PALÆONTOLOGICAL REPORT

OF

COAL MEASURE MOLLUSCA

MADE BY

EDWARD T. COX,

ASSISTANT GEOLOGIST.

This page in the original text is blank.

REPORT.

TO DR DAVID DALE OWEN,

Geologist of the State of Kentucky.

Sir: In accordance with your instructions I accompanied Mr. Leo Lesquereux in an excursion for the purpose of examining the coal field in the western part of Kentucky, with the view to collect palæontological data, that might greatly aid in identifying the different veins of coal, one with another, throughout the counties embraced in its extent; especially by means of the organic remains found in the roof-shales and accompanying rocks.

The merited celebrity of Mr. Lesquereux as a fossil Botanist, and the important labor which he had bestowed upon the coal plants of Pennsylvania and Ohio, made his selection for a similar work in Kentucky, the very best it was possible to make.

In connection with Mr. Lesquereux, I was especially instructed to pay attention to the fossil mollusca, and collect every possible evidence for identity from that source. This mode of establishing the position of coal beds has only been practically pursued by Mr. Lesquereux in this country; and a beginning is now being made, for the first time, to connect with the flora the testimony of the shells—an addition much needed in western Kentucky, on account of the great scarcity of the former, and abundance of the latter.

Our investigations, for identity, commencing with coal No. 1, B, at the bottom of the section in the first chapter of your report, and terminating with coal No. 12, includes, in all the strata, a vertical thickness of about eight hundred feet. It must not be supposed that these members include the whole thickness of the western coal field; though they mark, probably, the limits of the profitably working coals, there are one or two thin seams below No. 1, B, which, with a thick sandstone, usually pebbly, with underlying shale, make together one hundred feet or more; whilst above No. 12, there are a number of thin veins with intervening shales, limestone, and sand-rock, in all upwards of five hundred feet, making the whole measures in the western

part of the state from (1,400) fourteen hundred to (1,500) fifteen hundred feet.

The thin veins above No. 12, are not wanting in distinctive organic remains, and collections had already been made from some of these higher beds, amongst which are seveal new species. They have been omitted for the present, as being of the least importance, and because they require additional study.

In Mr. Lesquereux's report will be found an extremely interesting account of the formation of fossil fuel, and the equivalency of the various beds of coal throughout the field of our examination. It remains only necessary for me, on this occasion, to refer to each vein its peculiar fossil shells, so far as they have been ascertained.

It may be asked, how came marine shells to be imbedded in the roof-shales, if the coal has been formed in fresh water? They followed the influx of the sea after subsidence of the land, and are such as usually live in shallow or brackish water, belonging to the phytiferous (vegetable feeders,) and carniverous orders. The salt water gradually killed out the coal flora—the last remains of which mixed with algæ, became entangled in the sediment of the ocean, and served to supply bitumen, with which the dark shales that usually form the roof of the coal are so frequently charged.

Our observations go to show that wherever we found fossil remains of the molusca abundant in the roof-shale, coal plants are rarely found, whilst remains of marine plants are usually abundant.

COAL NO. 1, B.

This is the lowest workable coal in the western basin, varying in thickness from three to six feet, and charactérized by a solitary molusca* *Lingula umbonata nob.*, plate X, fig. 4. It is opened and worked by the Union Coal and Iron Company, one and a half miles below Carrsville, in Livingston county, where it is an outlier, and the most southern workable coal in the state. This vein has been opened and worked by several companies along Tradewater river, in Crittenden county.† It is most extensively worked on the property of Col. John Bell, where it is from three and a half to six feet thick, and known as the "Bell coal." Another opening was made into this vein on the same

*For the flora see Mr. Leo Lesquereux's report.
†See report of Dr. D D. Owen, State Geologist.

property, about three quarters of a mile farther from Tradewater, by Mr. Cook, whose name it bears.

In Union county it is mined by the Messrs. Casey's; out-crops near the old distillery back of Caseyville, also on the property of the Kentucky Coal Company, and various other localities in the same county.

On the eastern boundary of the basin it proves to be the main Hawesville and Breckinridge coal vein, at each of which localities we found the identical *Lingula umbonata* In the shales of the roof at Hawesville, where we had an excellent opportunity to examine, they were found in the greatest abundance.

The remaining figures on plate X belong to the *Cephalopoda* division of the mollusca, and were collected on a previous occasion by the survey, at Nolin Iron Works, Edmonson county. They are new, and occupy a low position in the Coal Measures, i. e., about one hundred feet above the conglomerate.

Very little has yet been done towards making openings into the other coals below No. 9, and what old workings have been undertaken are now mostly filled up, so that but little opportunity has been afforded for making collections from these beds. The only animal remains as yet found in them is from No. 7, or "*Black-band vein*," a thin seam of coal over-layed by a black bituminous, ferruginous carbonate of lime in thin bands, and these are fins, scales, and teeth of fish, that have not yet been determined. This vein, which is only noticed on account of its ferruginous calcareous black-band roof, from one and a half to two and a half feet in thickness, is best developed on the property of Mr. Alfred Towns, in Hopkins county, and usually contains from twenty to twenty-five per cent. of metallic iron. Its is also seen on the property of the Saline Mining Company, Gallatin county, Illinois, where it contains the same description of fish remains. Its position is about one hundred and thirty feet below No. 9.

COAL NO. 9.

This is the main working coal in the western part of the state, and is usually characterised by an abundance of fossil mollusca; amongst the most numerous are those figured on plate IX: *Avicula recta-lateraria, A. acosta, Solemamya soleniformis, Nautilus decoratus*, and *Productus muricatus*. Besides these there are *Nucula Hamerii, Nucula*, species undetermined, *Pecten*, species undetermined, *Pleurotomaria*

Grayvillensis, *Lozonema*, species undetermined, *Orthoceratite*, species undetermined, *Chonetes mesoloba*, (variety small, and prominently lobed,) *Productus equicostatus*, and *Bellerophon carbonarious*. This Bellerophon, which we propose to call *B. carbonarious*, has generally been refered to *B. Urei, Flem.*, by western Palæontologists—a conclusion with which we cannot agree; not from a desire to create a new species, but with a view to a proper understanding of the true geological position of the shells of the Coal Measures. The *B. Urei*, according to L. De Koninck, has a vertical range from the silurian to the carboniferous beds, whereas the *B. carbonarious* has not been found to range lower than the middle of the coal basin, and is only fully represented in the upper part. It certainly approaches very close to L. De Koninck's description of the *B. Urei*, (*Description Animaux Fossiles*, page 356, pl. xxx, fig. 4,) and may possibly be a variety, but cannot be considered identical. That there are several varieties or species referred to this shell, is evident from the description of the following authors here cited: *Capt. Portlock, Geology of Londonderry, page* 400; *Mr. Phillips' Geology of Yorkshire, page* 231; *M'Coy's Description of British Palæozoic fossils in the Geological Museum of Cambridge, page* 555; all of which differ materially. It is referred to *B. Urei* by *Norwood* and *Pratten; Notice of fossils from the carboniferous series of the western states; Journal Acad. Nat. Sci., June*, 1855; *page* 75, *plate IX., fig.* 6. The original of this figure is in my cabinet, and was loaned to them for representation, being at that time the only perfect specimen known. I an sorry to say, from some over-sight, for it was in the hands of a most excellent artist and esteemed friend, this figure gives a very incorrect idea of the shell; it exhibits but two-thirds of the true number of the spiral striæ—having only fifteen, whereas, there should have been twenty; (from the examination of a large number, they are found to range from 19 to 25;) the mouth, as well as the general contour, is essentially wrong. None of the various authors who have described the *B. Urei* mention the lateral expansion of the mouth into ears, a feature very decided in our shell. It also differs in having fewer spiral striæ, and by the more rapid increase of the last whorl. From the examination of several hundred good specimens, the average number of spiral striæ appears to be twenty-one, always, even in the youngest individual, terminating on the inferior

half of the last whorl, and have not been found to exceed twenty-five; whereas L. De Koninck reports on the *B. Urei*, from thirty-six to thirty-eight. *Dimensions*—Diameter .$\frac{78}{100}$ of an inch; proportional increase of the last whorl .$\frac{41}{100}$ to .$\frac{89}{100}$ of an inch; including the wings of the mouth; transverse diameter of the mouth .$\frac{44}{100}$ of an inch.

Remains of fishes, that have not yet been determined, are also found in the shales of this coal.

COAL NO. 11.

This is the next coal in the series, in which we found the remains of mollusca. For the most characteristic, see plate VIII., figs. 1 to 11, and plate IX, fig. 1. They are as follows: *Pecten Providencesis, Loxonema regularis, Chimnitzia parva, Pleurotomaria Bonharborensis, P. depressa, Arca carbonaria, Gervillia longispina, Plicatula striatocostata, Myalina pernaformis, Cardinia* (?) *fragilis, Macrocheilus, gracilis, Orthis resupinoides, Pecten*, species undetermined, *Avicula rectalateraria*, (not so abundant as in No. 9,) *Loxonema Hallii, Loxonema*, species nndetermined, *Macrocheilus inhabilis, Macrocheilus*, species undetermined, *Productus muricatus, rare, P. Rogersii, P. equicostatus, Athyris subtilita*, large and abundant, *Cardium*, species undetermined, *Spirifer Meusebachanus, Solenimya*, species undetermined, *Nucula*, species undetermined, *Orthis*, species undetermined, *Orthoceratite*, species undetermined, *Griffithides*, species undetermined.

This coal is usually separated into two members, by a clay parting from one to four inches in thickness, and is overlayed by a limestone. The upper part of this bed of coal is sometimes cannel, and the lower bituminous. It is best developed in Hopkins county—where it attains a thickness of nine feet—on the line of the Henderson and Nashville Railroad.

On the mining property of Edward and William Hawes, at Hawesville, Hancock county, No. 11 is found near the top of the hill, a few rods west of their entry into the main Hawesville coal, No. 1, B; well characterised by its peculiar fossils, and proves a remarkable thinning out of the measures near the eastern boundary of the basin. The vertical space between the two is here only two hundred and ten (210) feet, but may be somewhat increased, by the existence of an at present unknown fault.

COAL NO. 11.

This is the highest coal that we had an opportunity to examine in the series. It is characterised by the remains of fishes, not yet determined, and a small *orbicula*, of which we found no specimen sufficiently perfect for description.

As a full history of the coals, from the bottom to the top of the series, may be found in your report, and that of Mr. Lesquereux, it has been deemed unnecessary to repeat it here. There will also be seen, by a reference to the above reports, a demonstration of the fact, that the most persistent veins throughout the basin are Nos. 1 B., 9, and 11—they having been found at every locality where there is sufficient thickness of the measures to contain them.

For a better understanding of the fossil shells found associated with these coals, I herewith submit the annexed descriptions, and accompanying plates, Nos. VIII, IX. and X. For the beautiful and accurate representation of the fossil shells on these plates, we are indebted to Mr. John Chappellsmith.

The importance of the facts established by the survey of the coal-fields of Kentucky, cannot be over estimated. It has developed the various seams, and given characters by which the most important may at all times be known, and having established the identity of one, in any part of the basin, the relative position of the others may easily be known, by reference to the section in the first chapter of your report in this volume.

Next to agriculture, coal is the most important element of a country's prosperity and wealth. Its importance is just beginning to be felt in the west, and will increase with the constantly diminishing forest. As a fuel, it is the most convenient and economical, and no country can successfully compete in manufacturing without a cheap supply. It is the rich and well wrought coal-fields of England that enables her to maintain a supremacy in manufacturing, over the world; deprived of the coal, her importance as a nation would soon be lost.

In the British Islands not less than fifteen million tons of coal are annually raised, affording employment, in the mining operations, to more than one hundred and fifty thousand people. More than one third of this amount is derived from the Newcastle basin, embracing a superficial area of seven hundred and fifty square miles; whereas, in western Kentucky the coal-field contains more than three thousand

square miles, with an average thickness of all the coal seams about equal to those of the Newcastle district.

The superiority of coal as a fuel will be better understood when we consider, that one square mile of forest, containing twenty thousand trees, averaging two cubic yards of solid wood, would be equal to one acre of coal six feet thick. One hundred pounds of coal, occupying about one and a half square feet, will evaporate 1,200 pounds of water, equal to 150 gallons; while 100 pounds of well dried wood, occupying more than double this space, will evaporate only 700 pounds of water, equal to about 88 gallons; and six gallons of water evaporated in an hour is equal to a horse power.

E. T. COX,
Assistant Geologist.

A description of some of the most characteristic shells, of the principal coal seams in the western basin of Kentucky, by E. T. Cox, *Assistant Geologist.*

PECTEN PROVIDENCESIS. *Cox.*

(Plate VIII. fig. 1, left valve natural size.)

Semi-circular; as broad as high; nearly equilateral; left valve slightly convex; about thirty-three broad prominent ribs, of unequal width, and irregularly fluted; radiate from the beak to the circumference; crossed below the disk by two well defined bands, marking stages of growth. Anterior ear of the valve under description is wanting, but that of the right valve beneath, is in part exposed, finely ribbed, and crossed by concentric bands; inferior ear finely ribbed, crossed by fimbriating folds, curved outward from the beak. Rostral angle 95°; height 3.$\frac{22}{100}$ inches; width 3.$\frac{22}{100}$ inches. Its size and broad fluted ribs renders it easily distinguished from other species.

Position and locality. Found by the topographical assistant, Sidney S. Lyon, in the limestone which overlays the main coal, No. 11, at the town of Providence, Hopkins county, Kentucky. Fragments are somewhat numerous, but it is difficult to obtain them in as perfect a state of preservation as the one figured.

LOXONEMA REGULARIS. *Cox.*

(P. VIII, fig. 2, natural size.)

Elongated; acutely conical; volutions ten; regularly enlarging; convex; covered with fine transverse striæ; convex in the direction of the spire; sigmoidal on the last whorl; suture small, slightly impressed; body whorl about one half the whole length; colamella lip elongated, slightly reflected; outer lip thin; mouth about twice as long as broad; spiral angle 35°; length 2.$\frac{10}{100}$ inches; width .$\frac{81}{100}$ inch.

It most nearly resembles *L. Halli, Norwood and Patten, Jour. Acad. Nat. Sci. June,* 1855, but differs in being larger, less acute, and more convex on the volutions. It was found by Sidney S. Lyon, Topographical Assistant, and is converted into pyrites of a bright yellow color and metallic lustre, and is in a fine state of preservation.

Position and locality. Rare, in a dark bituminous soft stratum of pyritiferous carbonate of lime; about one foot above the black shale forming the roof of the Bonharbour coal, No. 11, Daviess county, Kentucky.

CHIMNITZIA PARVA. *Cox.*

(Pl. VIII, fig. 3, enlarged; 3*a* natural size.)

Small; acute; volutions about six; very ventricose; marked with strong transverse ribs, slightly curved in the direction of the spire, and separated by a deep furrow as wide as the ribs; body whorl occupies about one third the entire length of the shell; columella lip slightly prolonged; mouth subcircular; length $.\frac{15}{100}$ inch; width $.\frac{9}{100}$ inch.

Position and locality. Occurs in the dark bituminous, pyritiferous, calcareous stratum over the shale roof of Bonharbour coal, No. 11, Daviess county, Kentucky.

PLEUROTOMARIA BONHARBORENSIS. *Cox.*

(Pl. VIII, fig. 4, enlarged; 4*a* natural size.)

Small; conical; a little longer than wide; volutions six; acutely convex; marked with a well defined concave band; distinct on all the whorls, and crossed with fine striæ; convex in the direction of the spire; ten to twelve spiral lines on the under part of the last whorl, diminishing to two or three on the preceding whorls; crossed by fine transverse striæ, rather strongly curved with the convexity in the direction of the mouth, giving a beautiful reticulation on the under part of the last whorl, and ornamenting the preceding whorls, on the upper part, with two to three spiral rows of small tubercles; spiral angle about 75°; length $.\frac{27}{100}$ inch; width $.\frac{21}{100}$ inch.

It differs from the *P. Grayvillensis, Norwood and Pratten, Jour. Acad. Nat. Sci., June,* 1855, *pl. ix., fig.* 7, by its ornaments, and in being more acute.

Position and locality. Abundant, in the roof shales of the Bonharbour coal No. 11, Daviess county, Kentucky.

ARCA CARBONARIA. *Cox.*

(Pl. VII, fig. 5, natural size.)

Transversly elongated; beaks not elevated; anterior extremity short; obtusely rounded; tumid at the umbo, from which a slight ob-

lique mesial sinus extends to the base, where it becomes profound; base emarginated; hinge area straight, almost forming a right angle with the posterior margin which is nearly straight; slightly sinuate above; obtusely rounded below; upper posterior part obliquely truncated; surface covered with concentric lines marking stages of growth, and fine radiating ribs, numbering on the disk about seven in one and a half lines; width 1.$\frac{4\,6}{1\,0\,0}$ inches, height .$\frac{6\,9}{1\,0\,0}$ inch.

Position and locality. Rather abundant in the limestone over the main coal No. 11, at Providence, Hopkins county; also in a limestone over an equivalent coal on the property of Edward and William Hawes, near Hawesville, Hancock county, Kentucky.

GERVILLIA LONGISPINA. *Cox.*

(Pl. VIII, fig. 6, left valve natural size.)

Lunate; hinge area straight; posterior ear defined by a deep sinus; hollowed out on its lateral margin, and terminated by a long spine; beak depressed, pointed; anterior margin and base together form a semicircle; eliptically pointed at the posterior extremity; posterior border slightly concave, from which rises an abrupt ridge, gradually declining to the base and anterior border; anterior ear wanting; surface covered with fine striæ and strong marks of growth; length from beak to posterior extremity 1.$\frac{4\,3}{1\,0\,0}$ inches, height .$\frac{9\,3}{1\,0\,0}$ inch. This remarkable species has no analogy with any other with which we are acquainted. A portion of the spine has been restored from fragments found in the rock.

Position and locality. Not uncommon in the limestone which overlays the main coal No. 11, at Providence, Hopkins county, Kentucky.

PLICATULA STRIATO-COSTATA. *Cox.*

(Pl. VIII, fig. 7; right valve natural size.)

Triagonal; inequilateral; right valve moderately convex; from nine to ten large elevated ribs arise irregularly below the beak, increasing in size to the circumferance, separated from one another by deep furrows, crossed about one-third the length above the base by an irregular concentric groove, below which, on the anterior side, the ribs are slightly bent forward, giving the appearance of having been broken; above this are two other rather indistinct bands; surface and ribs covered with fine irregular thread-like striæ, increasing by intercalation, rising from

each side, and terminate on the summit of the ribs, numbering, at three lines from the beak, sixteen in the space of two lines; base semicircular, crenulated; height 1.$\frac{0\,8}{1\,0\,0}$ inches; width 1.$\frac{2\,5}{1\,0\,0}$ inches.

Position and locality. From the limestone over the main Providence coal, No. 11, Hopkins county, Kentucky.

MYALINA PERNAFORMIS. *Cox.*

(Pl. VIII, fig. 8; right valve natural size.)

Sub-quadrate; inequilateral; beak pointed, projecting beyond, and moderately curved over the cardinal border; cardinal border nearly straight; anterior margin and base rounded; posterior margin straight; near which a prominent ridge gradually slopes to the front and base; surface covered with strong concentric, somewhat fimbriating lines of growth; length 1.$\frac{1\,3}{1\,0\,0}$ inches; width .$\frac{8\,7}{1\,0\,0}$ inch.

Position and locality. Common in the limestone over the main coal No. 11, at Providence, Hopkins county, Kentucky.

PLEUROTOMARIA DEPRESSA. *Cox.*

(Pl. VIII, fig. 19, 10*a*; natural size.)

Small; lenticular; depressed; about five volutions scarcely elevated; nearly flat above; defined by a row of acutely pointed tubercles, not so wide as the intervening notch; last whorl obtusely rounded below, bordered by a sharp edge, which has a narrow depressed band above, only visible when the implanted tubercles are removed; ornamented on the upper and lower side with obsolete lines of growth bent backwards; umbilicus shallow; mouth notched; columella and outer lip rounded; height .$\frac{3\,3}{1\,0\,0}$ inch; width .$\frac{5\,1}{1\,0\,0}$ inch; spiral angle 130°.

This species may at first easily be mistaken for *P. sphærulata, Conrad,* (*P. coronula Hall; Stansbury's expedition to the Great Salt Lake,* 1852, *page* 413, *pl.* 4, *fig.* 6,) but is much more depressed, and the angle of the last whorl more acute. The tubercles not so numerous, and less elevated.

Position and locality. Common in the shale forming the roof of No. 11 coal, at Bonharbour, Daviess county, and Airdrie, Muhlenburg county, Kentucky.

CARDINIA? FRAGILIS. *Cox.*

(Pl. VIII, fig. 9; left valve natural size.)

Shell very thin; transversely ovate; beak scarcely elevated; anterior slope slightly hollowed; anterior extremity short, rounded below; base and posterior side obtusely rounded; hinge line straight, slightly truncated behind the beak; surface covered with broad concentric furrows; height .$\frac{9}{100}$ inch; width 1.$\frac{20}{100}$ inches.

It is difficult, from the poorly preserved specimens now collected, to determine the genus with certainty; but believing it to be a characteristic shell, have placed it conditionally amongst the cardinia. When well preserved the valves may be found ornamented with fine concentric striæ.

Position and locality. Abundant in the black shale, which sometimes forms the roof of No. 11 coal, at Airdrie, Muhlenburg county, Kentucky.

MACROCHEILUS GRACILIS. *Cox.*

(Pl. VIII, fig. 11, enlarged; fig. 11 *a*, natural size.)

Small; conical; about six volutions; convex; suture small; last whorl half the length of entire shell; columella lip elongated; slightly refected; mouth subovate; length .$\frac{25}{100}$ inch; width .$\frac{15}{100}$ inch; spiral angle 56°.

It differs from *M. acutus, Sow.*, by the more rapid increase of the whorls, prolougation of the columella lip, and less rotundity of the mouth. Though the specimen under description is most likely a young shell, it cannot be confounded in any stage of developement with its cogenitors.

Position and locality. Common in the shale over No. 11 coal, Bonharbor, Daviess county, Kentucky.

ORTHIS RESUPINOIDES. *Cox.*

(Pl. IX, fig. 1, end view, natural size; fig. 1 *a*, entering valve; fig. 1 *b*, profile.)

Hinge line straight; less than the width of the shell; cardinal area well marked, gradually sloping back on the receiving valve; large angular foramen; both valves covered with fine thread-like striæ, radiating from the beaks to the circumference, numbering on the disk thirteen in .$\frac{12}{100}$ of an inch, crossed by fimbriating lines marking stages of growth; obsolete on the umbo; well marked and more numerous from the base for one third the length; receiving valve moderately convex;

greatest depth at the umbo; beak small, acute, elevated above and gradually sloping, with a slight depression to the sides; entering valve remarkably ventricose, and a little longer than the receiving valve; greatest depth at the disk; a very obscure shallow sinus is perceptible, running from the rostrum to the disk, where it is lost or obliterated by the crushed condition of the base of the shell; surface ornamented with five or six broken spines, two lines in diameter and about the same height, and several scars of missing spines; beak very tumid, acutely terminated, slightly incurved, moderately arched on the cardinal margin; sides obtusely rounded, broad and distinctly marked by rugose fimbriating lines of increment; width $1.\frac{8\,6}{1\,0\,0}$ inches; length $1.\frac{5\,4}{1\,0\,0}$ inches; hinge line $1.\frac{0\,2}{1\,0\,0}$ inches; depth of receiving valve $.\frac{3\,5}{1\,0\,0}$ inch; depth of entering valve $.\frac{9\,5}{1\,0\,0}$; width of cardinal area $.\frac{1\,2}{1\,0\,0}$ inch; depth $.\frac{0\,7}{1\,0\,0}$ inch.

Though several authors have suggested the appearance of scars left by spines, on some species of orthis; this is believed to be the first specimen of the genus upon which they have actually been found attached.

The great convexity of the entering valve, the obtuseness of both valves at their lateral border, and the greater prolongation of the entering valve, distinguishes this species from the *O. resupinata*, (Mart. sp.,) to which it is most nearly related.

Position and locality. From the siliceous micaceous shale forming the roof of the upper coal, No. 11, at Mr. Hawes' mine, Hawesville, Hancock county, Kentucky.

AVICULA RECTA-LATERAREA. *Cox.*

(Pl. IX, fig. 2, right valve natural size.)

A little higher than broad; inequilateral; slightly oblique; covered with numerous radiating ribs, increasing in number by the intercalation of new ones, occasionally by dichotomy; nearly as high as broad; a little wider than the space which separates them from one another; anterior ear extends to the lateral border, with which it nearly forms a right angle; posterior ear a little shorter than the anterior, is not terminated by an angle, but by a rounded and well defined by a notch at its base; umbo slightly tumid, crossed by irregular concentric wrinkles; surface and ears covered with fine striæ, and fimbriating lines of increment; anterior side rectalineal; base and posterior side obtusely

rounded; hinge area straight; a little narower than the shell; height .$\frac{89}{100}$ of an inch; width .$\frac{86}{100}$ of an inch; anterior ear .$\frac{40}{100}$ of an inch; posterior ear .$\frac{38}{100}$ of an inch.

It is easily distinguished from *A. papyracea, Sow.*, with which it has been confounded, by the absence of a notch on the side, at the extremity of the anterior ear, and from the *A. subpapyracea, De Ver.*, with which it is more nearly related, by its less obliquity, straight antero-lateral margin, wrinkles on the umbo, and simple ribs.

Position and locality. It is most usually found converted into yellow pyrites, and in great abundance in the black shale forming the roof of No. 9 coal, at the Kentucky Coal Company's and Curlew mines, Union county, Kentucky, and in the equivalent beds of Gallatin county, Illinois.

A species, which we have not been able to distingnish from this, occurs also, but not as abundant, in coal No. 11, at "Thompson's vein," at Curlew mines, Union county, and at Bonharbour, Daviess county, Kentucky.

AVICULA ACOSTA. *Cox.*

(Pl. IX, fig 3; right valve natural size.)

Small; inequilateral; very oblique; sub-elliptical; wings terminating in small acute angles; anterior half as broad as the shell; posterior very small; surface and wings covered with fine concentric striæ; no ribs; height .$\frac{14}{100}$ of an inch; width .$\frac{42}{100}$ of an inch cardinal border .$\frac{30}{100}$ of an inch.

Position and locality. This small and fragile species is found in great abundance in the roof shales of No. 9 coal, in Union county, Kentucky, and equivalent beds, Gallatin county, Illinois, and appears to be characteristic of this vein, not having yet been found in any other position.

NAUTILUS DECORATUS. *Cox.*

(Pl. IX, fig. 4, profile natural size; fig. 4 *a*, portion of the same showing, *septum* and *siphuncle*; fig. 4*b*, outline of the septa.

Discoidal; whorls two and a half, not embracing, increasing in width in the proportion of .$\frac{26}{100}$ to .$\frac{61}{100}$ of an inch; obtusely rounded on the periphery; sides slightly convex; deeply plicated, forming elevated ridges, one to each septa, and curved in the same direction; a depression in their centre produces two rows of small tubercles, more promi-

nent on the last than preceding whorls, most decided on the outer edge; septu along the central third of the periphery slightly curved backwards; regularly curved backwards on the sides; where the shell has been well preserved it is closely covered with fine striæ, strongly arched backwards, on the periphery, into tongue shaped markings; siphuncle medium size; central or nearly central; umbilicus open, showing all the whorls; mouth transverse, subreniform; vertical height $.\frac{5}{100}\frac{4}{0}$ of an inch; transverse diameter $.\frac{6}{100}\frac{1}{0}$ of an inch; greatest diameter of the shell $1.\frac{3}{100}\frac{5}{0}$ inches; depth of septu next to the last chamber $.\frac{0}{100}\frac{4}{0}$ of an inch.

This beautifully ornamented *Nautilus*, differs from the *N. tuberculatus, Sow.*, with which it is most nearly related, in not being concave on the sides, as well as in its markings and the outline of its septu.

Position and locality. It is found crushed in the roof shales of No. 9 coal, at the mines of the Kentucky Coal Company, Union county, Kentucky, and in a more perfect state of preservation in the fossiliferous nodules of calcareous sulphuret of iron in the same shale; which, when thrown out, decompose, from the action of the atmosphere and yield readily their store of fossils to the collector.

SOLENIMYA SOLENIFORMIS. *Cox.*

(Pl. IX, fig. 5; natural size.)

Transversely elongated; inequilateral; beaks not elevated, sloping to the front, about one-third the length from the anterior end; extremities and base obtusely rounded—more decided anteriorly in young than in adult specimens; cardinal border straight; surface covered with concentric lines and furrows; length $2.\frac{7}{100}\frac{4}{0}$ inches; width $1.\frac{4}{100}\frac{5}{0}$ inches.

Position and locality. It is very abundant in the black shale which forms the roof of No. 9 coal, on the property of the Kentucky Coal Company, Union county, Kentucky, and in the same character of shale, over the thirteen inch coal, in the bed of the Ohio river, at the head of French Island.

PRODUCTUS MURICATUS. *Norwood and Pratten.*

Pl. IX, fig. 6; natural size.)

For description, *see Journal Academy Natural Sciences, Aug.*, 1854, *pl.* 1, *fig.* 8.

Position and locality. Characteristic of coal No. 9, and found in great abundance in the black shale forming its roof, at the Curlew and Kentucky Coal Company's mines, Union county; at Lewisport, Hancock county, Kentucky; and at the Saline and Shawneetown Company's mines, Gallatin county, Illinois.

GONIATITES NOLINENSIS. *Cox.*

(Pl. X, fig. 1, quarter view natural size; fig. 1*a*, outline of dorsal septu;* fig. 1*b*, outline of ventral septu.)

Discoidal; one and a half to two whorls, increasing in the proportion of .$\frac{70}{100}$ of an inch to 1.$\frac{25}{100}$ inches; periphery very convex; sides obtusely rounded; umbilicus large, round, vertically walled; dorsal lobe and sinus dart shaped, first lateral lobe elliptically pointed, a little longer and broader than the dorsal; lateral sinus angular, acutely pointed, about twice as broad, and one-third longer than the dorsal; second lateral lobe subovately rounded; ventral sinus longer and more acute than the corresponding dorsal lobe; second ventral lobe obtusely rounded, and broader than the lateral sinus, with which it corresponds; mouth moderately transverse; greatest diameter 2.$\frac{17}{100}$ inches; width of umbilicus .$\frac{45}{100}$ of an inch; transverse diameter of mouth 1.$\frac{25}{100}$ inches; vertical hight 1.$\frac{08}{100}$ inches.

It is closely related to *G. crenistria, Phill.*, but differs in having the last chamber less transverse; umbilicus larger, and the dorsal lobe acutely pointed; not bifid as in the *G. crenistria.* The specimens found are not well enough preserved to show any ornaments that may have existed on the shell, they are all converted into oxide of iron; and like their associates *N. ferratus, nob.* and *N. canaliculatus, nob.* have been used at Nolin Furnace for the manufacture of iron.

Position and locality. Nolin Iron Works Edmonson county, Kentucky, in a thin stratum of ferruginous fire-clay with fragments of coal closely resembling charcoal, about one hundred feet above the conglomerate.

NAUTILUS FERRATUS. *Cox.*

(Pl. X, fig 2, half natural size; fig. 2*a* section natural size.

Globose, convoluted, whorls two, embracing, increasing in width in the proportion of 1.$\frac{45}{100}$ inches to 2.$\frac{71}{100}$ inches, regularly rounded on

*Explanation of the nomenclature. Fig. 1*a*, the arrow is in the dorsal lobe, and points to the mouth in the direction of increase; *d*, dorsal lobe; *d, s*, dorsal sinus; *l'*, first lateral lobe; *l, s'*, first lateral sinus; *l"*, second lateral lobe. Fig. 1*b*, *v, s*, ventral sinus; *v, l'*, first ventral lobe; *v, s"*, second ventral sinus; *v, l"*, second ventral lobe.

the periphery and sides; septu obtusely curved backwards on the sides, rapidly rising forward into conical arches on the middle of the periphery, about three lines apart in the middle where two inches wide; periphery marked in casts with an obsolete band about one line in width; last chamber large, about as deep as wide; mouth subreniform; umbilicus moderately large, profound, nearly vertically walled, slightly enlarged on the last whorl. Diameter 3.$\frac{3\,2}{1\,0\,0}$ inches; transverse diameter of mouth about 2.$\frac{7\,1}{1\,0\,0}$ inches; vertical height 1.$\frac{6\,4}{1\,0\,0}$ inches; width of umbilicus $\frac{3\,4}{1\,0\,0}$ of an inch.

It is readily distinguished from *N. globatus, Sow.*, and *N. bilobatus, Sow.*, with which it is related; by the size and shape of its septu, and the less rapid increase of its whorls. The specimen under description is destitute of spiral or transverse striæ, though it is possible they may exist when found in a more perfect state of preservation.

Position and locality. Found in great abundance, converted into oxide of iron and mostly imperfect; associated with *G. Nolinensis, nob.* about one hundred feet above the conglomerate, in a stratum of ferruginous fire-clay and carbonaceous matter; Nolin Iron Works, Edmonson county, Kentucky. Being an excellent ore it has contributed largely for the manufacturing of iron.

NAUTILUS CANALICULATUS. *Cox.*

(Pl. X, fig. 3, natural size; fig. 3 *a*, section of a smaller specimen.)

Discoidal, whorls two, to two and a half, increasing in width in the proportion of $\frac{5\,0}{1\,0\,0}$ to 1.$\frac{3\,0}{1\,0\,0}$ inches; obtusely rounded on the sides; broad, but shallow groove on the periphery, diminishing in depth from the mouth backwards, obsolete on the first whorl when exposed, a narrow indistinct band extends along the centre of the dorsal groove in well preserved specimens; septu about two lines apart in the middle, where three quarters of an inch in width, curved backwards on the sides and periphery, on the rounded edges of the groove they bend semi-elliptically forward; umbilicus large, deep, vertically walled, exposing partially all the whorls; mouth transversely subovate; diameter 2.$\frac{5\,1}{1\,0\,0}$ inches; vertical height of the mouth, about 1.$\frac{3\,0}{1\,0\,0}$ inches; transverse diameter 1.$\frac{4\,5}{1\,0\,0}$ inches; width of umbilicus .$\frac{4\,2}{1\,0\,0}$ of an inch.

It differs from the *N. sulcatus, Phil.*, by its rounded sides, greater breadth on the periphery, smaller and more vertically walled umbilicus.

Position and locality. Abundant in the same bed with *G. Nolien-*

sis and *N. ferratus*. Nolin iron works, Edmondson county, Kentucky.

LINGULA UMBONATA. *Cox.*

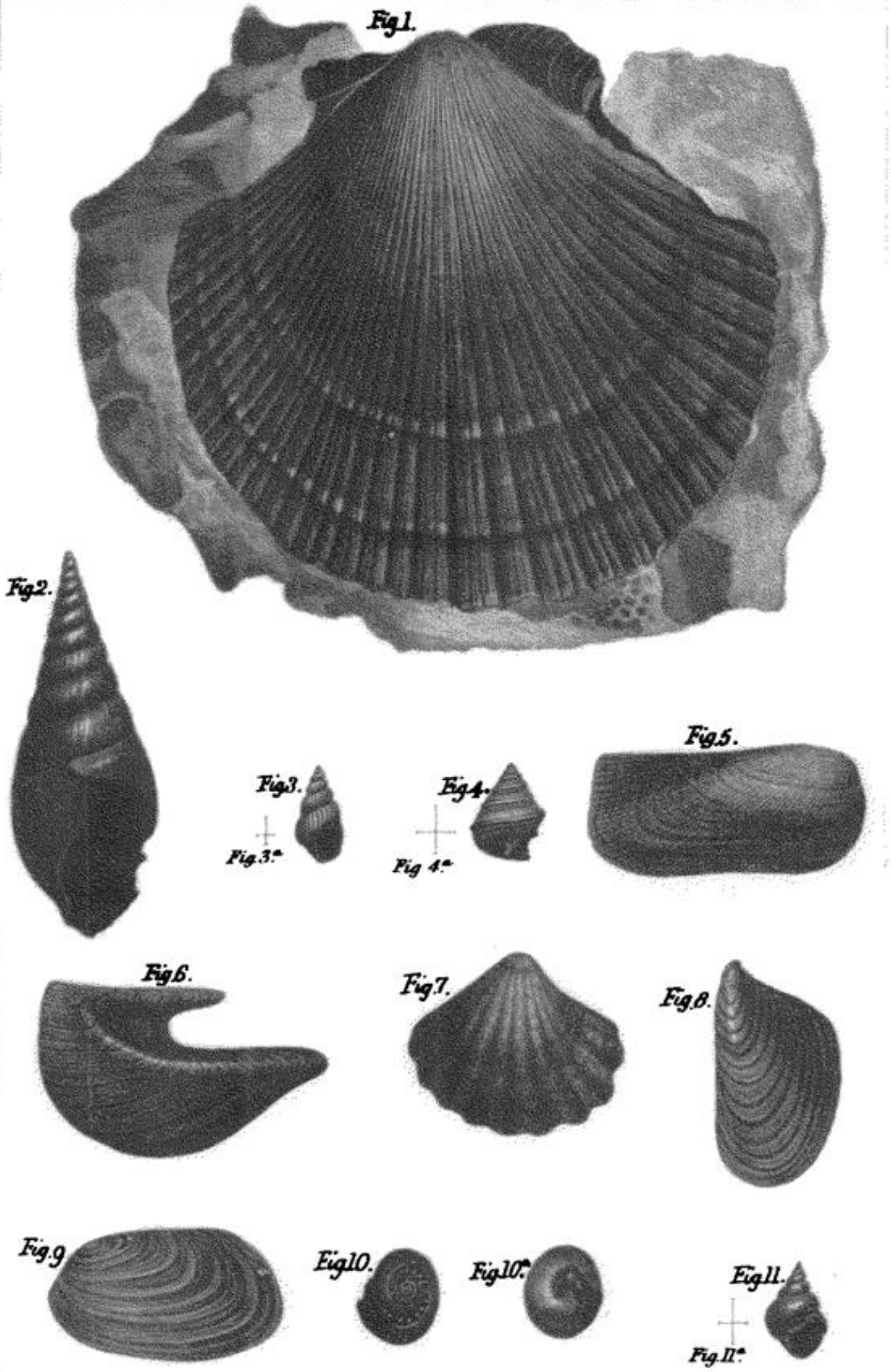
(Pl. X, fig. 4, entering valve enlarged; fig. 4 *a*, natural size.)

Subpentagonal, longitudinally elongated, very tumid at the umbo; beak elevated, pointed, not projecting beyond the cardinal border; greatest width about one-third the length below the beak; sides nearly parallel, slightly convex and narrowing towards the front; front very obtusely rounded, posterior lateral margins rather acutely rounded, uniting in an elliptical point at the beak; slightly flattened along the mesial line, commencing from a point near the beak, and gradually widening to the front margin, a little pinched in near the umbo; surface beautifully marked with fine concentric striæ between the more distinct lines of growth; length .$\frac{19}{100}$ of an inch; width $\frac{13}{100}$ of an inch.

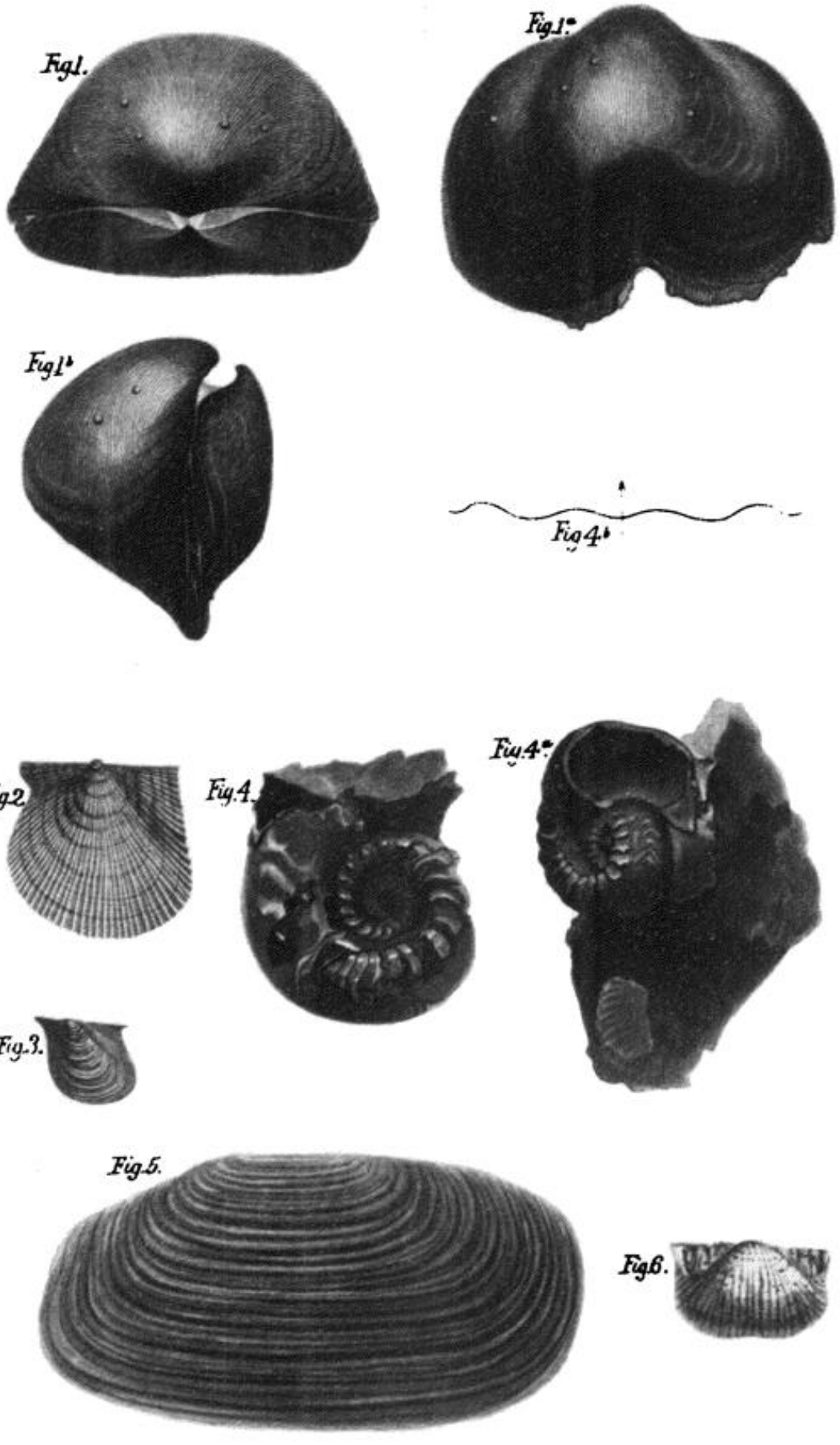
This species is easily recognized in well preserved specimens, by its prominent umbo, and its peculiar longitudinally flattened mesial area. It attains a much greater size, but we have none larger sufficiently perfect to figure.

It is highly characteristic of No. 1, B, coal, and has been found in beds of this level, by Mr. Lesquereux, in Ohio and Pennsylvania.

Position and locality. Very abundant in the black slate roof of No. 1, B, coal, at Bell's mines, Crittenden county; Casey's mines, Union county, and Hawesville mines, Hancock county, Kentucky.

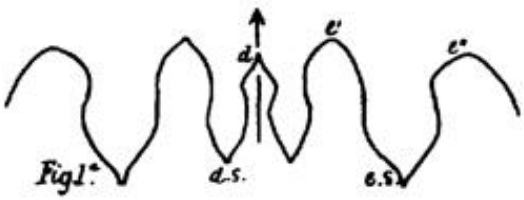


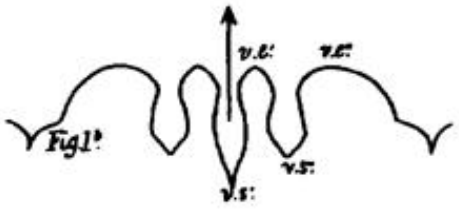
Pecten 1 providencis. Leaiorema 2 regularis. Chemnitzia 3 parva. 3a natural size, Pleurotomaria 4 bonharborensis. 4a natural size. P.10.10a depressa. Area 5 carbonaria. Gervillia 6 longispina, Plicatula 7 striato Costata. Myalina 8 pernaformis. Cardinia ? 9 fragilis. Macrocheilus 11 gracilis. 11a natural size

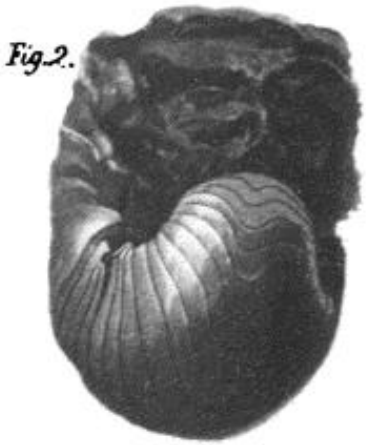


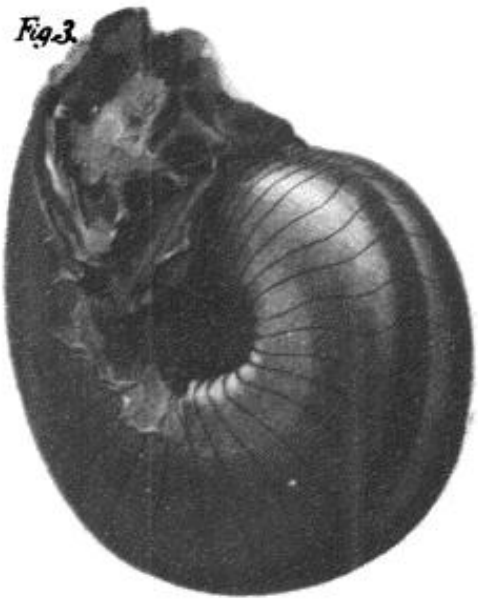
Orthis 1 resupinoides 1a entering valve 1b profile Avicula 2. recta lateralis 4.3 acosta Nautilus 1 decoratus 1a front view 1b outline of septa Solenimya 5 soleniformis Productus 6 murcatus

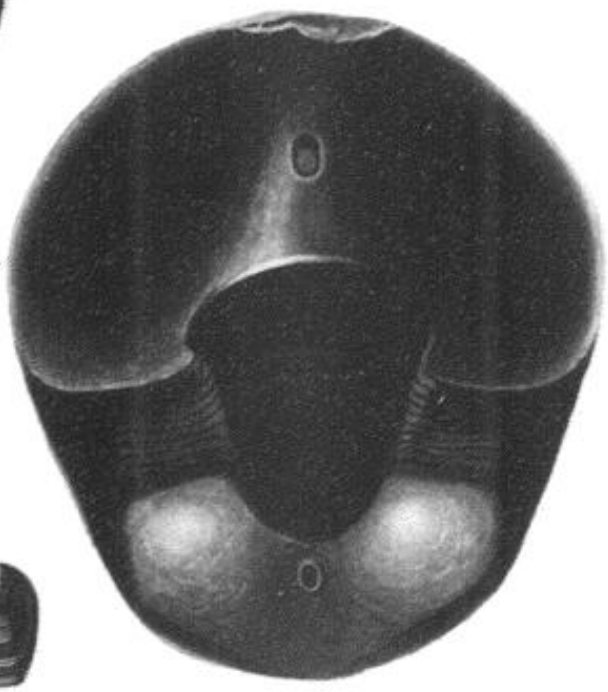
PLATE X











Gonatites 1. nolinensis 1ª dorsal outline of septa. 1ᵇ ventral outline of septa Nautilus 2 ferratus reduced ⅛. 2ª section of same nat. size N.3 annulatulatus nat size 3ª section of same smaller individual Lingula 4. nimbonatu enlarged. 4ª natural size

INDEX.