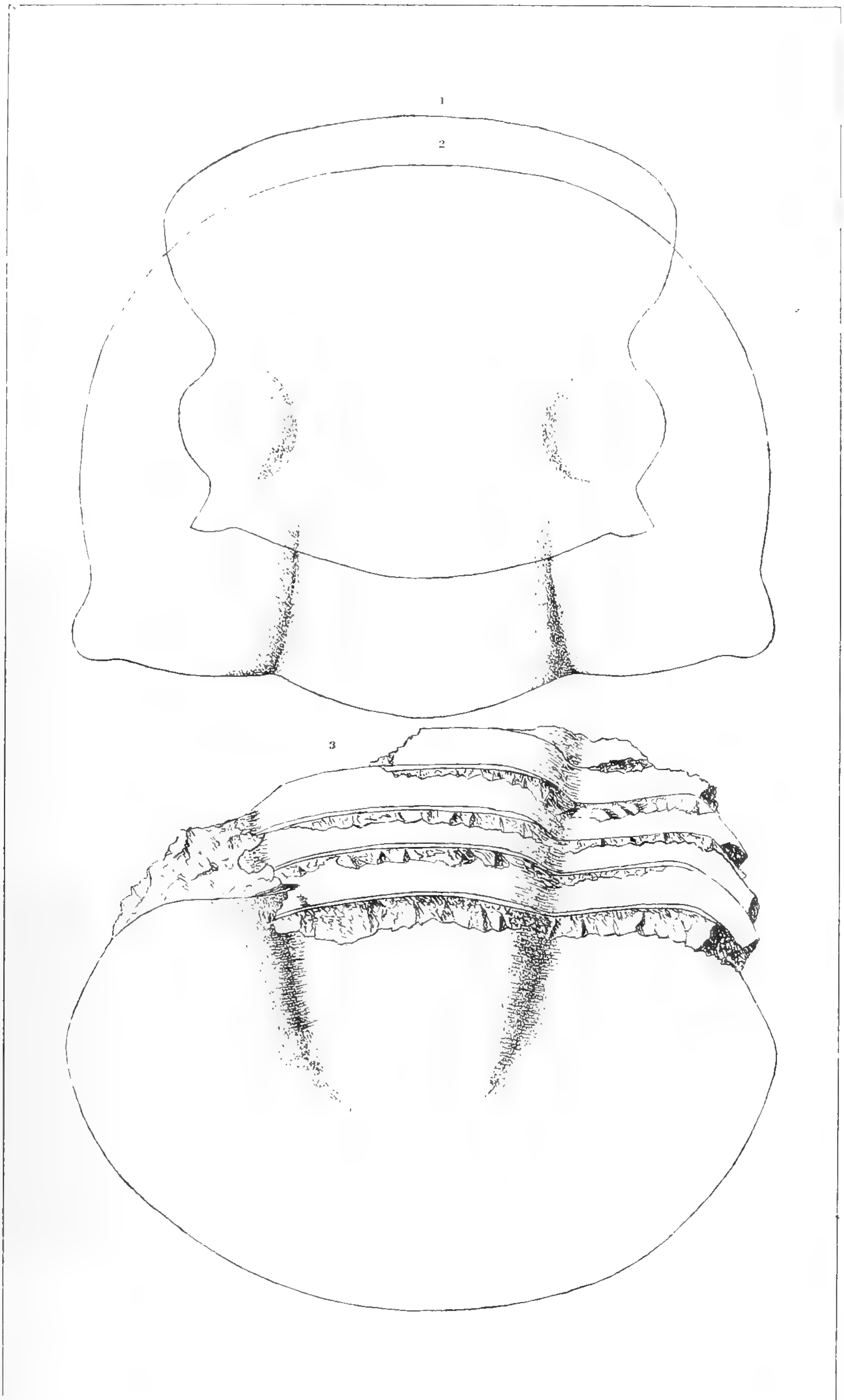
Page 420.

FIG. 1. The glabella and palpebral lobes of a large individual.

ILLÆNUS IMPERATOR, HALL.

Page 420.

FIG. 2. The glabella and palpebral lobes of a specimen of this species, natural size.
" 3. The pygidium and part of four thoracic segments of this species, natural size.
These figures represent the natural size of reduced figures 15 and 17 of Plate 22.



F. P. Whitfield, del.

PLATE XXIV.

ORTHOCERAS COLUMNARE, HALL.

Page 411.

FIG. 1. View of a very fine specimen of this species, showing the surface markings, form of the septa, size and proportions of the siphuncle. From a specimen in the collection of Prof. Marcy.

ORTHOCERAS ANNULATUM, SOWERBY.

Page 411.

FIG. 2. A specimen (a cast of the interior) of this species, showing the septa and siphuncle.
" 3. A fragment, showing the angular form of the annulations and the lines of the septa.
" 4. A fragment, showing the transverse or concentric undulating striæ, and the longitudinal ridges, forming nodes where they cross the annulations.

CYRTOCERAS LATERALE, HALL.

Page 407.

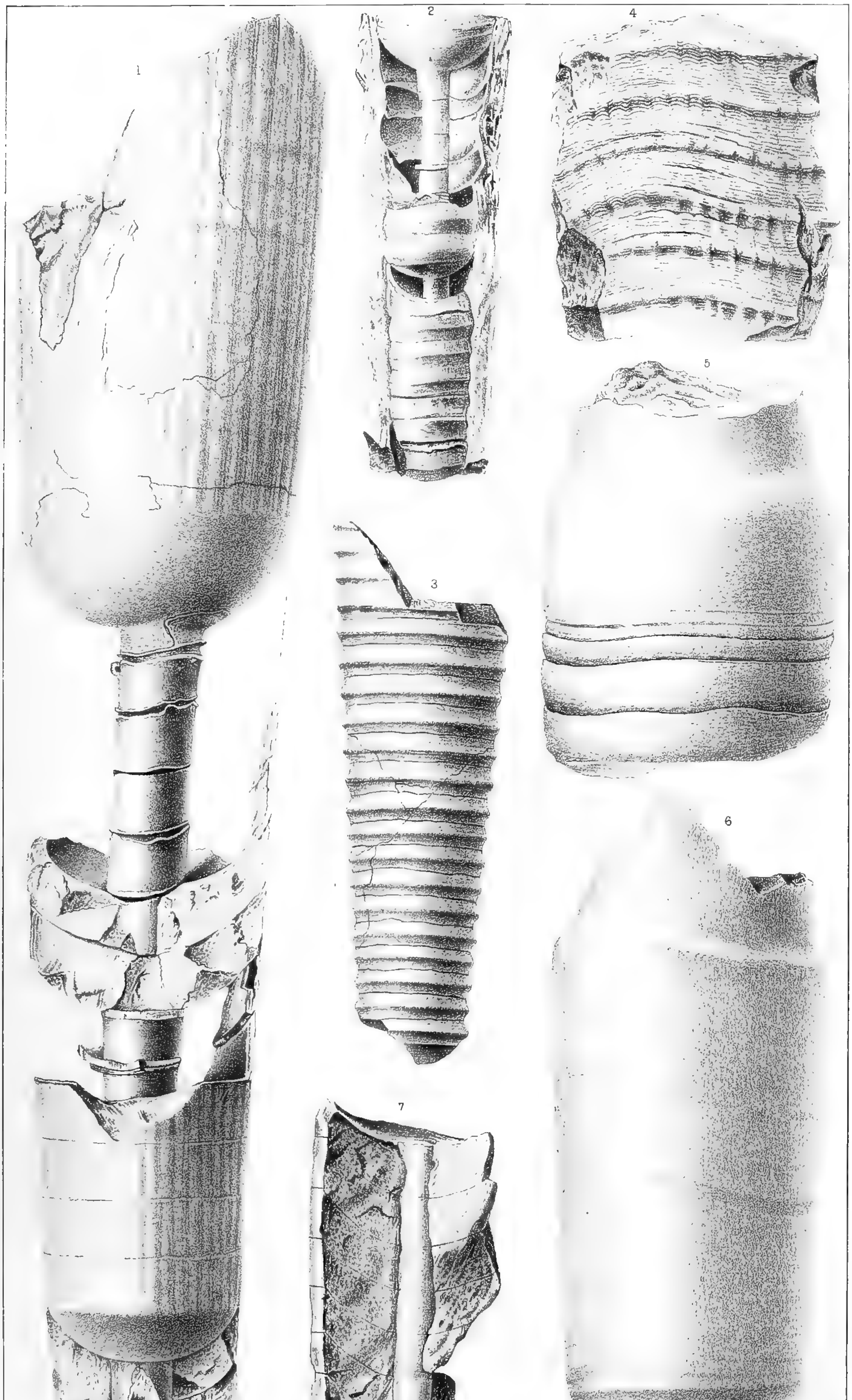
FIG. 5. View of a specimen of this species, showing a few of the septa, and the outer chamber strongly constricted below the aperture. This figure is erroneously referred in the text to *O. alienum*.

ORTHOCERAS ALIENUM, HALL.

Page 414.

FIG. 6. View of a cast of the outer chamber of this species, showing the gradually tapering form and the broad constriction near the aperture.
" 7. A section of a fragment, showing the septa and siphuncle.

(CEPHALOPODA.)



R. P. Whitfield. del

A. J. Ibbotson Lith

PLATE XXV.

Obolus conradi, Hall.

Page 375.

Fig. 1. Interior of a ventral valve, made from a cast in the natural mould.

" 2. Interior of a smaller ventral valve, obtained by the same process as fig. 1. The dotted lines show the extent of the cavities beneath the transverse plate.

" 3. Interior of a dorsal valve, taken from a gutta-percha cast in the natural mould. The figures 2 and 3 are from the same casts as those figured on plate 13.

Spirifera plicatella, var. *radiata, Sow.*

Page 378.

Fig. 4. Dorsal view of a large cast, showing the cavities left by the removal of the dental lamellæ and the septum of the dorsal valve.

" 5. Cardinal view of the same specimen as fig. 4, showing also the extent of the area.

" 6. An oblique view of the interior of both valves, showing the septa and dental lamellæ.

Pentamerus (Pentamerella) ventricosus, Hall.

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Figs. 7, 8. Dorsal and front views of an individual, showing the plications more distinctly than usual.

Pleurotomaria occidens, Hall.

Page 392.

Fig. 9. Lateral view of a very fine specimen, showing the external characters of the species.

" 10. View of the aperture. This specimen is from the Niagara limestone of Lyons, Iowa, received from Dr. Farnsworth.

Pleurotomaria (Trochonema) hoyi, Hall.

Page 393.

Figs. 11, 12. Lateral and basal views of a specimen of this species, showing the surface striæ and the wide umbilicus.

Trochonema (Cyclonema?) pauper, Hall.

Page 395.

Fig. 13. Lateral view of a specimen in the collection of the Michigan University, at Ann Arbor, received under the name of *Pleurotomaria Halei*.

Cyrtoceras brevicorne, Hall.

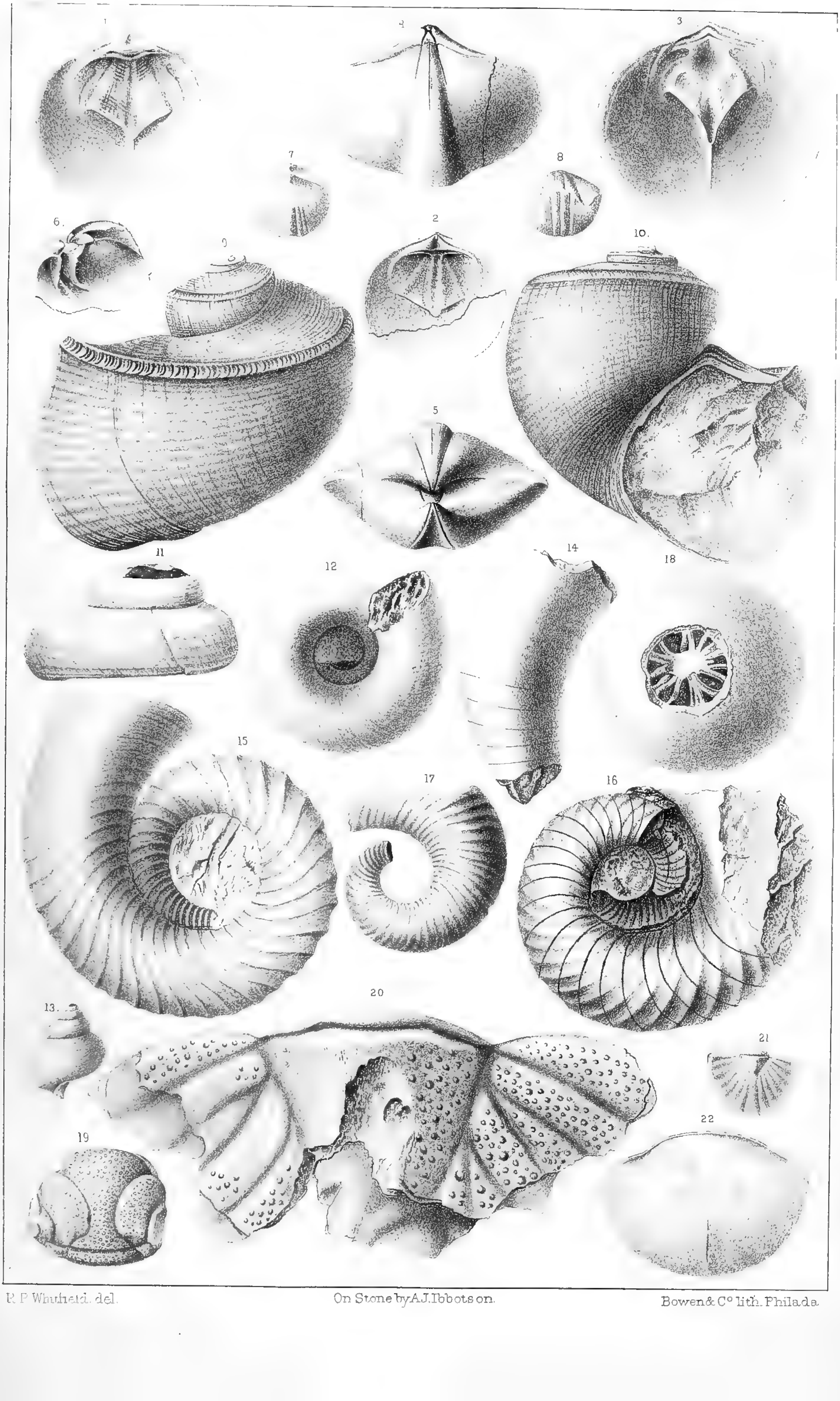
Page 407.

Fig. 14. Lateral view of a specimen, showing the septa.

Trochoceras costatum, Hall.

Page 402.

Fig. 15. Lateral view of the upper surface, from a gutta-percha cast in the natural mould.



R. P. Whitfield. del.

On Stone by A.J.Ibbotson.

Bowen & C° lith. Philada.

PLATE XXV—Continued.

TROCHOCERAS ÆNEAS, HALL.*

FIG. 16. View of the upper surface of the specimen described.

TROCHOCERAS (GYROCERAS) BANNISTERI, WINCH. & MAR.

Page 403.

FIG. 17. View of the specimen taken from a gutta-percha cast, of the umbilical side showing it to be a dextral species.

ORTHOCERAS ABNORME, HALL.

Page 415.

FIG. 18. Transverse section of a specimen, showing the ramifying processes within the siphuncle.

LICHAS OBVIUS, HALL.

Page 424.

FIG. 19. View of the glabella and lateral lobes of a specimen from the Niagara limestone at Lyons, Iowa.

LICHAS PUGNAX, WINCH. & MAR.

Page 424.

FIG. 20. The pygidium of this species, from the same specimen as the figure by Messrs. Winchell and Marcy, omitting the thoracic segments. Collection of Prof. Marcy.

BRONTEUS ACAMAS, HALL.

Page 422.

FIG 21. View of a small pygidium of this species. This figure is from the original of *Bronteus occasus*, W. & M.

ILLÆNUS ARMATUS, HALL.

Page 418.

FIG. 22. A pygidium of this species, enlarged to two diameters, from a specimen loaned by Prof. Winchell. The specimen shows a broad oval impression on each side of the median line and anterior to the middle. Similar marks have been observed on other specimens, and they may have been the areas of muscular attachment.

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* *Trochoceras æneas, nov. sp.*—Shell sinistral, closely coiled, volutions somewhat rapidly increasing in size, flattened above and rounded on the dorsum, the inner ones not projecting above the outer; number of volutions undetermined. Septa numerous, about four in a distance equal to the greatest diameter of those measured, moderately concave, but appearing more deeply so from the flattening of the volution; strongly arching forwards on the back, and less strongly on the ventral side.

Surface marked by moderately sharp undulations which are directed backwards from the inner to the outer sides of the volution, and arranged a little more closely than the septa, eleven of the latter equaling thirteen of the former on the dorsal margin.

This species differs from *T. costatum*, the only other sinistral species occurring in the same association, in the flattening of the upper side; the concentric undulations are finer than any other except *T. Bannisteri*, from which it differs in the flattened dorsum.

Formation and locality.—In rocks of the Niagara group, at Lyons, Iowa. The specimen was received from Dr Farnsworth.