ELEMENTARY NATURAL HISTORY SERIES

No. 2

KEY

TO THE

UPPER DEVONIAN

OF SOUTHERN

NEW YORK

* * *

Designed for Teachers and Students
In Secondary Schools

BY

GILBERT DENISON HARRIS

Assistant Professor, Paleontology and Stratigraphic Geology,
Cornell University;
Geologist to the State of Louisiana
Member of the Geological Society of France

ITHACA

For sale by the Co-Operative Society, Cornell University, Ithaca, N. Y.
Price: pamphlet form, 25 cts., postage, 3 cts.; flexible board, 30 cts., postage, 5 cts.

ELEMENTARY NATURAL HISTORY SERIES

No. 2

—— o ——

KEY

TO THE

UPPER DEVONIAN

OF SOUTHERN

NEW YORK

* * *

Designed for Teachers and Students
In Secondary Schools

—— o ——

BY

GILBERT DENNISON HARRIS

Assistant Professor, Paleontology and Stratigraphic Geology,
Cornell University,
Geologist to the State of Louisiana,
Member of the Geological Society of France

ITHACA:
Harris Co.
P

PREFACE

There is but one natural, practical and interesting way of learning the science of the earth—Geology—and that is by studying the earth itself. Experience has shown again and again that students who have gone through the ordinary text-book training in geology retain for a time some generalized ideas relating to the science, but of real geology they know little. Nor is it in any way a fault of theirs.

This pamphlet is intended to encourage students to teach themselves from rocks and fossils obtained near their respective homes. It will not take the place of the text-book, but will serve to introduce or supplement the same, and give its teachings more interest, more meaning. Noteworthy localities in the vicinity of each of the larger high schools and other institutions of learning are often referred to, thus intensifying the interest the learner may have in the science, by the thought always pleasant, of knowing about things near at home.

A work of this kind can, however, be of but local application; for were references made to the geology about every institution of learning in every state of the Union the size of the work and its consequent cost would defeat the very purpose for which it was written. As stated on the title page, this is applicable to the Upper Devonian (Portage and Chemung) rocks of southern New York.

Certain it is that much that is given on the following pages —and a great deal more—has already been published in the voluminous state reports on the geology and paleontology of New York, as well as in the Journals and Proceedings of scientific societies. But the average teacher and pupil have neither time nor inclination to use these learned tomes, even though the school library may possess them; they need something more convenient and better adapted to their use.

The preliminary statements in the first half of the work, when it is used as an introduction to a course in geology, are necessary to give full meaning to the latter half. When used as a supplement, it is believed they will still bear reviewing.

As soon as the student has outgrown this work he is in a position to make use of larger and more technical works. Those most important are:

Natural History of New York; Division 6, Paleontology;
Vol. 4, Brachiopoda, price $2.50.
Vol. 5, Pt. I, Lamellibranchiata (1) Monomyaria, $2.50.
" " " " " (2) Dimyaria, $2.50.
" " Pt. II, Gastropoda etc., $2.50.

Send orders to the Secretary of the University of the State of New York, Albany, N. Y.

The following very important and inexpensive works can be ordered from the Director of the U. S. Geological Survey, Washington, D. C., for prices which follow:

Bulletin 3, U. S. Geol. Survey, 1884, 36 pp., $0.05.
" 16, " " " " 1885, 86 pp., 3 pl., $0.05.
" 41, " " " " 1887, 121 " 4 " $0.15.
" 76, " " " " 1891, 393 " $0.25.
" 120, " " " " 1894, 81 " $0.10.

Topographic maps about Olean, Elmira and Ithaca at 5 cents each.

The 13th, 15th and 16th annual reports of the State Geologist contain a vast amount of information on the geology of southern and central New York. For conditions of distribution apply to the State Geologist, or the State Paleontologist, Albany, N. Y.

Two very important volumes now out of print, but to be had occasionally from second-hand dealers, are the large quarto volumes by Hall and Vanuxem, known as the Final Report of the State Geological Survey, volumes 3 and 4. They contain a great amount of local geological information. They are usually sold at $3.00 or $4.00 per volume.

Cornell University: G. D. Harris.
Sept. 30, 1899.

CONTENTS

PRELIMINARIES

PART I.

INTRODUCTION TO THE STUDY OF THE UPPER DEVONIAN OF NEW YORK STATE.

PART II.

THE UPPER DEVONIAN OF SOUTHERN NEW YORK.

—— * ——

EXPLANATION OF PLATE II.

Collecting Outfit.

1. A hammer ; preferably a bricklayer's hammer, like the one figured; cost, about.....$ 0.75
2. A cold-chisel ; cost, about..... ..... 0.25
3. A basket to carry specimens in; a basket rather than a bag because specimens from different localities can be kept separately more easily by a layer of paper and are not so apt to rub and grind against each other and spoil as when put in a bag.
4. Plenty of old newspaper for wrapping, and
5. A large, substantial lunch.

NOTE.—It is of course understood that this is a beginner's outfit. Need will soon be felt for a compass, note-book, clinometer, tape measure, Locke level, topographic maps, etc., etc.

Collecting Outfit

PART I.

INTRODUCTION TO THE STUDY OF THE UPPER DEVONIAN OF NEW YORK STATE.

Occurrence of Rocks.

Where rocks are seen.—The casual observer notices clays, sand and gravel along roads and in fields as he passes through the country; he notes here and there a boulder, or a stream-bed replete with flat stones, sees occasionally a quarry, a railroad cut, or a precipitous river bank where large masses of rock are exposed to view. Rarely does he stop to consider what these objects really are or how they came to be where they are. The story in each case is a long one, and this brief work will be limited chiefly to the last-mentioned class, namely those seen in quarries or other excavations, natural or artificial.

Rocks everywhere; a hard lesson.—At the outset the learner must grapple with and master one fundamental and all-important fact, for unless his mind is perfectly clear on the subject he can form no correct conception of what follows. The fact is this: Though large masses of hard rock are *usually observed* only where some natural or artificial digging has recently been going on, they *do exist* everywhere though hidden from view by a blanket of soft or loose earthy matter, like sands, soils and gravel. In mountainous regions where there is no soil the rocks are everywhere apparent, but in southern New York they are so generally covered over and hidden that their presence is often

and even generally unsuspected. That they do underlie the whole region can easily be proven by digging wells or sinking shafts anywhere to a moderate depth through the soil and loose material, when solid rocks are sure to be encountered. Plate III shows one of a vast number of instances where this universal state of affairs can be seen, viz., soft, loose earth or soil above, in which trees and vegetation in general thrive; firm rocks arranged in layers below.

Kinds of Devonian Rocks in Southern New York.

Shale.—While examining the rocks in any quarry or natural exposure in southern New York the student will observe that certain layers are quite thin, soft, and contain but little grit and are so fine in texture that the ordinary hand glass fails to reveal their component particles, save perhaps a bit of mica here and there. They can often be whittled with a knife and used as slate pencils without scratching the slate. These are termed shaly layers, or shale.

Sandstone.—Thicker, harder layers, usually very "gritty" and polishing or scratching a knife-blade when rubbed upon it, and containing grains of sand often large enough to be seen with a hand glass, or even the naked eye, are called sandstone layers or sandstone.

Calcareous layers, or limestone.—Hard layers, often thick and containing fragments of shell-fish and effervescing or bubbling when touched by a drop of strong acid are termed calcareous layers. In southern New York they are generally too impure to be properly termed limestone. They are sometimes called "fire stone." By long exposure to the atmosphere the lime (calcium carbonate) leaches out and the rock is left a soft dark brown or black crumbling mass, often retaining the casts or impressions of fossil shells.

Conglomerate.—A layer or bed composed of large pebbles (generally large white quartz pebbles) cemented together by other material is called a pudding stone or conglomerate.

Explanation of compound terms, like arenaceous shale, etc.—A layer or bed may show characters in common with several of the above-named kinds of rock. For example a shaly layer may contain some grit (sand, *arena*); it would then be termed arenaceous shale. It may be also more or less calcareous or limy and would then be spoken of as an arenaceous, calcareous shale. A sandstone may not be very gritty, and it may have considerable shaly matter in its composition and would then be styled an argillaceous or shaly sandstone. A sandstone or shale may be more or less calcareous; a sandstone may become a conglomerate if its pebbles are large. A conglomerate may be sandy or calcareous, and so on.

The noun in each case indicates the most important or essential characters of the rock, while the adjectives refer to the less important or casual features.

Definition and Explanation of a Few Important Geological Terms.

Joints.—As well shown in Plate III, there are often more or less vertical crevices or cracks traversing the rock layers in one or more directions. These are technically termed *joints*, and rocks possessing them are said to show a *jointed structure.* Two sets of joints are shown on Plate III, one nearly parallel to the lake shore, the other roughly at right angles to the first.

Dip.—That rocks when undisturbed lie in layers of various thickness one above the other, like boards in a pile, has already been mentioned. These various layers are, however, almost never perfectly horizontal, they incline or slope more or less in one direction or another. This inclination or slope is called the *dip* of the rocks and its amount and direction are determined as follows (see Fig. 1): The angle made by any of these layers and surface of the water, or any horizontal surface, is the *amount* of dip. The direction of any plane that cuts vertically any horizontal line drawn on the surface of any layer is the *direction of the dip.* The direction of the horizontal line drawn on the surface of any layer is termed the *strike* of the layer.

To determine the direction of dip a pocket compass is very useful. It is, according to the above definition, at right angles to the water line, as shown in Fig. 1. There are various ways of determining the amount of dip. Hold a level (see Fig. 1) over the arrow. Measure with a protractor or graduated limb of any kind the angle made between the level and the arrow, this is the amount of dip expressed in degrees. Again (see Fig. 1) measure up from water line any convenient number of feet or metres, say 15. There drop a perpendicular to the surface of the water, say 6½ feet or metres. Then 6½÷15 expresses the rate or amount of dip of these rocks.

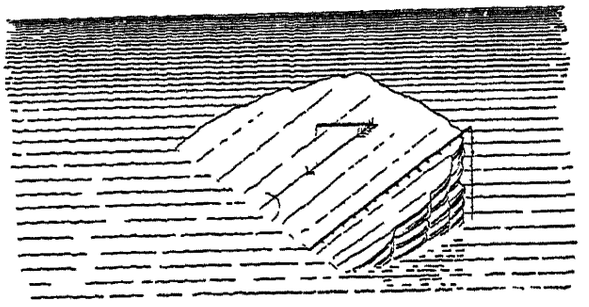


Fig. 1.

In the ordinary rock exposures one rarely finds the surface of layers or beds laid bare to any considerable extent; it is much more common to see them side-view, as in Plates I, III and IV. Plate III shows how the different layers if traced from "a" to "c" descend toward the right. This descent may or may not be the whole amount of dip of these layers. So far as the observer is concerned there may be a sloping or dipping cliff-wards or lake-wards as well as towards the right. Observations in gorges or cuts in other directions will enable the observer to determine the true dip of these rocks. Dip being a matter of the inclination of a plane, it is obvious that at least three points not in a straight line must be determined in order to fix the position of the plane. (See observation on opposite page.)

Considerable stress is here laid on the subject of dip, for as will be apparent upon due consideration of the subject, it furnishes the means of estimating the thickness of groups or formations where they have never been drilled through and measured vertically. In southern New York west of about the meridian of Binghamton the rocks dip to the southward at the rate of from 25 to 50 feet per mile, averaging perhaps 40 feet. If then one starts at Cortland and walks due south 50 miles and is at the same level above sea as when he started he knows he is on rocks stratigraphically about 40x50 ft. higher than those at Cortland.

Fossils.

What they are.—Very frequently we notice in fragments of rocks certain marks or imprints that seem to have been made by some organic being. They sometimes recall the shape and markings of certain sea-shells of today. As we break open more rocks and study more carefully all the markings, moulds and impressions we find the conclusion is irresistible that they were made by some kind of by-gone sea-shells, often quite different from those we see on the beaches to-day.

How they came to be in the Devonian rocks of Southern New York.—Sea-shells in solid rock? How came they there? These are the queries that perplexed even the wisest minds up to within a comparatively recent date; queries, too, that the collector must be ready to explain to every man who espies him and comes to see what he is collecting.

Observation.—Outcrops of one and the same layer may often be identified at considerable distances from each other. To determine the direction and amount of dip when three such outcrops are known, see the solution (graphic) of the following problem: A rock layer is found on one side of a valley at B, 200 metres higher than it is at A, 2 kilometres distant. At C, on the opposite side of the valley, its altitude above A, 2.1 kilometres distant, is 100 metres. The distance between C and B is 1.65 kilometre. The direction of the line C—B is north 20° west. Required the direction and amount of dip of this layer.

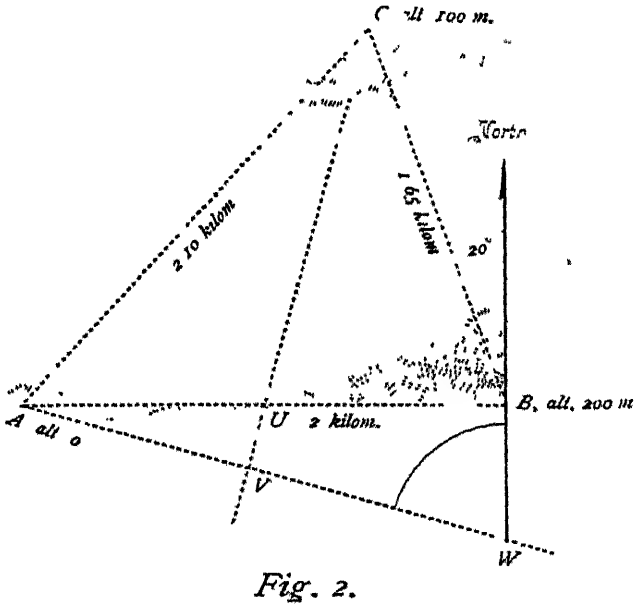


Fig. 2.

Find by proportion the point on A—B at an equal altitude with C. It is at U in this instance, half way from A to B. Draw C—U and continue it a short distance. Drop A—V perpendicular to C—U extended, and continue it to W. Measure angle A W B (here about 74°); this is the direction of dip, i. e., north about 74° west. V is by construction on C—V the *line of strike* 100 metres above A. Then if the distance A—V is found by measurement to be about .96 kil.=960 metres then 100÷960 is the amount of dip sought.

Look at the rocks themselves. What are they? Some are soft and decompose rapidly; others are harder and withstand the elements for a longer period. But all in course of time will disintegrate and form clay or sand, accordingly as they were shaly or sandy rocks. Such rocks are in fact nothing but hardened clayey or sandy mud. The shells in them prove that the sands and mud before hardening formed a part of an old sea-bottom where sea-shells lived, died, and were buried beneath more sand and mud washed over them by inflowing rivers. If the water is deep, or the bottom of the sea is gradually sinking, the thickness of such deposits may become very great—several thousands of feet. The lower beds become intensely compressed and hardened after the lapse of long ages, especially if they are subjected to volcanic heat and activity. If then a movement of the earth's crust takes place and these low-lying beds are raised above sea level they are visible to man in quarries and other places as heretofore stated, and he terms them "hard rocks"; the shells and other traces of life they contain are called fossils.

That the conditions under which the rocks in southern New York were deposited or formed may be clear to the mind of the reader the following two outline maps have been inserted (Fig's. 3 and 4). They both show the same area (see degrees of Lat.

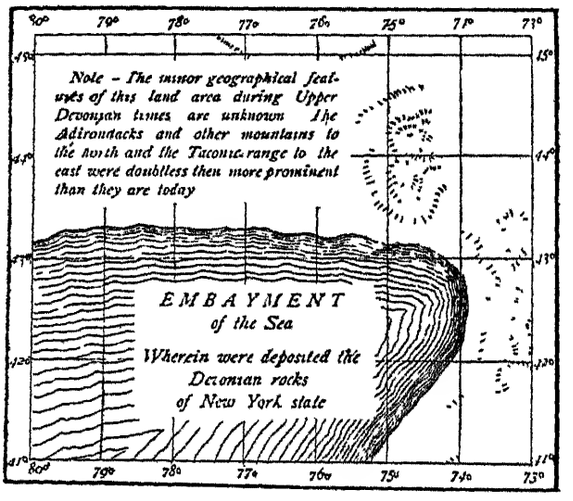


Fig. 3.

and Long.), the one approximately as the area appeared in Devonian times, the other as it appears to-day—showing especially

the distribution of the Portage and Chemung groups of southern New York. Into the Embayment of the sea flowed large rivers, and brought the sand, mud and slime among which lived the shells hereinafter figured. It is this vast accumulation of sedimentation that has subsequently been raised above sea-level and still later carved by flowing waters that makes the beautifully diversified region of southern New York.

The Portage material was deposited first, hence underlies, passes under, the Chemung. Beneath the Portage in turn are Middle Devonian, Hamilton beds, cropping out across the state north of the Portage. They passed through similar stages of formation to those of the Upper Devonian beds, though in a somewhat more remote period of time.

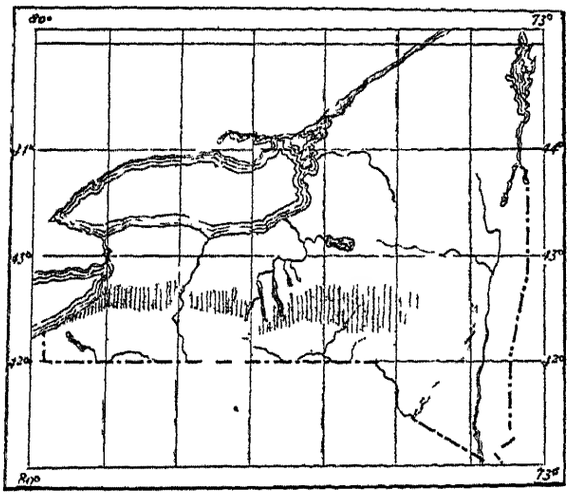


Fig. 4.

PART II.

THE UPPER DEVONIAN OF SOUTHERN NEW YORK.

SUBDIVISIONS

The Portage Group.—Many local names have been applied to the rocks of this group on account of their varied appearance at different localities. At base, from Chenango river westward to Lake Erie, is the *Genesee shale* a thin-bedded, fragile shaly mass, varying in thickness from a few feet only in the east to 125 feet in central New York Its fossils are few and generally small, and mainly confined to the basal and upper layers. (See Fig's. 1-9, Pl. V.) Fish remains are reported from these shales on the shore of Lake Erie and at a few other localities.

Above, are the *Sherburne* shales and sandstones in the east, the Lower Portage shaly sandstones of Cayuga lake section, the lower *Cashaqua* and *Gardeau* shales (Naples beds) and sandstones of the Genesee section and west to Lake Erie. Thickness, 150–250 feet. Fossils, rare: *Chonetes*, *Cardiola*, *Lunulicardium*, *Cladochonus*, etc. See Pl. V and VIII.

Still higher up in the Portage are the *Ithaca* beds of the Cayuga section and to the east, 300–500 feet thick, represented farther west by the upper *Naples* beds. Very fossilferous from Ithaca eastward. See Plates V–VIII. Somewhat fossiliferous westward, though bearing a very different fauna, especially characterized by coiled Cephalopods and fish remains.

Plate III [illegible]

[illegible]

Montagu Falls, Corpus River

Highest of all the Portage rocks are the *Oneonta* shales and sandstones in the east, the Upper Portage sandstones of Cayuga section and to the west; 500 feet thick; fossils scarce.

The Chemung Group.—The rocks of this group are so named from Chemung Narrows, Chemung county. (See Frontispiece, Pl. I). They are at least 1,200 feet thick and consist of gray shales and shaly sandstones often replete with large, well-preserved fossils, especially brachiopods. (See Pl. IX–XIII) In the western part of the state there are several "Rock cities" or outcrops of coarse conglomerates belonging to this group: the Salamanca, the Pope Hollow, the Panama and Charlotte conglomerates. These coarser layers when struck in oil wells in northwestern Pennsylvania are termed oil sands, since they are loose and porous and are veritable reservoirs of oil.

In the Catskills the Chemung rocks consist of red and green shales, sandstones and conglomerates, and form a part of what was once known as the *Catskill* group. Fossils rare, mostly land and fresh water species. See Fig. 124.

The above statements may be expressed briefly as follows:

	Western N. Y.	*Central N. Y.*	*Eastern N. Y.*
Chemung group	Shales, sandstones and conglomerates.	Typical Chemung shales and sandstones.	Catskill shales, sandstones and conglomerates
Portage group	Upper Portage sandstones Naples beds Cashaqua and Gardeau shales and sandstones	Upper Portage sandstones Ithaca beds Sherburne or Lower Portage shales and sandstones.	Oneonta shales and sandstones Ithaca beds Sherburne shales and sandstones.

Kinds of Life Represented by the Fossils of Southern New York.

Though the Devonian may be called the Age of Fishes on account of the considerable development of that class of animals in certain localities at that time, it does not necessarily follow that the young collector in this part of New York is going to fill at

once his basket with fish remains. On the contrary, he will search long and well before finding a trace of these animals. On the other hand, he will usually have no difficulty in obtaining all the fossils he cares to take home, but they will be shells, not fishes. In the Chemung rocks from Binghamton westward there are certain layers of rock almost made up of the remains of one little animal, *Spirifer disjunctus* (see Pl. XI, fig's 87, 88), a brachiopod that flourished during the Chemung period and then became extinct. Other brachiopods represented by Pl's. XI and XII are in places very common.

The true mollusks were well represented in the Chemung, as Pl's. IX, X and XI testify. Of these the lamellibranchs (Pl's. IX and X) were by far the most numerous. Cephalopods and gastropods were comparatively scarce.

Echinoderms were represented by a few crinoids and other rarer forms. Bryozoans and corals are locally abundant, but generally scarce. The same remark applies to the sponges. Trilobites, and other crustaceans generally, are very scarce.

Fragments of plants are of quite common occurrence, though identifyable specimens are rare. They belong to tree-ferns and tree-lycopods.

Of the Portage group, the Ithaca beds are characterized by a brachiopod fauna, whereas the Naples beds to the west are characterized by cephalopods, fishes, lamellibranchs and gastropods.

List of a Few Important Localities, with Kinds of Rock, Location of Outcrops, and Some of the More Important Fossils at Each.*

Addison.—*Rocks:* Light grayish-green sandstone and shale.

Exposure: Bear's Falls. Best fossils found below falls, about 60 ft. above creek bed in a layer 1½ ft. thick; *Spirifer* and *Atrypa* especially abundant.

Fossils: Spirifer disjunctus (87)†, *Athyris angelica* (97), *Stropheodonta cayuta* (115), *Grammysia*, somewhat like (22), *Orthothetes chemungensis* (117), *Pterinea chemungensis* (67), *Schizodus* sp., see fig. 77, *Atrypa aspera?* (101), *Strophonella cælata* (118), *Stropheodonta perplana* var. *nervosa* (114), *Productella lachrymosa* (102), *Atrypa reticularis* (54).

Alfred.—*Rocks:* Coarse, light brownish, greenish and grayish sandstone, and light grayish shale.

Exposure: Terra-Cotta quarry. Bank 100 ft. high; 1 ft. layer at top, very fossiliferous. Fossils also found in creek bed below in the so-called blue stone.

Fossils; Spirifer disjunctus (87), *Sp. mesacostalis* (40), *Mytilarca chemungensis* (73), *Schizophoria impressa* (52–53), *Schizophoria tioga* (111), *Camarotœchia contracta* (90–91), *C. orbicularis* (92–93), *Productella hirsuta* (105–106), *P. lachrymosa* var. (103), *Euomphalus hecale* (86), *Dictiophyton tuberosum* (119), *Sanguino-*

---

*The number of good collecting localities can be multiplied almost indefinitely. Specimens from localities not mentioned in this list are usually similar if not identical with those from the nearest given locality. Only a small part of the fossil fauna at each locality can be given here.

†These figures refer to the number placed by the side of each illustration on Plates V—XIII.

Note.—The writer is under obligation to Mr. T. A. Caine, C. U., 1901, for information and collections from Binghamton, Owego, Elmira, Corning, Addison, Hornellsville, Alfred, Olean, Salamanca, Randolph, Ellicottville, Mt Morris and Bath. Otherwise when no credit is given, the writer is personally responsible for the localities and fossils mentioned.

lites truncata (75), *Leptodesma lichas* (72), a Cystidian (120), *Edmondia*, *Schizodus*, *Sphenotus clavulus* (79), *Leptodesma potens* (70), *Grammysia* sp.

Bath.—*Rocks:* Light greenish gray, irregularly bedded sandy shales.

Fossils: *Atrypa reticularis* (54), *Cyrtina hamiltonensis* (45), *Productella truncata* (47–48), crinoid stems, *Bryozoa* (123), *Stropheodonta* sp., *Manticoceras* (see Fig. 35 *a*—*a*).

Belmont.—*Rocks:* Sandstone and olive shale.

Exposures: Quarries near-by.

Fossils: *Spirifer mesacostalis* (40), *Schizophoria impressa* (52–53), *Orthothetes chemungensis* (116–117), *Camarotœchia contracta* (90–91), *Productella hirsuta* (105–106).—H. S. Williams.

Binghamton.—*Rocks:* Grayish arenaceous shales and shaly sandstone.

Fossils: *Spirifer disjunctus* (87), *Goniophora chemungensis* (81), *Schizophoria impressa* (52–53), *Ambocœlia umbonata* (108–109), *Microdon bellistriatus* (20), *Pterinea chemungensis* (67), *Rhipidomella vanuxemi* (110).

Chautauqua.—*Rocks:* Light grayish or greenish shales and sandstone.

Exposures: Near-by quarries and stream beds. See also loose flat stones in fields and at roadside.

Fossils: *Spirifer disjunctus* (87), *Camarotœchia contracta* (90–91), *Productella lachrymosa* (102–104), *Ambocœlia umbonata* (108–108), *Mytilarca chemungensis* (73), *Sphenotus contractus* (78), crinoid stems (122).

The Panama conglomerate can be seen by driving to Panama or visiting the "Rock quarry" near the "Checkered schoolhouse" N. W. of Ashville on the summit of the high hill. At latter place see *Euomphalus* (Fig. 86).

Corning.—*Rocks:* Gray sandstone, sometimes very calcareous, and shale.

Exposure: Kelley's quarry, just back of convent.

Fossils: *Schizophoria impressa* (52–53), *Spirifer disjunctus* (87), *Sp. mesacostalis* (40), *Mytilarca chemungensis* (73), *Ambocœlia umbonata* (108-109), *Orthothetes chemungensis* (117).

Cortland.—Lithological and faunal characters very similar to those of Ithaca, which see.

Cuba.—*Rocks:* Gray sandstone, often calcareous, and olive shale.

Exposures: Guilford quarry; Smith quarry; ravine in South Cuba.

Fossils: *Spirifer disjunctus* (87), *Orthothetes chemungensis* (117), *Chonetes scitula* (50), *Camarotœchia contracta* (90-91), *Athyris angelica* (97, 99), *Productellæ*, etc.—H. S. Williams.

Delhi.—*Rocks:* Red, gray and green sandstone and shale.

Exposures: Silver lake, or Robinson's pond, 5 miles west of Delhi; roadside above lake. This is practically the eastern termination of the Chemung fauna.

Fossils: *Spirifer mesacostalis* (40), *Ptychopteria*, *Leptodesma* and a few others.—C. S. Prosser.

Ellicottville.—*Rocks:* Greenish gray sandstone and shale.

Exposures: Numerous ravines on hillsides, especially those on the hill west of town.

Fossils: *Spirifer disjunctus* (87). *Athyris angelica* (97), *Dalmanella leoninsis* (113), *Orthothetes chemungensis* (117), and many others.

Visit the Salamanca conglomerate, a typical "Rock city," 5 or 6 miles southwest of town.

Ellington.—*Rocks:* Gray, reddish and bluish shales; micaceous brown shale; gray sandstone.

Exposures: South of creamery; Clear creek, west branch in particular.

Fossils: *Spirifer disjunctus* (87), *Ambocœlia umbonata* (108-109), *Athyris angelica* (97), *Camarotœchia duplicata* (94), *Productella*, *Leptodesma*, *Edmondia*, *Sphenotus*, etc.

Go from Cherry creek to Charlotte Center and see huge boulders of Charlotte conglomerate. Its fauna is practically the same as that of the brownish sandstone at Alfred. Visit Portage rocks in Canadaway creek gorge.

Elmira.—*Rocks:* Grayish and greenish gray sandstone and shale, often calcareous.

Exposures: Quarries on East hill, especially H. G. Platt's.

Fossils Spirifer disjunctus (87), *Sp. mesacostalis* (40), *Schizophoria impressa* (52-53), *Ambocœlia umbonata* (108-109), *Productella speciosa* (46), *Schizophoria tioga* (111), *Stropheodonta cayuta* (115), *Orthothetes chemungensis* (116), *Pterinea chemungensis* (67), *Atrypa reticularis* (54), *Atrypa aspera* (101), *Spathella typica* (25), *Leptodesma*, fossil wood.

Visit cliffs up Chemung river west from the city.

Forestville.—*Rocks:* Black and iron-stained shale, with calcareous concretions.

Exposures: Walnut creek, 30 ft. below R. R. and about 10 rods down the creek. A typical western New York Portage fauna: *Platyceras*, *Palæoneilo constricta* (13), *Prœcardium venustum*, *Leptodesma*, *Loxonema*, *Bellerophon*, *Orthoceras*, *Goniatites*, 2 species, *Chonetes scitula* (50), crinoid stems, and sea-weed (*Fucoides velum*).

See fold in rocks 6 rods north of R. R. culvert. About 20 rods above culvert, fissile blue-green shale with concretions (septaria). Fossils as above.

Little ravine ⅔ mile south of tannery contains in layers *Productellæ* in abundance.

Visit lake shore and break up all calcareous concretions for fossils.

Fredonia.—*Rocks:* Light and dark gray shale; sandstone to the south of Laona at water-works.

Exposures: Lake shore, Portage shale. Portage sandstone to the south of Laona. Chemung arenaceous shales on the hillside at Alden's quarry, ½ mile west of Cassadaga lake. Visit cuts on D. A. V. & P. R. R.

Fossils in Alden's quarry: Camarotœchia duplicata (94), *Ambocœlia umbonata* (108-109), *Productellæ*, etc.

Visit the ravines of Canadaway creek.

Friendship.—Prof. H. S. Williams records similar fossils and rocks here at Miller's quarry and ravine south of town as are to be found at South Cuba, which see.

Hornellsville.—*Rocks* Black and olive shales below (Portage in affinities); gray sandstone and shales upon the hills (see Sherwood's quarry).

Exposures Railroad cut west of the station with *Cardiola retrostriata* (11), *Bactrites acicula* (36), *Productella speciosa* (46), *Cladochonus* (61), *Schizophoria impressa* (52-53).—H. S. Williams.

In quarries 3 miles southwest of town: *Spirifer disjunctus* (87), *Spirifer mesacostalis* (40), *Mytilarca chemungensis* (73), *Schizophoria impressa* (52-53), *Schiz. tioga* (111), *Athyris angelica* (97), *Orthothetes chemungensis* (116-117), *Euomphalus hecale* (86), *Rhipidomella vanuxemi* (110).

Ithaca.—*Rocks:* Bluish gray sandstone and shale, and nearly black shale.

Genesee beds with fossils (Fig's. 1-7 and 9, Pl. V) at Esty's glen, lower portion of glen, 4 ft. below hard sandstone ledge. Also ¼ mile south of Glenwood. Lower 100 ft. in Taughannock gorge.

Lower Portage sandstone with true Portage or western fauna: McKinney's station; at foot of Ithaca falls.

Ithaca shale: Williams brook, southwest corner of lake, just above R. R.

Ithaca sandstone with *Cryptonella eudora:* University quarries; quarries at base of South hill.

Typical Ithaca brachiopod fauna: Triphammer falls; Eddy's dam; quarries on South hill, including the old Inclined plane.

Fossils: See Pl's. V—VIII.

Excursions: Taughannock glen; Tully or upper Hamilton limestone at entrance; farther in, lower 100 ft., Genesee shale; upper 100 ft., lower Portage.

Obtain *Spirifer levis* at base of Ithaca falls, south side, ledge 2 ft. above water level. Obtain Fig. 62 from shale back of the old Esty barn.

Jamestown.—*Rocks:* Grayish or greenish-gray sandstone and shale; often calcareous.

Exposures: East Jamestown quarries, with *Amboccelia umbonata* (108-109), *Productella hystricula* (107), *Camarotœchia contracta* (90-91), *Cam. duplicata* (94), *Dalmanella leonensis* (113), *Athyris angelica* (97), *Athyris polita* (98), *Spirifer disjunctus* (small) (87), *Mytilarca chemungensis* (73), *Sphenotus contractus* (78), crinoid stems, Bryozoa.

Visit quarries on eastern flank of hill north of Falconer, the quarries and little ravines on Swede and English hills, and obtain *Leptodesma potens* (70-71) and other fine Chemung species.

Excursions: Panama conglomerate at Panama, 14 miles west of town. Fossils: *Ptychopteria* (74), *Leptodesma*, etc. Return by Checkered schoolhouse above Ashville and see same conglomerate with *Eumphalus* (86). Visit Pope Hollow 10 miles east of town, just in Cattaraugus county. Observe Pope Hollow conglomerate high up on north flank of the Hollow. It is stratigraphically about 180 ft. above the Panama conglomerate. Climb up north declivity. Fossils numerous. Observe Chautauqua lake from crest of hill.

Mt. Morris.—*Rocks:* Dark gray, and nearly black shale. Also thick beds of argillaceous sandstone.

Exposure: Genesee river banks, just above old wooden bridge.

Fossils: Lunulicardium fragile (17), *Lingula*, *Orthoceras*, scarce.

Naples.—*Rocks;* Black shale, gray sandy shale, thick, heavy-bedded sandstone.

Exposures: Genesee shale, near Woodville hotel at head of Canandaigua lake, with *Lunulicardium fragile* (17) and others.

Grimes gully, near knife factory; Portage shale with many plant remains. At 3d falls a bed with *Cardiola retrostriata* (11), *Pleurotomaria capillaria* (31), *Manticoceras patersoni* (35 *a*—*a*), *Bactrites*. A 2d bed with *Leiorhynchus*, *Atrypa reticularis* (54), *Ambocœlia umbonata* var. *gregaria* (108).

Chemung rocks exposed two miles south of Naples; a "little south of the schoolhouse on the road from Naples to Ingleside. This layer is exposed by the roadside near the foot of the hill, five or six rods from the Ingleside road", the fossils are: *Dictyophyton tuberosum* (119), *Spirifer mesacostalis* (40), *Atrypa hystrix* (100), *Productella speciosa* (46), *Ambocœlia*, etc.—Luther.

Norwich.—*Rocks:* Gray shaly sandstone and shales.

Exposures: 1½ miles south of Norwich, valley road, on Wm. Breed's land; 1 mile west of Norwich quarry on John Brookin's.

Fossils: Tropidoleptus carinatus (96), *Actinopteria boydi* (18), *Cyrtina hamiltonensis* (45), *Chonetes scitula* (50), *Leiorhynchus mesacostalis* (44), *Spirifer mesastrialis* (39), *Schizodus*, *Phacops rana* (63), and others.—Clarke.

Another outcrop with similar fossils is reported by Prof. Prosser from railroad cut ¼ mile north of D. L. & W. station. It contains also *Atrypa reticularis* (54).

Olean.—*Rocks* (lower): Gray shaly sandstone and shales.

Rocks (upper): Red shales and conglomerate (Carboniferous) at Rock city.

Fossils (below, around the town): *Camarotœchia contracta* (90-91), *Athyris angelica* (99), *Spirifer disjunctus* (87), *Productella hystricula* (107), *Sphenotus clavulus* (79), *Leptodesma potens* (70-71), *Mytilarca chemungensis* (73), fish bones and plant fragments.—H. S. Williams.

Ferruginous sandstone below the Olean conglomerate contains *Spirifer disjunctus* (87) and *Rhynchonella allegania* (95).

Owego.—*Rocks:* Grayish sandstone and shale.

Exposure: Allen ravine (Stearn's quarry) 1½ miles northwest of town. Observe large, beautiful casts of *Lovonema.*

Fossils: Spirifer disjunctus (87), *Sp. mesacostalis* (40), *Schizophoria impressa* (52-53), *Ambocœlia umbonata* (108-109), *Orthothetes chemungensis* (116-117), *Atrypa reticularis* (54), *Lovonema terebra* (85), Bryozoa, crinoid stems, etc.

Randolph.—*Rocks:* Grayish micaceous sandstone and shale.

Exposures: Geo. Hubbard's quarry, 2½ miles south of depot. Also along Battle creek from creamery to reservoir.

Fossils: Spirifer disjunctus (87), *Schizophoria impressa* (52-53), *Athyris angelica* (97), *Dalmanella leonensis* (113), *Camarotœchia duplicata* (94), *Mytilarca chemungensis* (73), *Sphenotus contractus* (78), and many others.

Salamanca.—*Rocks:* Light gray or greenish-gray sandstone and shale. Conglomerates, 1 to 3 miles north.

Exposure: Whalen hill, northwest of town, 100 ft. above creek, ledges along roadside.

Fossils: Spirifer disjunctus (87), *Athyris angelica* (97), *Camarotœchia duplicata* (94), *Mytilarca chemungensis* (73).

Excursion: Visit conglomerate ledge 1 mile north of town east of the water reservoir. Two miles farther north is a celebrated "Rock city." It is a flat pebble Chemung conglomerate.

Wellsville.—*Rocks:* Grayish sandstone and olive shale.

Exposure: Quarry about 100 ft. above R. R. station.

Fossils: Spirifer disjunctus (87), *Productella hirsuta* (105), *Ambocœlia umbonata* (108-109), *Goniophora chemungensis* (81), *Macrodon chemungensis* (76), *Orthoceras, Aviculopecten, Crenipecten,* fish scales, etc.—H. S. Williams.

Waverly.—*Rocks:* Light and dark grayish shaly sandstone and grayish shale.

Exposures: Side of Erie railway, (see Frontispiece, Pl. I,) especially in a little ravine leading up to the quarries. Cayuta creek valley, quarries 2 miles north of East Waverly. Quarries on hillside east of Sayre.

Fossils: *Spirifer disjunctus* (87), *Pterinea chemungensis* (67), *Pt. reversa* (68), *Schizodus chemungensis* (77), *Goniophora chemungensis* (81), *Palæoneilo bisulcata* (82), *Microdon bellistriatus* (20), *Mytilarca chemungensis* (73), *Stropheodonta cayuta* (115), *Orthothetes chemungensis* (116-117), *Schizophoria tioga* (111-112), *Sc. impressa* (52-53), *Atrypa aspera* (101), *A. reticularis* (54), *Spirifer mesacostalis* (40), *Tropidoleptus carinatus* (96), *Productella lachrymosa* (102-104), *Ambocœlia umbonata* (108–109), *Camarotœchia contracta* (90-91), *Pleurotomaria*, *Loxonema*, corals, crinoid stems, and many others.

———— o ————

Explanation of Plate V.

(Portage Fossils.)

Fig's. 1–9 especially characteristic of the Genesee beds.

Fig.

1. *Orbiculoidea lodensis.* Brachial valve. Common in uppermost beds of the Genesee shale. A Brachiopod.
2. *Lingula spatulata.* Genesee and Ithaca Portage beds, eastward.* A Brachiopod.
3. *Schizobolus concentricus.* Upper Genesee shale. A Brachiopod.

4&5. *Ambocœlia umbonata.* Distorted somewhat; both valves; more common in Ithaca Portage, eastward, and in the Chemung.

6. *Chonetes lepidus.* Commoner in Portage beds to the east.
7. *Styliolina fissurella.* A Pteropod. Uppermost Genesee beds.

*By the words "eastward," "east," or "eastern" it is meant that the species is more abundant to the east of a line drawn from about Seneca lake southward. "West," etc., indicate its predominance in that part of the State west of the same meridian.

8. *Goniatites complanatus.* A Cephalopod. Commoner in Portage above. Found at very base of Genesee shale from Cayuga lake to Lake Erie.
9. Fragment of a stem of a plant, common in uppermost Genesee ledges.

(Portage Pelecypoda)

10. *Cardiola* (species?). Lower Portage sandstone horizon, westward.
11. *Cardiola retrostriata.* " " " " westward.
12. *Palæoneilo filosa.* Middle Portage, eastward. Eastern Chemung.
13. *Palæoneilo constricta.* East and west Portage and east Chemung.
14. *Nucula corbuliformis*, probably. East Portage and east Chemung.
15. *Modiomorpha subalata* var. *chemungensis.* Portage, eastward.
16. *Leptodesma sociale.* Middle Portage shale; western Chemung.
17. *Lunulicardium fragile.* Genesee and middle Portage beds.
18. *Actinopteria boydi.* Middle Portage and eastern Chemung.
19. *Goniophora* cf. *minor.* Middle Portage, eastward.
20. *Microdon bellistriatus.* Middle Portage, eastward and east Chemung.
21. *Grammysia subarcuata.* " " "
22. *Grammysia elliptica.* " " "
23. *Schizodus chemungensis.* Middle Portage, eastward and eastern Chemung. See also Pl. X, fig. 77.
24. *Mytilarca chemungensis*, variety. Middle Portage, eastward and east and west Chemung. See also Pl. X, fig. 73.
25. *Spathella typica.* Middle east Portage and east Chemung.

NOTE.——The figures shown on this and other plates are usually from one-half to two-thirds life size.

Explanation of Plate VI.

(Portage Gastropoda, Cephalopoda, Pteropoda.)

Fig.

26–27. *Bellerophon ithacensis.* Rare, at Ithaca.

28. *Platyceras* sp. Middle Portage and Chemung.

29. *Macrocheilus* (sp. probably *macrostomus* distorted). Middle Portage.

30. *Loxonema* (sp. probably *delphicola*, eroded). Middle Portage, but generally a Hamilton species.

31. *Pleurotomaria capillaria.* Middle Portage and Chemung. Also in Hamilton beds below.

32. *Gomphoceras tumidum.* Middle Portage.

33. *Orthoceras bebryx* var. *cayuga* (about ⅔ nat. size). Middle Portage. Common.

34. *Orthoceras demus.* Middle Portage. Ithaca.

35. *Tornoceras peracutum.* Outline showing sigmoidal suture lines. From middle Portage at Ithaca. In *Manticoceras patersoni*, a characteristic west Portage Cephalopod, the suture lines run as indicated by *a*—*a*.

36. *Bactrites acicula.* Middle Portage and eastern Chemung.

37. *Tentaculites spiculus.* Middle Portage. Rare.

Explanation of Plate VII.

(Portage Brachiopoda.)

Fig.

38. *Spirifer levis.* Lower Portage sandstone, eastward. About ⅔ nat. size.

39. *Spirifer mesastrialis.* Middle Portage and Chemung, eastward.

40. *Spirifer mesacostalis.* " " " "

41–2. *Camarotœchia eximia.* " " " " "
ward.

43. *Pugnax pugnus.* " " " " "
ward.

44. *Leiorhynchus mesacostalis.* Middle Portage, eastward.
45. *Cyrtina hamiltonensis.* Middle Portage and Chemung, eastward, and Hamilton shales.
46. *Productella speciosa.* Middle Portage and Chemung.
47–8. *Productella truncata* " " " lower beds.
49. *Stropheodonta mucronata.* Middle Portage, eastward.
50. *Choncetes scitula.* Portage and Chemung, locally very abundant.
51. *Cryptonella eudora.* Middle, east Portage, rare in Chemung.
52–3. *Schizophoria impressa* (both valves, interior casts). Middle, east Portage and E. and W. Chemung.
54. *Atrypa reticularis.* East Portage and east Chemung. Very abundant in Hamilton beds below.
55. *Lingula complanata.* Middle Portage shale.
56. *Crania hamiltoniæ* (showing muscular scars). Middle east Portage and below.
57. The same; showing traces of *Stropheodonta mucronata* through the shell.
58. *Lingula punctata.* Middle east Portage (and Chemung?).

Explanation of Plate VIII.

(Portage fossils of various classes.)

Fig.

59. *Conularia congregata.* Middle, east Portage. A Pteropod. Regarded by some as a Cephalopod.
60. *Stictopora meeki.* Portage. A Bryozoan.
61. *Cladochonus* sp. Lower Portage sandstone. A coralline form.
62. *Plumalina plumaria.* Middle to lower Portage, eastward. A Hydrozoan. Sometimes regarded as a fern.
63. *Phacops rana.* Lower and middle Portage, eastward, rarely in Chemung. Abundant in Hamilton beds. A Trilobite.

Explanation of Plate IX.

(Chemung Pelecypoda.)

Fig.

64. *Aviculopecten tenuis.* Western Chemung. Rare.
65. *Aviculopecten duplicatus.* " " Common.
66. *Crenipecten crenulatus.* " " "
Specimen somewhat distorted.
67. *Pterinea chemungensis.* Eastern Chemung. Common.
Left valve. See 69.
68. *Pterinea reversa.* " " Rare.
69. *Pterinea chemungensis.* Right valve. See 67.
70. *Leptodesma potens.* Western Chemung. Common. Left valve.
71. *Leptodesma potens.* Right valve.
72. *Leptodesma lichas.* Western Chemung. Common.

Explanation of Plate X.

(Chemung Pelecypoda.)

Fig.

73. *Mytilarca chemungensis.* Chemung. Common.
74. *Ptychopteria* sp. Common locally in conglomerates and closely associated rocks of western N. Y.
75. *Sanguinolites undulatus.* Western Chemung. Rare.
76. *Macrodon chemungensis.* Eastern " "
77. *Schizodus chemungensis* var. *quadrangularis.* Eastern Chemung. Common.
78. *Sphenotus contractus.* Western Chemung. Common.
79. *Sphenotus clavulus.* " " " locally.
Generally rare.
80. *Edmondia philipi.* " " "
81. *Goniophora chemungensis.* Eastern " Rare.
82. *Palæoneilo bisulcata.* " " "
83. *Modiomorpha mytiloides.* " " and Portage.
Rare. Abundant in Hamilton beds.

Explanation of Plate XI.

(Chemung Cephalopoda, Gastropoda, and Brachiopoda.)

Fig.

84. *Orthoceras* sp. Common in both Chemung and Portage rocks.
85. *Loxonema terebra.* Eastern Chemung. Locally common.
86. *Euomphalus hecale.* Western New York. Chemung conglomerates and associated rocks.—After Hall.
87. *Spirifer disjunctus.* East and west Chemung. The most characteristic and abundant Chemung fossil. Opposite valve similar except with medial fold in place of sinus.
88. *Spirifer disjunctus.* Internal cast of same valve as represented by fig. 87.
89. *Spirifer mesacostalis.* Same species as fig. 40. Showing extreme cardinal cuspidation. East Portage, east and west Chemung.
90. *Camarotœchia contracta.* East and west Chemung. Common. Brachial valve.
91. Same species as fig. 90; pedicle valve, deeply imbedded in rock.
92. *Camarotœchia orbicularis.* Western Chemung. Rare.
93. " "
94. " *duplicata.* Both valves. Western Chemung.
95. " *allegania.* Western N. Y. Sandstone just below Olean conglomerate.
96. *Tropidoleptus carinatus.* East Portage and east Chemung.
97. *Athyris angelica*, somewhat decorticated. Western Chemung. Common.
98. *Athyris polita*, internal cast. West Chemung. Rare—common.
99. *Athyris angelica*, perfect, with very fine radiating striæ.

Explanation of Plate XII.

(Chemung Brachiopoda.)

Fig.

100. *Atrypa hystrix.* Exfoliated. West Chemung.
101. *Atrypa aspera*, var. Eastern and western Chemung.
102. *Productella lachrymosa.* Chemung, especially western.
103. " " var. *stigmata.* W. Chemung.
104. " " Imprint of brachial valve.
105. " *hirsuta.* Western Chemung. Pedicle valve.
106. Same as fig. 105; opposite, or brachial valve.
107. *Productella hystricula.* Western Chemung.
108. *Amboccelia umbonata* var. *gregaria.* Interior cast of pedicle valve. Chemung. Common.
109. Same as 108, brachial valve.
110. *Rhipidomella vanuxemi.* Cast of interior of pedicle valve. East Portage and east Chemung.
111. *Schizophoria tioga.* Imprint of exterior of pedicle valve. Chemung, mostly eastern.
112. Same as 111. Sarface more or less exfoliated.
113. *Dalmanella leonensis.* Cast of interior of pedicle valve, and the exterior of the same valve. Western Chemung, especially Cattaraugus and Chautauqua Co's.
114. *Stropheodonta perplana* var. *nervosa.* Cast. Eastern Chemung.
115. *Stropheodonta cayuta.* Eastern Chemung, mostly. Common.
116. *Orthothetes chemungensis.* Chemung, east and west.

Explanation of Plate XIII.

Fig.

117. *Orthothetes chemungensis.* Somewhat eroded pedicle valve. Common.
118. *Strophonella cælata.* Interior of brachial valve. Central Chemung. Rare.

(Sponge.)

119. *Dictiophyton tuberosum.* Common locally in lower Chemung, especially on Mr. Cotton's place near Avoca.

(Echinoderms.)

120. A Cystidean. In drift at Alfred

121. Crinoid stems and calyx, small.

122. Transverse sections of larger crinoid stems. Very common locally in Portage and Chemung rocks.

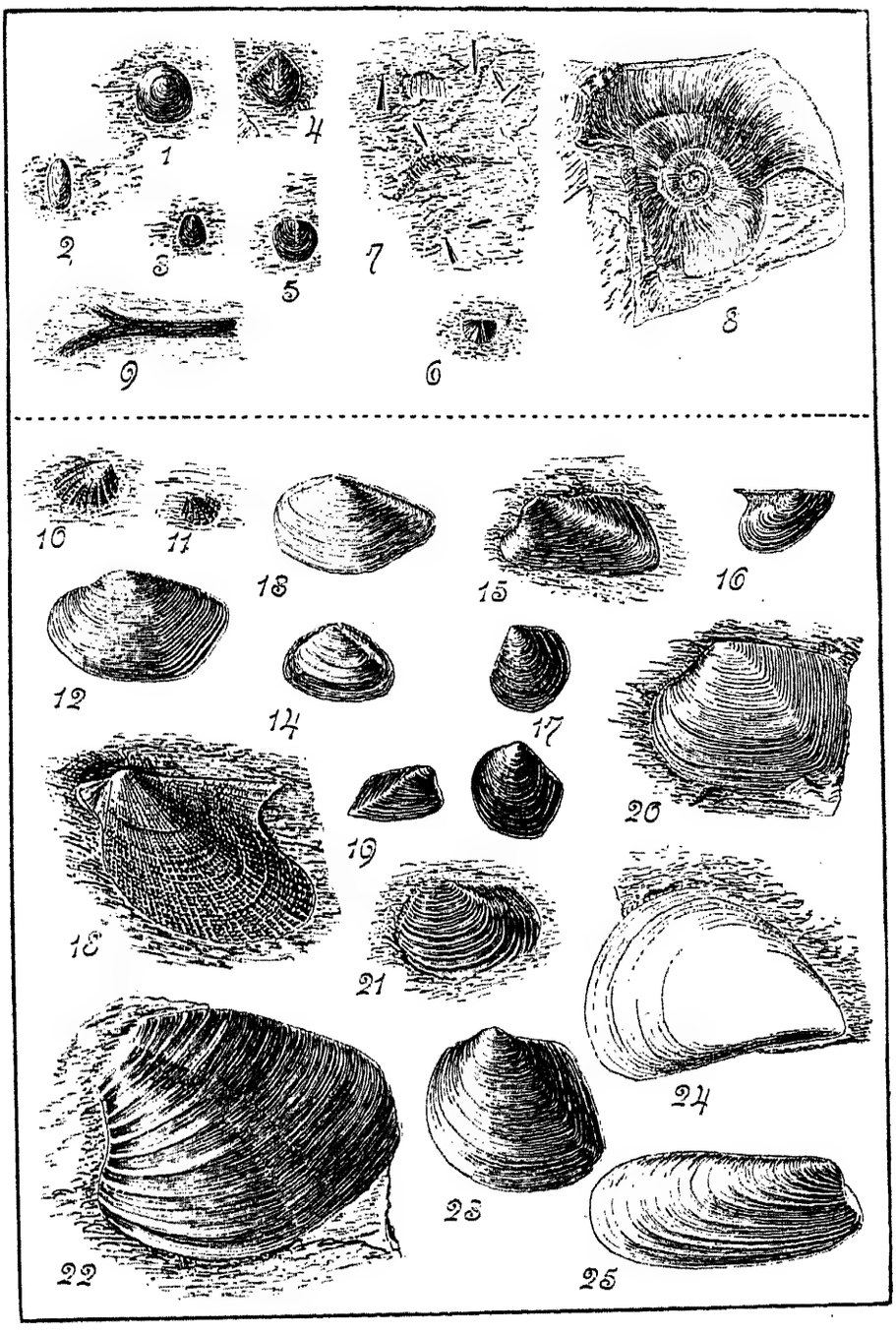
(Bryozoa.)

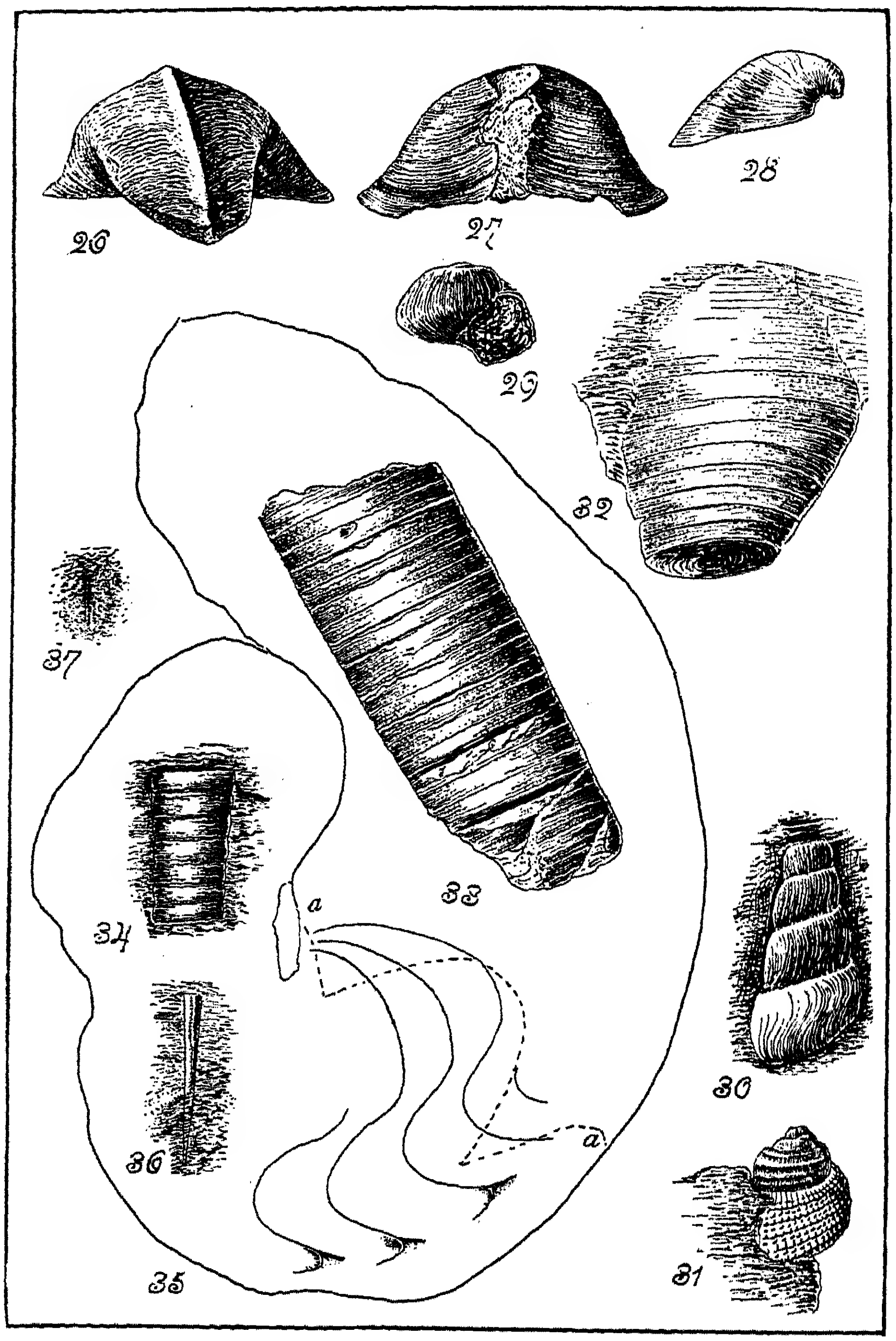
123. *Fenestella* sp.

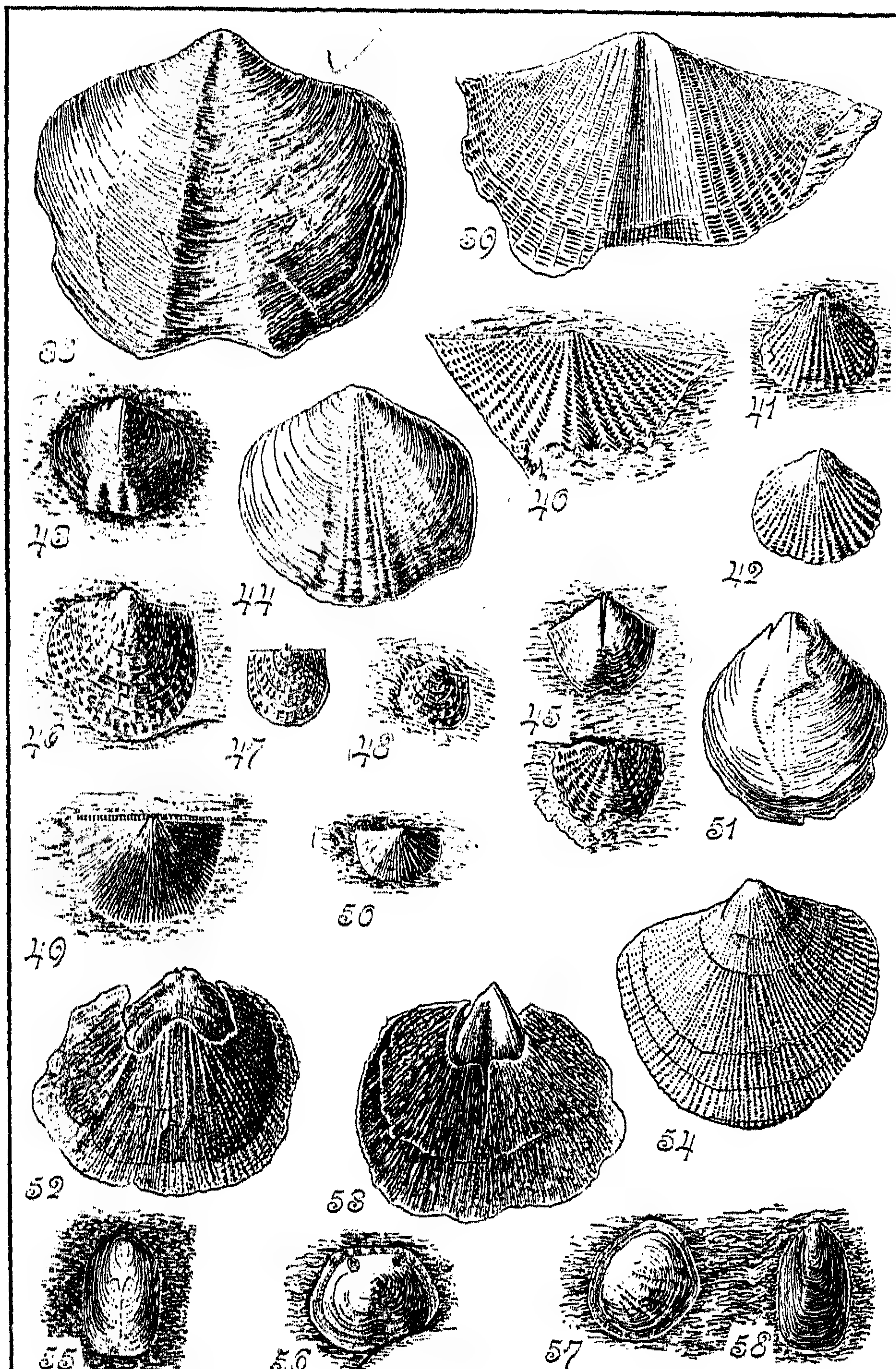
(Fossil bivalve supposed to be related to fresh-water forms.)

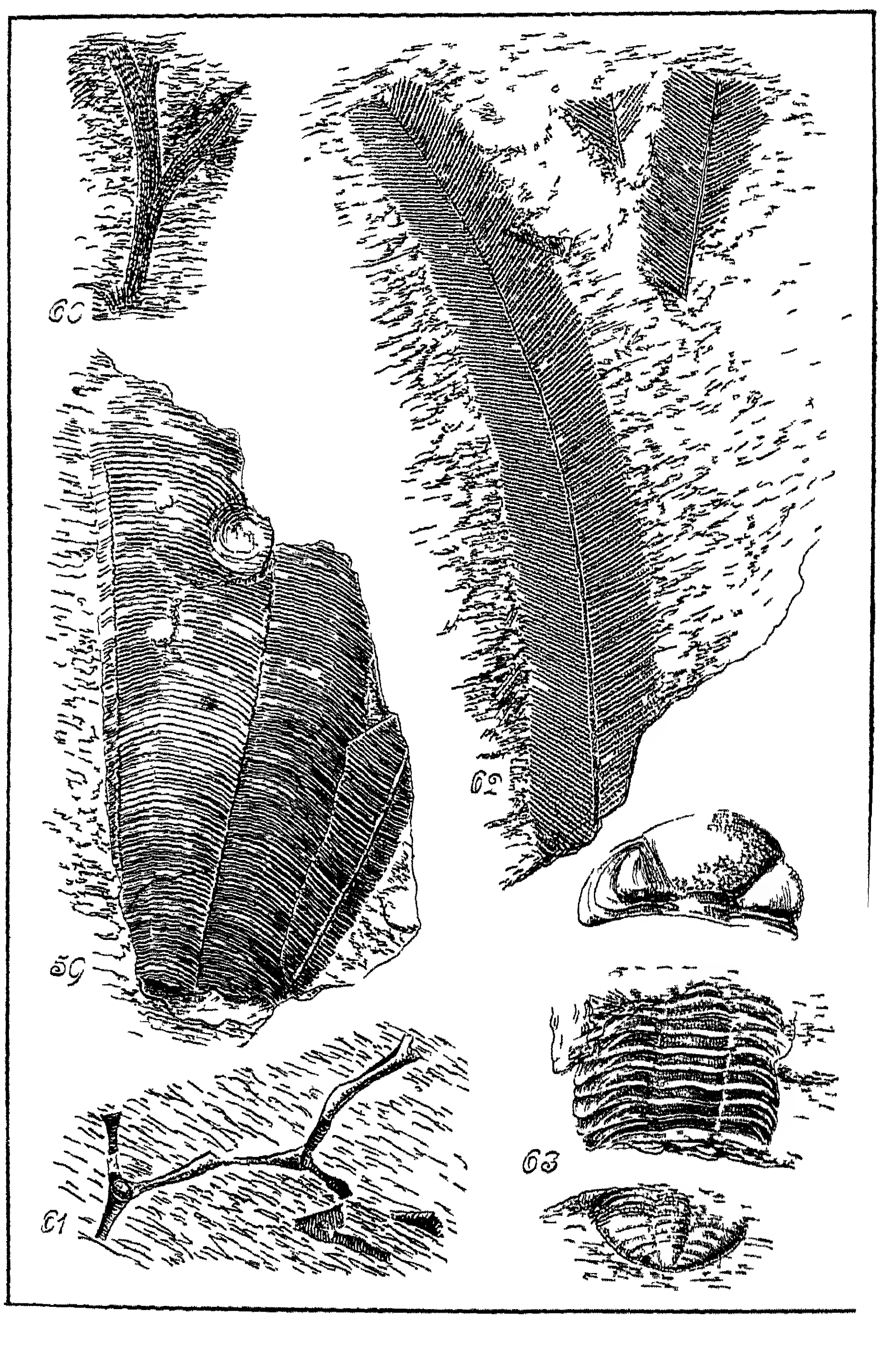
124. *Aunigenia catskillensis.* Common locally eastward in Oneonta and Catskill rocks.

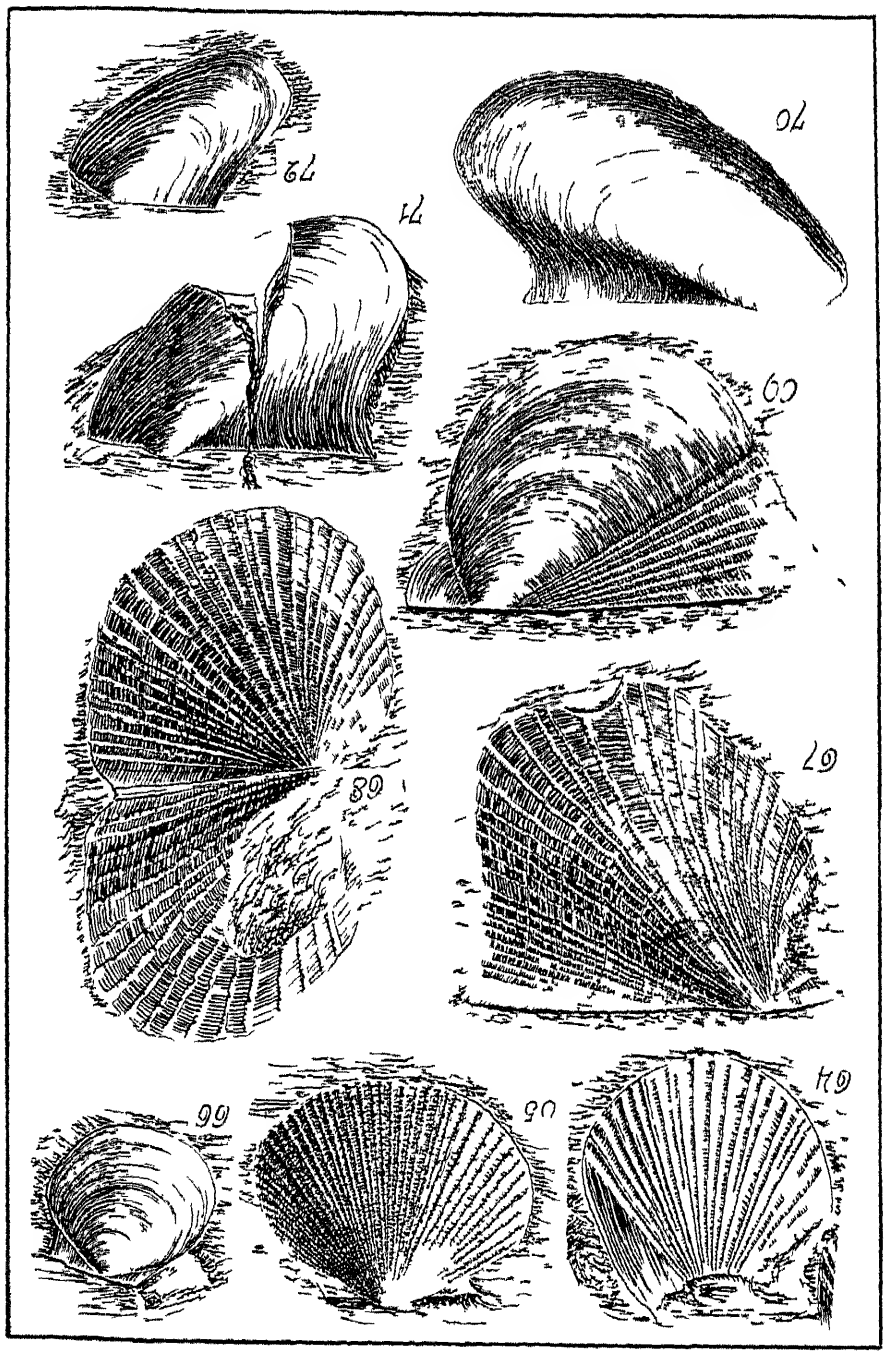
As a rule, the figures which follow are somewhat less than life size; especially is this true of the Cephalopods. Size, however, differs with different individuals and cannot be regarded as of great importance in determining specimens.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25


26
27
28
29
32
37
33
34
a
a
30
36
31
35

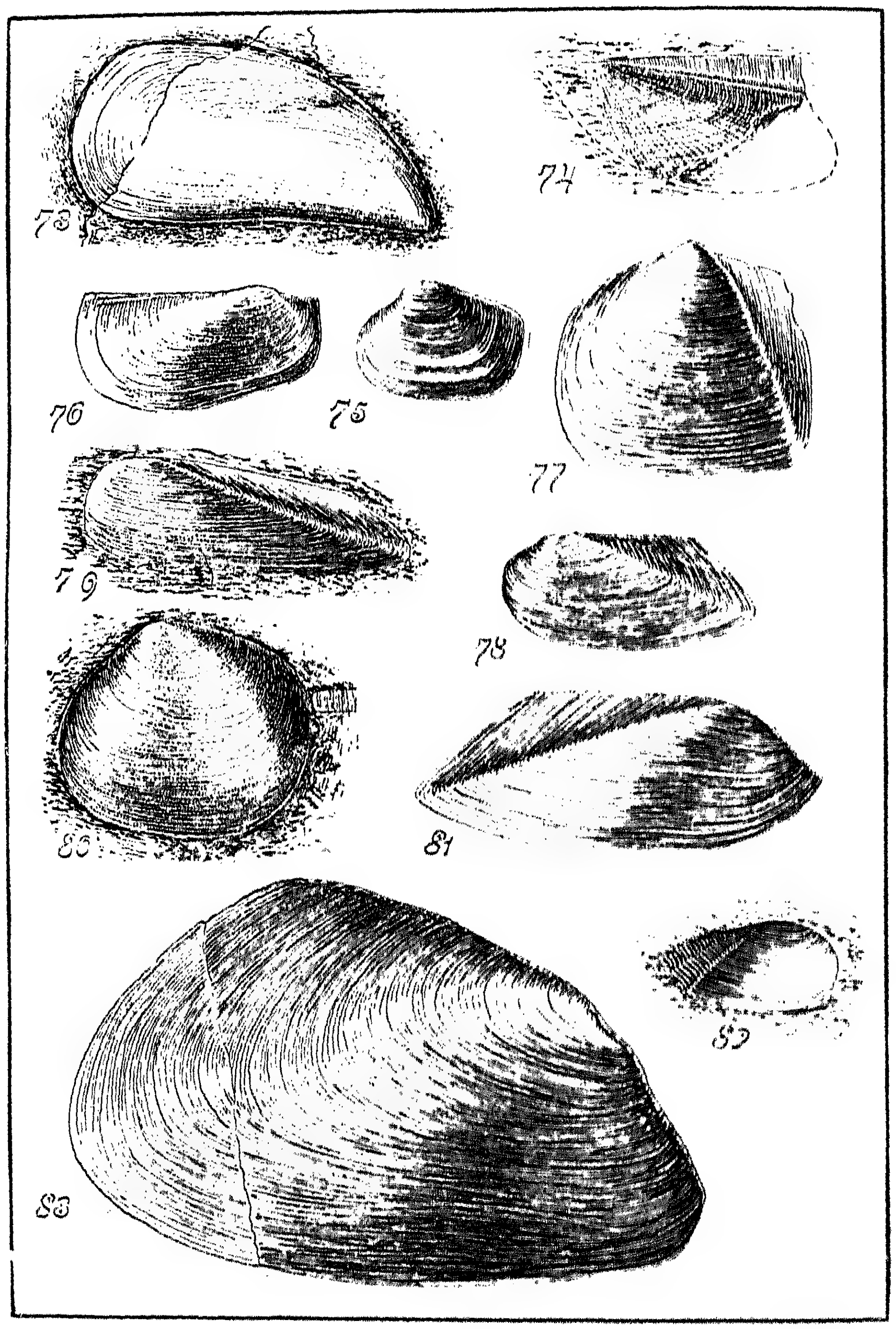

38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58

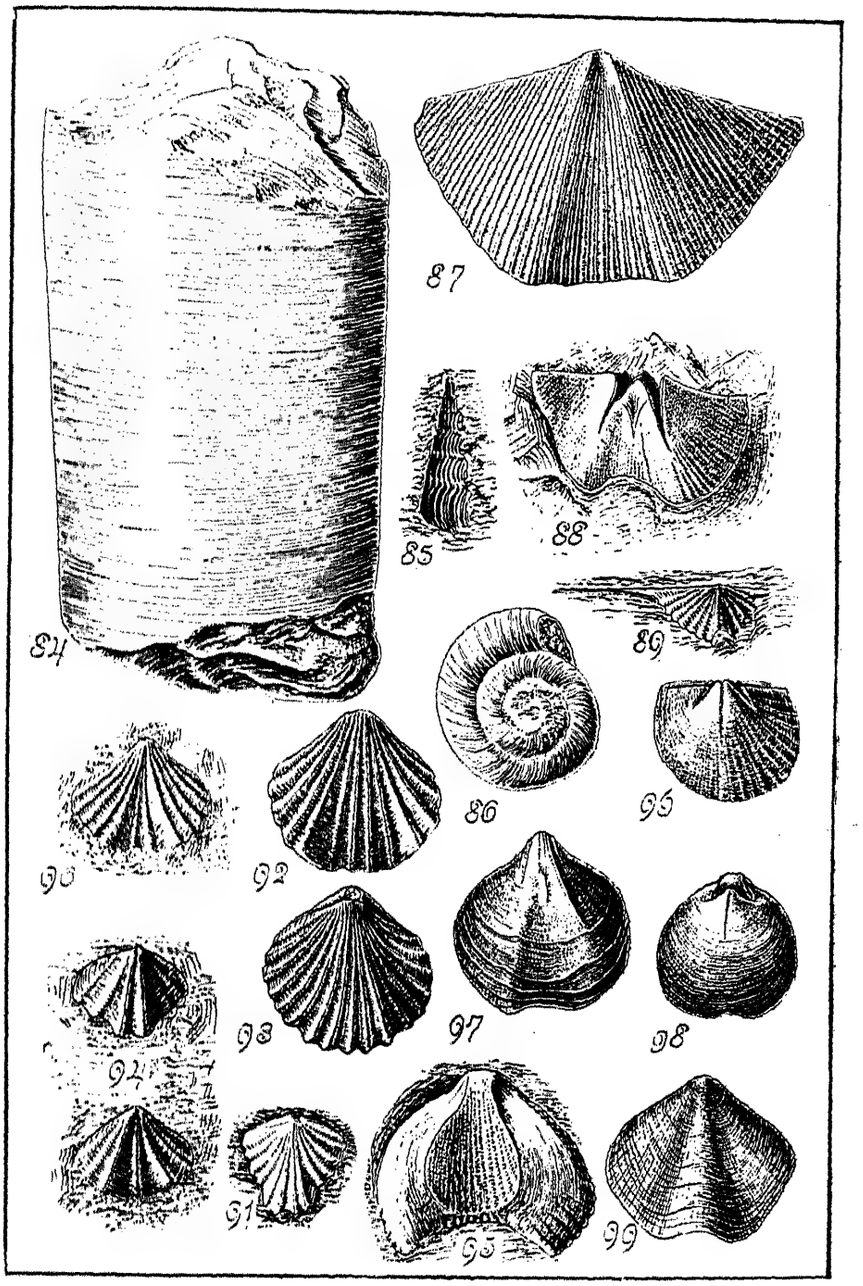

60
59
61
62
63

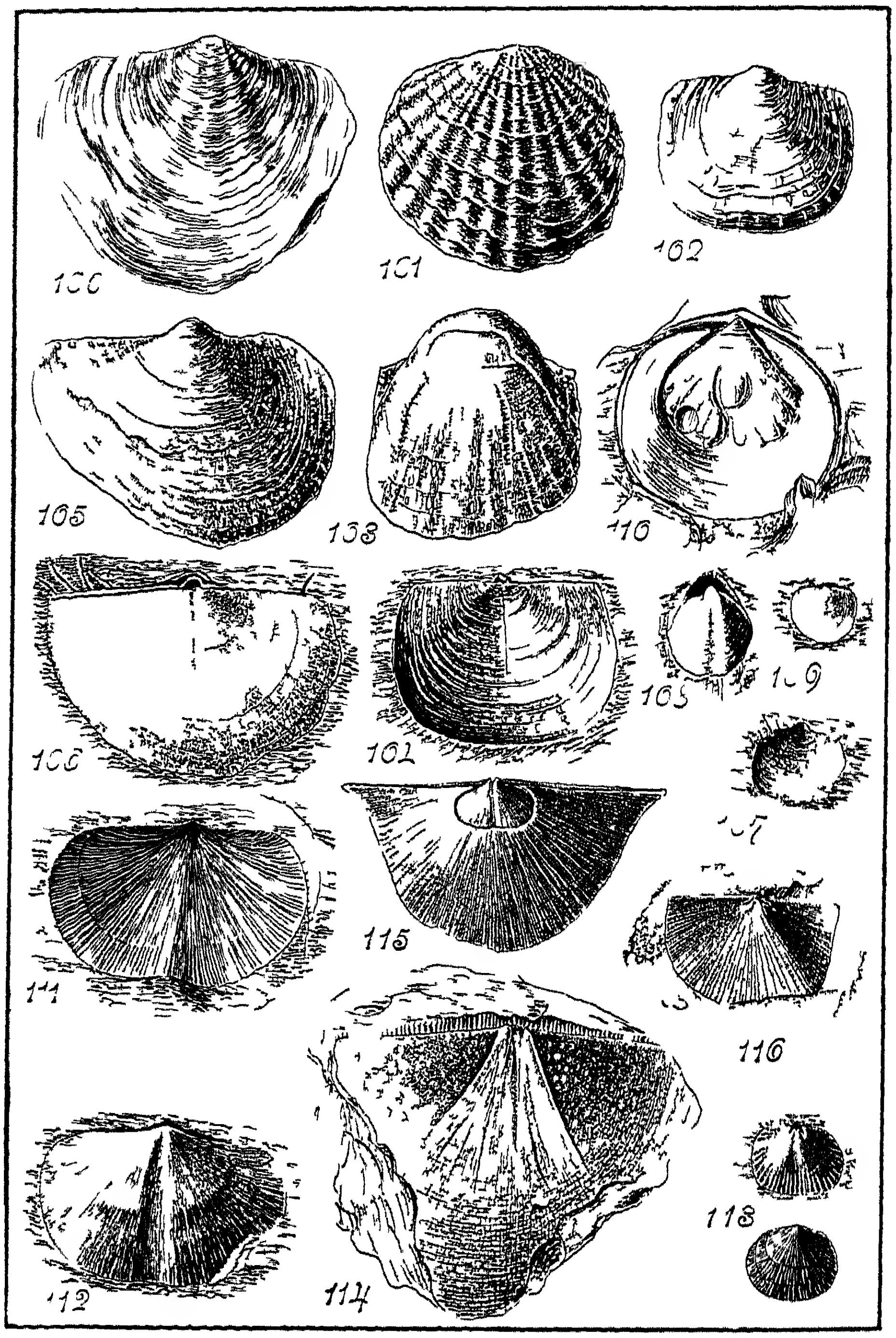

72
71
70
69
68
67
66
65
64

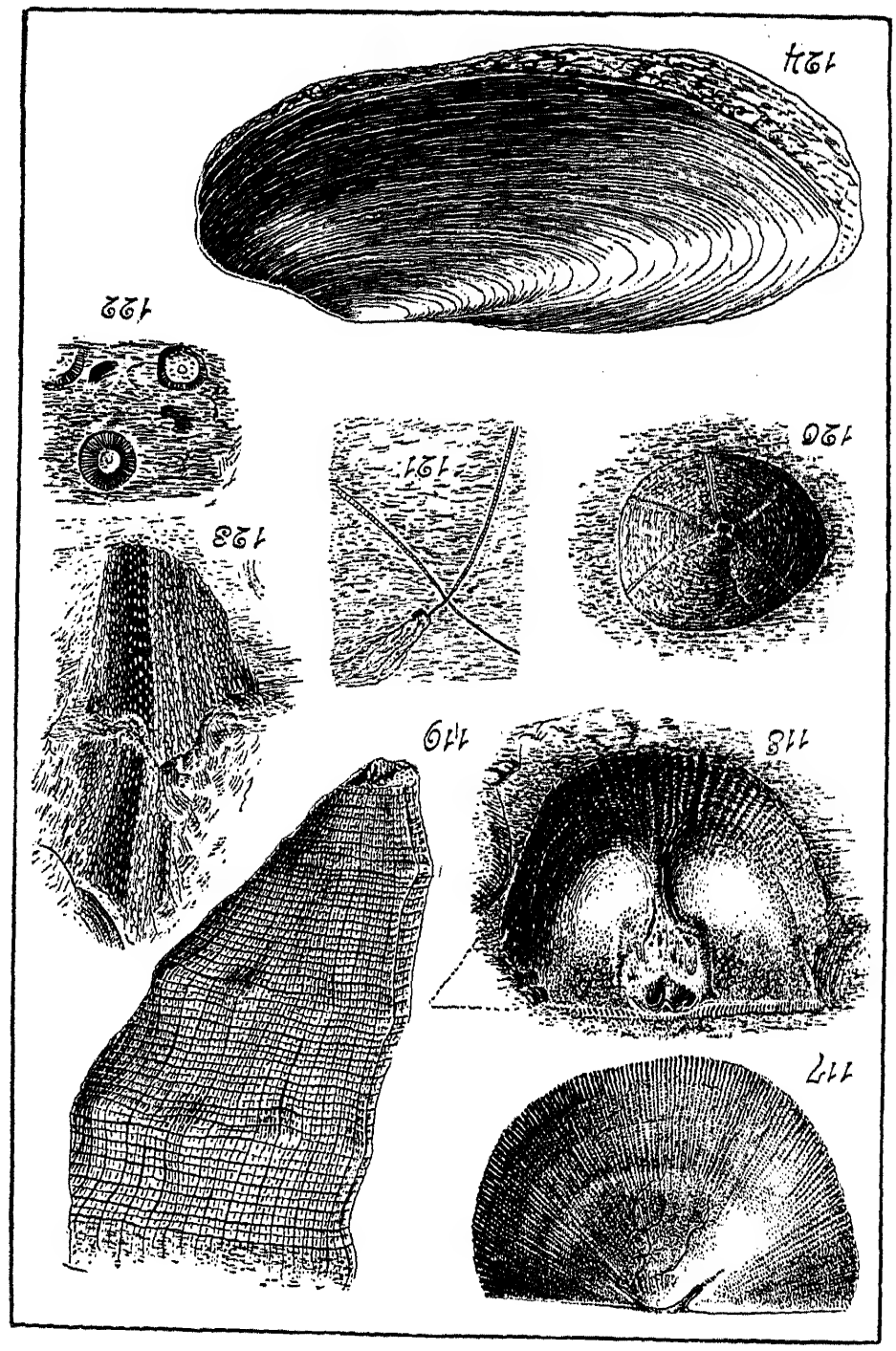
Pl. X

E. N. M. A. N. 2




84
87
85
88
89
86
96
90
92
94
93
98
97
91
95
99


102
105
110
111
115
116
112
114
118


117
118
119
120
121
122
123
124

KEUFFEL & ESSER CO.

NEW YORK

127 FULTON Street & 42 ANN Street

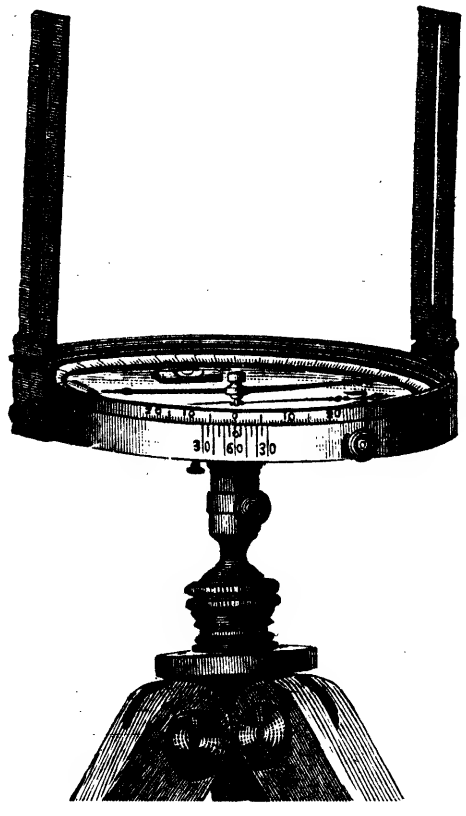
ESTABLISHED 1867

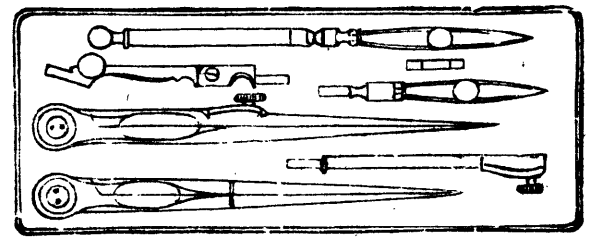
DRAWING MATERIALS

AND

SURVEYING INSTRUMENTS

BRANCHES | 111 Madison St., Chicago
708 Locust St., St. Louis





ALL REQUISITES
FOR
FIELD AND OFFICE WORK

Transits, Lenses,
Compasses, Chains,
Rods, Poles,
DRAWING INSTRUMENTS
Etc. Etc.

We make and carry the most complete and best assorted stock in America. Our goods are recognized as the standard of quality. They all bear our trademark and are warranted by us. Our prices are reasonable. Our lavishly illustrated catalogue minutely and correctly describes our goods. It contains much valuable information, and is sent gratis on application.

ELEMENTARY NATURAL HISTORY SERIES

* * * *

Established for the purpose of furnishing, at small cost, Reliable information on local subjects of natural history.

No. 1

Chautauqua Lake Shells : *Kinds, Distribution, Characteristics ; how and when collected ; all described aud well illustrated. Specially applicable to southern Chautauqua, Cattaraugus and Allegany counties.*

8vo, 44 pp., 29 figs., map, plates.

Price: *Postpaid;* **30 cts.**

No. 2

Key to the Upper Devonian of Southern New York : *Giving detailed information regarding the Geology of the vicinities of many of the more important High Schools and other institutions of learning in the south and south-western part of the State.*

8vo, 13 full page plates, 124 figures of common fossils.

Price : *Paper, Postpaid,* **28 cts;** *Flexible Board, Postpaid,* **35 cts.**

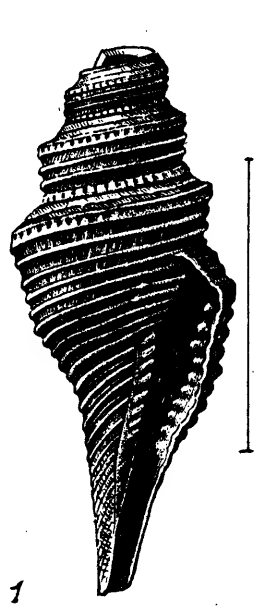
Other Numbers *similar to No. 2 but covering the remaining portions of the State ; together with an* **Introductory Text-Book of Geology** *written especially for the students of New York State,— now in course of preparation.*

Address all communications regarding the above mentioned works to the

CORNELL CO-OPERATIVE SOCIETY,

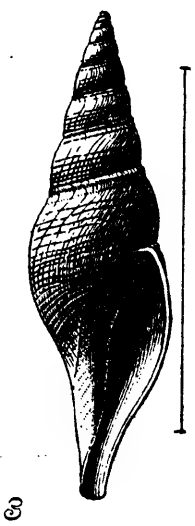
CORNELL UNIVERSITY,
Ithaca, New York.

SAMPLE PLATE

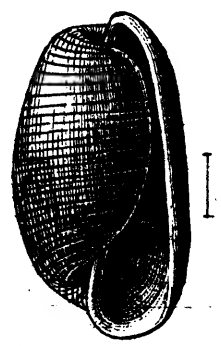


1

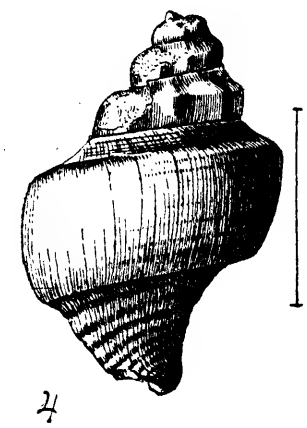
2



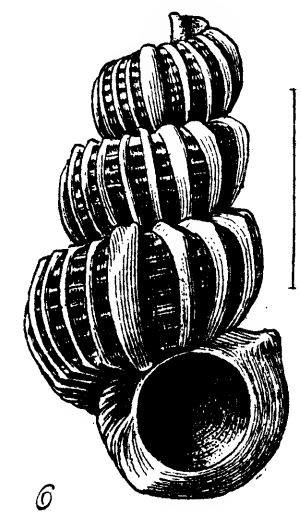
3



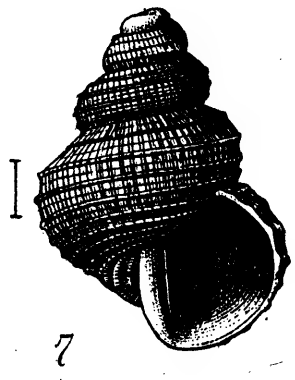
5



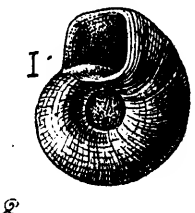
4



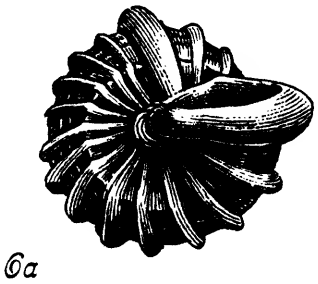
6



7



8



6a

BULLETINS OF AMERICAN PALEONTOLOGY.

THE ONLY PUBLICATION IN AMERICA DEVOTED EXCLUSIVELY TO PALEONTOLOGY.

——⁞⁞::o::⁞⁞——

Address all communications to

BULLETINS AMERICAN PALEONTOLOGY,

Cornell University, Ithaca, N. Y.