

PALÆONTOLOGICAL REPORT

OF

COAL MEASURE MOLLUSCA

MADE BY

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ASSISTANT GEOLOGIST.

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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 several 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 carnivorous 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 characterized 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, *Loxonema*, species undetermined, *Orthoceratite*, species undetermined, *Chonetes mesoloba*, (variety small, and prominently lobed,) *Productus equicostatus*, and *Bellerophon carbonarius*. This *Bellerophon*, which we propose to call *B. carbonarius*, has generally been referred 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. carbonarius* 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 am 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 $\frac{7}{10}$ of an inch; proportional increase of the last whorl $\frac{41}{100}$ to $\frac{88}{100}$ 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 undetermined, *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 overlaid 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 $3\frac{2}{10}$ inches; width $3\frac{2}{10}$ 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 $2\frac{1}{10}$ inches; width $\frac{9}{10}$ 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; 3a 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 $\frac{1.5}{100}$ 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; 4a 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 $\frac{2.7}{100}$ inch; width $\frac{2.1}{100}$ 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.)

Transversely 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 $1.\frac{4}{8}$ inches, height $.\frac{6}{8}$ 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; elliptically 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 $1.\frac{4}{8}$ inches, height $.\frac{3}{8}$ 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 overlies 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 circumference, 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 $1.\frac{0.8}{100}$ inches; width $1.\frac{2.5}{100}$ inches.

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

MYALINA PERNAFORMIS. *Coz.*

(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 $1.\frac{1.3}{100}$ inches; width $.\frac{8.7}{100}$ inch.

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

PLEUROTOMARIA DEPRESSA. *Coz.*

(Pl. VIII, fig. 19, 10a; 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 $.\frac{3.3}{100}$ inch; width $.\frac{5.1}{100}$ inch; spiral angle 130° .

This species may at first easily be mistaken for *P. sphaerulata*, *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 $\frac{.92}{100}$ 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 retracted; 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, prolongation 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 development with its cogenitors.

Position and locality. Common in the shale over No. 11 coal, Bon-harbor, 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 $1.\frac{86}{100}$ inches; length $1.\frac{54}{100}$ inches; hinge line $1.\frac{02}{100}$ inches; depth of receiving valve $.\frac{35}{100}$ inch; depth of entering valve $.\frac{25}{100}$; width of cardinal area $.\frac{12}{100}$ inch; depth $.\frac{07}{100}$ 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. *Coz.*

(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 rectalinear; base and posterior side obtusely

rounded; hinge area straight; a little narrower than the shell; height $\frac{9}{100}$ of an inch; width $\frac{9}{100}$ of an inch; anterior ear $\frac{4}{100}$ of an inch; posterior ear $\frac{3}{100}$ 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 distinguish 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 $\frac{4}{100}$ of an inch; width $\frac{4}{100}$ of an inch cardinal border $\frac{3}{100}$ 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. 4b, outline of the septa.)

Discoidal; whorls two and a half, not embracing, increasing in width in the proportion of $\frac{9}{100}$ to $\frac{8}{100}$ 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-

ment 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 $\frac{5}{10}\frac{4}{8}$ of an inch; transverse diameter $\frac{6}{10}\frac{1}{8}$ of an inch; greatest diameter of the shell $1\frac{3}{10}\frac{5}{8}$ inches; depth of septu next to the last chamber $\frac{6}{10}\frac{4}{8}$ 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.

SOLENUMIA 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 $2\frac{7}{10}\frac{4}{8}$ inches; width $1\frac{4}{10}\frac{5}{8}$ 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. *Coz.*

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

Discoidal; one and a half to two whorls, increasing in the proportion of $\frac{7}{10}$ of an inch to $1\frac{2}{10}$ 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 $2\frac{1}{10}$ inches; width of umbilicus $\frac{1}{10}$ inches; transverse diameter of mouth $1\frac{2}{10}$ inches; vertical height $1\frac{0}{10}$ 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. *Coz.*

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

Globose, convoluted, whorls two, embracing, increasing in width in the proportion of $1\frac{4}{10}$ inches to $2\frac{7}{10}$ inches, regularly rounded on

*Explanation of the nomenclature. Fig. 1a, 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. 1b, *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 $3\frac{3}{10}$ inches; transverse diameter of mouth about $2\frac{7}{10}$ inches; vertical height $1\frac{6}{10}$ inches; width of umbilicus $\frac{3}{10}$ 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 $\frac{5}{10}$ to $1\frac{3}{10}$ 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 $2\frac{5}{10}$ inches; vertical height of the mouth, about $1\frac{3}{10}$ inches; transverse diameter $1\frac{4}{10}$ inches; width of umbilicus $\frac{2}{10}$ 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. Nolin-*

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

LINGULA UMBONATA. *Cox.*

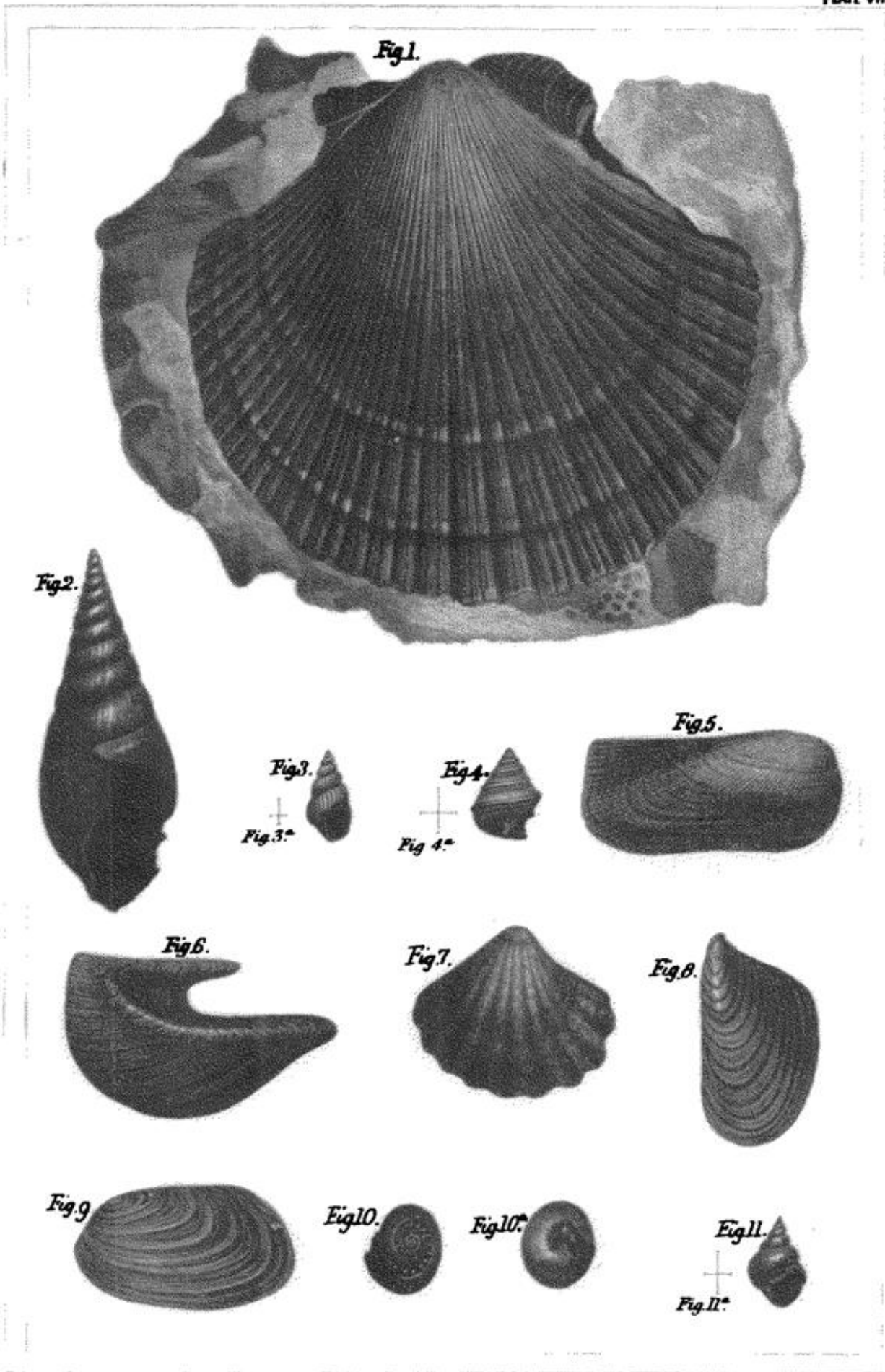
(Pl. X, fig. 4, entering valve enlarged; fig. 4 α , natural size.)

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 $\frac{1.9}{10}$ of an inch; width $\frac{1.3}{10}$ of an inch.

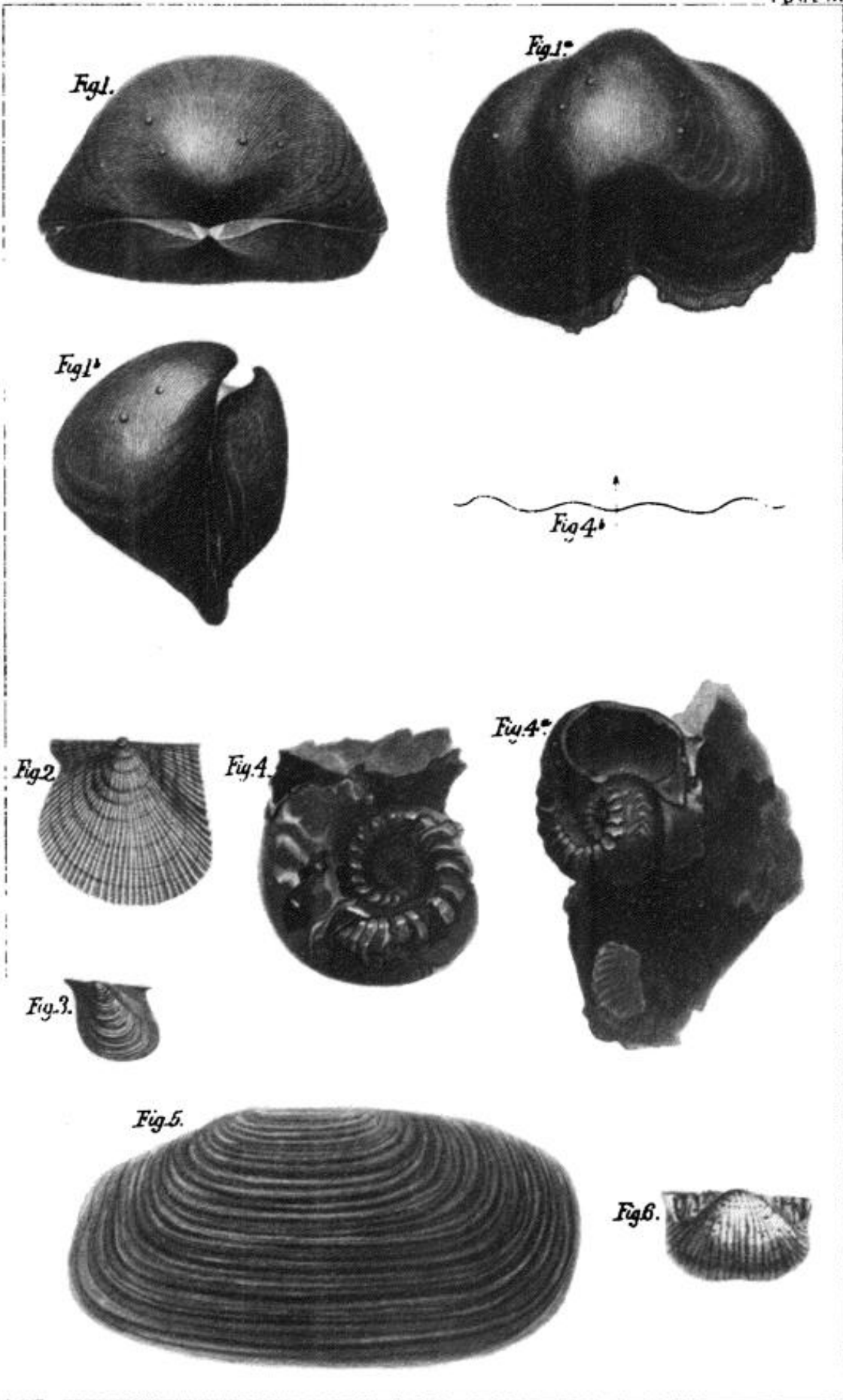
This species is easily recognized in well preserved specimens, by its prominent umbo, and its peculiar longitudinally flattened mesial area. It attains a much greater size, but we have none larger sufficiently perfect to figure.

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.

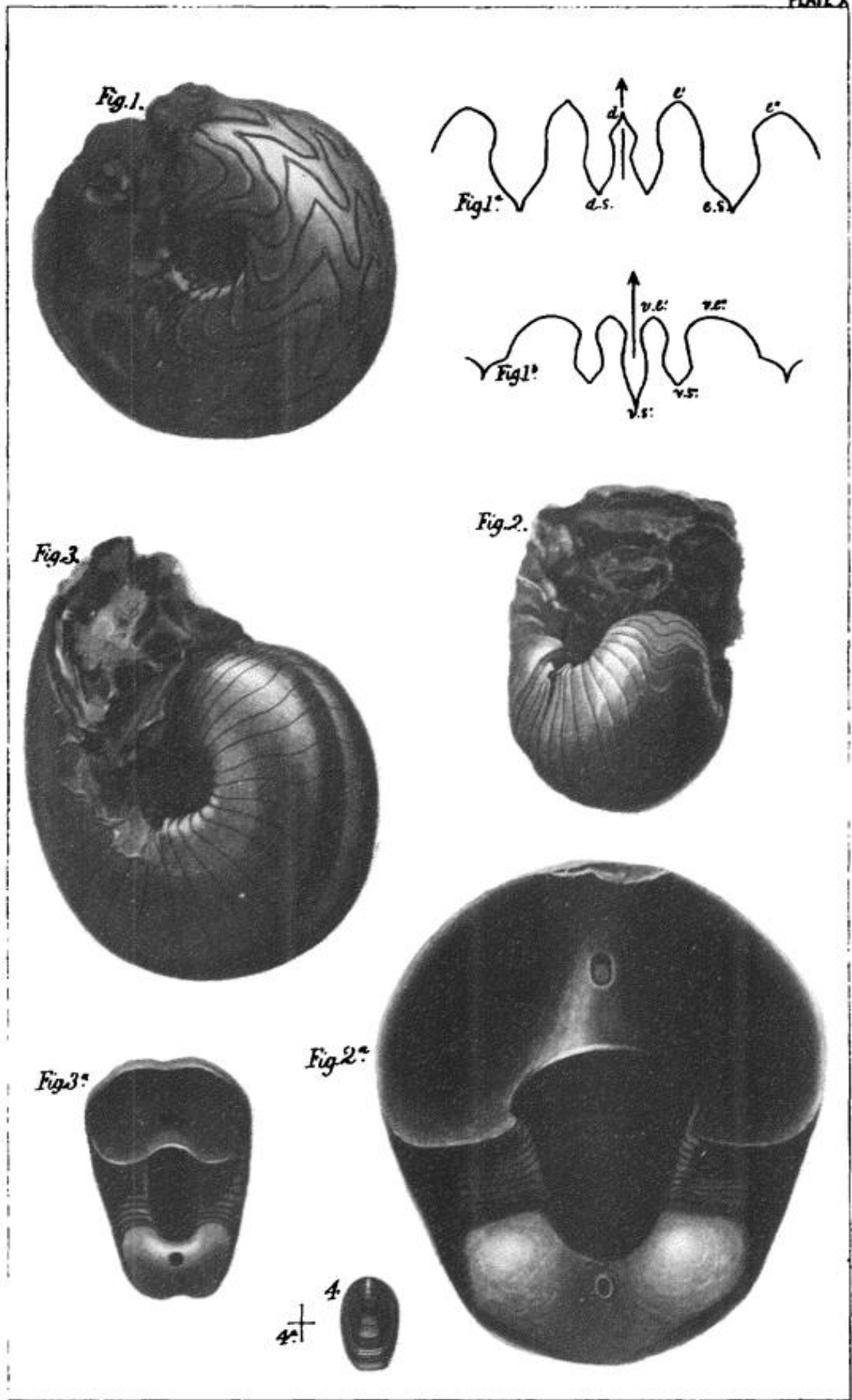
Position and locality. Very abundant in the black slate roof of No. 1, B, coal, at Bell's mines, Crittenden county; Casey's mines, Union county, and Hawesville mines, Hancock county, Kentucky.



Pecten 1 *providentis*. *Loxostoma* 2 *regularis*. *Chenuitzius* 3 *parva*. 3* natural size, *Pleurotomaria* 4 *bonharborensis*. 4* natural size. *P. 10. 10** *depressa*. *Arca* 5 *carbonaria*. *Gervillia* 6 *longispina*. *Plicatula* 7 *striato* *Costella*. *Myalina* 8 *pernaformis*. *Cardinia* ? 9 *fragilis*. *Murexochelus* 11 *gracilis*. 11* natural size



Orthis 1 *resupinoides* 1^a entering valve 1^b profile *Avicula* 2. *recta-lateralis* 3. *acosta* *Nautilus* 4 *decoratus* 1^a front view 1^b outline of septa *Solenomya* 5 *soleniformis* *Productus* 6 *muricatus*



Goniatites I. nolimensis 1^a dorsal outline of septa. 1^b ventral outline of septa *Nautilus*
2 ferratus reduced \times . 2^a section of same nat. size *N. 3. nimbosulcatus* nat size 3^a section
of same smaller individual *Lingula*. 4. *nimbonatu* enlarged. 4^a natural size.

INDEX.

Acinocrinus abnormis, - - - - -	479
Adair, Green, Allen and Bourbon counties, geology, &c., &c., - - -	159
Agricultural geology, - - - - -	31
Agriculture, general remarks on - - - - -	195
Airdrie furnace, ore, limestone, slag and iron, - - - - -	337
Airdrie shaft, Green river, section at, - - - - -	24
Airdrie shaft, Muhlenburg county, - - - - -	23
Alum spring, - - - - -	55, 127
Anderson county, geology of, - - - - -	61
Anderson county soils and sub soils, - - - - -	203
Area carbonaria, - - - - -	567
Ashes of coal, color of, - - - - -	512
Asterocrinus capitalis, - - - - -	472
Asterocrinus? coronarius, - - - - -	476
Avicula acosta, - - - - -	572
Avicula recta lateraria, - - - - -	571
Baker ore bank, - - - - -	450, 451, 453
Barren Coal Measures of Pennsylvania and Kentucky, - - -	14, 21
Barytes, sulphate of, Estill county, - - - - -	140
Barytes, sulphate of, in Garrard county, - - - - -	77, 81
Barytes, sulphate, Henry county, - - - - -	60, 103
Bath county coal, - - - - -	27
Bath county, geology, soils, &c., &c., - - - - -	130
Bath county, mineral waters, - - - - -	208
Bell's (Washington) mineral spring, - - - - -	52
Big Lick, Nelson county, section at, - - - - -	97
Bituminous shale of Jessamine county, - - - - -	302
Bituminous shale, Muhlenburg county, - - - - -	335
Black band iron ore, in shale over coal No. 12, Airdrie shaft, - - -	23
Black band iron ore, Airdrie furnace, Muhlenburg county, - - -	337
Black slate in Cumberland county, - - - - -	150
Blue ash lands of Nelson county, - - - - -	91, 92
Blue hole, Hart county, - - - - -	163
Blue Licks, (lower,) battle ground, - - - - -	106
Blue Lick, (lower,) mineral waters, - - - - -	361
Blue limestone, mineral waters of the, - - - - -	363
Boone county soils and sub soils, - - - - -	210
Boone's creek, Fayette county, section on, - - - - -	68
Bourbon county, geology of, soils, &c., &c., - - - - -	62, 213

Boyle county, geology, soils, &c., &c.,	- - - -	144, 224
Bracken county, geology, soils, &c., &c.,	- - - -	109
Breathitt county cannel coal,	- - - -	30
Rreckinridge county soils,	- - - -	225
Bullitt county, soils, sub-soils, marls, iron ore, and limestone,	- - - -	227
Burdett's knob, Garrard county,	- - - -	77
Campbell county, soils and sub-soil,	- - - -	234
Campbellsville sulphur water, Taylor county,	- - - -	57
Cannel coal of Breathitt county,	- - - -	30
Cannel coal in Morgan county,	- - - 29, 156 to 159, 326 to 332	
Cannel coal to be sought for at base of Western Coal Measures,	- - - -	11
Cardinia ? fragilis,	- - - -	570
Carroll county soils and sub-soil,	- - - -	237
Casey county, geology, soils, &c.,	- - - -	146
Caverns in limestone, Fayette county,	- - - -	67
Chaplin creek, Nelson county,	- - - -	87
Chætetes lycoperdon, analysis of,	- - - -	262
Chemical geology,	- - - -	51
Chemical report of geological survey,	- - - -	173
Chimnizia parva,	- - - -	567
Christian, Todd, Logan, and Simpson counties, geology, &c., &c.,	- - - -	166
Clarke county, geology, soils, growth, &c.,	- - - -	71
Clay's ferry, Kentucky river, section at,	- - - -	69
Clays of Hancock county,	- - - -	282
Cliffs of Kentucky river, railroad bridge, mouth of Dick's river,	- - - -	29
Coal, Airdrie, Muhlenburg county, fossils of,	- - - -	543
Coal, Arnold's mine, Hopkins county, fossils of,	- - - -	547
Coal, in Bath county,	- - - -	27, 132
Coal, Battery rock, fossils of,	- - - -	527
Coal beds of Kentucky, horizontal exposition of,	- - - -	524
Coal, Bell's mine, Crittenden county, fossils of,	- - - -	529
Coal, below the lowest conglomerate, in eastern coal-field,	- - - -	9
Coal, bituminous, Morgan county,	- - - 327, 329, 330, 333, 334	
Coal, Bonharbour, Daviess county, fossils of,	- - - -	547
Coal, Breckinridge, fossils of,	- - - -	532
Coal, Casey's mines, fossils of,	- - - -	529
Coal, Curlew mines, Union county, fossils of,	- - - -	542, 546
Coal, cannel, Breathitt county,	- - - -	30
Coal, cannel, Daviess county,	- - - -	462
Coal, cannel, Morgan county,	- 29, 156, 157, 158, 159, 326 to 332	
Coal, in Estill county,	- - - -	140
Coal, on the equivalent of the main Pittsburg bed, in Kentucky,	- - - -	15
Coal-field, eastern,	- - - -	26
Coal-fields of Kentucky. western, palæontological characters of,	- - - -	522, 526

Coal-field, western boundary of the eastern, in Greenup county, - -	425
Coal, in Hart county, . - - - - -	163
Coal, Hartford, Ohio county, fossils of, - - - - -	543
Coal, Hawesville, fossils of, - - - - -	531
Coal, Henderson shaft, fossils of, - - - - -	544
Coal, Jackfield's, Hopkins county, fossils of, - - - - -	542
Coal, Lewisport, Hancock county, fossils of, - - - - -	544
Coal, "Little Vein," of Union county, - - - - -	14
Coal, Llewellyn mine, Union county, fossils of, - - - - -	546
Coal, Lofland's, - - - - -	16
Coal, lower, Lesley's description of in Pennsylvania, - - - - -	550
Coal Measures, barren, - - - - -	552
Coal Measures, connected section of upper and lower, in Kentucky, -	18
Coal Measures, fossil flora, - - - - -	499
Coal Measures of Kentucky, general remarks on, - - - - -	9
Coal, M'Cormick's, - - - - -	28
Coal, M'Nairy, Muhlenburg county, fossils of, - - - - -	543, 547, 548
Coal, Miller's, Muhlenburg county, fossils of, - - - - -	547
Coal, Mulford's mines, Union county, fossils of, - - - - -	542
Coal, No. 1, in Union, Hopkins, Christian, Muhlenburg and Butler, -	17
Coals, No. 1 to No. 12, fossils of, - - - - -	527 to 554, 560
Coal, No. 1 B, fossil shells of, - - - - -	560
Coal, No. 2, individual layers in the place of, in Union county, - -	12
Coal, No. 3, or Ice-house coal, - - - - -	12
Coals, Nos. 6, 5, 4, and 3, - - - - -	17
Coal, No. 9, in Union, Henderson, Hopkins, and Butler, - - - - -	17
Coal, No. 9, fossil shells of, - - - - -	561
Coal, No. 11, fossil shells of, - - - - -	563
Coal, No. 12, in Hopkins and Muhlenburg, - - - - -	17
Coal, Old Distillery, fossils of, - - - - -	550
Coal, Peaks of Otter, fossils of, - - - - -	543
Coal, Pigeon run, Hopkins county, fossils of, - - - - -	547
Coal, Pomeroy, position of, - - - - -	13
Coal, in Powell county, - - - - -	134
Coal, Providence, Hopkins county, fossils of, - - - - -	546
Coal, in Rockcastle county, - - - - -	155
Coal, theory of its formation, - - - - -	502, 512
Coal, Thompson's mine, Union county, fossils of, - - - - -	546
Coal, Union mines, Crittenden county, fossils of, - - - - -	531
Coal, value of, - - - - -	564
Codastur alternatus, - - - - -	493
Copper ore, from Bath county? - - - - -	133
Copper ore, Estill county, - - - - -	137
Cottage Furnace, Estill county, - - - - -	135

Creel's, Mrs., sulphur spring, Marion county, - - - - -	57
Crider's hill, Russell county, section on, - - - - -	149
Crittenden county sub-soil, - - - - -	240
Crocus creek salt borings, and petroleum, - - - - -	151
Cumberland county, geology, &c., &c., - - - - -	150
Daviess county coal, - - - - -	462
Daviess county soils and sub-soil, - - - - -	241
Devonian black slate, - - - - -	118, 119
Dick's river, sections at, - - - - -	78, 79, 80
Dismal swamp, approximate cross section of, - - - - -	508
Dulatocrinus lacus, - - - - -	482
Drennon's springs, - - - - -	53
Drummond's lake of Dismal swamp, - - - - -	508, 509
Eastern coal field, - - - - -	26
Eminence, Henry county Chalybeate spring, - - - - -	53
Efflorescence from a corn field, Hopkins county, - - - - -	295
Esculapian springs, - - - - -	55, 127
Estill county, geology, soils, &c., &c., - - - - -	135
Estill county, iron ore, and mineral waters, - - - - -	56, 244, 245
Estill springs, Sweet Lick knob, - - - - -	56, 245
Explanation of plates of Coal Measure fossil plants, - - - - -	556
Explanation of plates of Coal Measures mollusca, - - - - -	577
Explanation of plates of crinoidia, - - - - -	495
Fayette county, geology, forest growth, soils of, &c., &c., - - - - -	65
Fayette county, magnesian limestone and fossil chætetes, &c., - - - - -	259
Fire-clay of Coal Measures, - - - - -	511
Fish, remains of in shales of coals Nos. 7, 9 and 12, - - - - -	510, 549, 560
Flat lick, Lincoln county, - - - - -	143
Fleming county, geology, soils, &c., &c., - - - - -	127
Forest growths characterizing geological formations, - - - - -	427
Forest growth, Garrard county, - - - - -	77, 78
Forest growth, Mercer county, - - - - -	81, 82
Forest growth, Washington county, - - - - -	84
Forest growth, Woodford county, - - - - -	66
Fossil fish, in coals Nos. 7, 9, and 1, black band vein, - - - - -	540, 549, 561
Fossil trees in sandstone of Coal Measures, - - - - -	520
Franklin county soils, &c., and lead and lead ores, &c., - - - - -	60, 61, 246
Franklin county, stratigraphical geology, &c., - - - - -	59
Freestone knob, near Rockville and Loughery's quarry, - - - - -	121
Freestone, in Powell county, - - - - -	136
Freestone, in Rowan county, - - - - -	129
Gallatin county, soil and sub soil, - - - - -	203
Garrard county, geology, soils, &c., &c., - - - - -	75, 265
Gervillia longipina, - - - - -	568

Goniatites Nolinensis, - - - - -	574
Goose creek knobs, Casey county, section, - - - - -	147
Grant county, soils, sub soils, and sandstones, - - - - -	272
Graphiocrinus, 14 brachialis, - - - - -	477
Grape juice, Catawba, specific gravity of, - - - - -	112
Greenup county, geology and topography of, - - - - -	425
Greenup county, iron ores, - - - - -	276, 450
Grigsby's (R. B.) white sulphur spring, Nelson county, - - - - -	52
Grimes' quarry, magnesian limestone, Fayette county, - - - - -	69
Hancock county, soils, sub soil, clays, and iron ore, - - - - -	278
Hancock county, topography and geology, - - - - -	457
Hardin county, soils and sub soil, - - - - -	284
Hardinsville mineral spring, Shelby county, - - - - -	52
Harmony, Owen county, mineral spring, - - - - -	54
Harrison county, soils and sub-soil, - - - - -	289
Harrodsburg mineral springs, - - - - -	51
Hart county, geology, &c., &c., - - - - -	162
Henderson county, tobacco soil, - - - - -	34
Henry county, geology, soils, &c., &c., - - - - -	103, 292
Hopkins county, iron ores, efflorescence, &c., - - - - -	295
Howard's creek, Kentucky river, section at, - - - - -	71
Human skeletons, &c., at Augusta, - - - - -	116
Hydraulic limestone, Christian county, - - - - -	166
Hydraulic limestone, Estill county, - - - - -	137
Hydraulic limestones, Garrard county, - - - - -	77
Hydraulic limestone, Marion county, - - - - -	101
Hydraulic limestone, Nelson county, - - - - -	93, 94
Ice house coal, or coal No. 3, suited for manufacture of iron, - - - - -	12
Inflammable gas, Franklin county, - - - - -	61
Iron, from Airdrie furnace, Muhlenburg county, - - - - -	340
Iron, from Nelson furnace, Nelson county, - - - - -	344
Iron ore, Bath county, - - - - -	131, 132
Iron ore, Boyle county, - - - - -	145
Iron ores used at Buffalo furnace, - - - - -	450
Iron ore, limonite, of Bullitt county, - - - - -	233
Iron ore in Eastern coal-field, - - - - -	23
Iron ore, Estill county, - - - - -	135, 244
Iron ore, Flat lick, Lincoln county, - - - - -	143
Iron ore, limonite, Franklin county, - - - - -	253
Iron ores, Greenup county, - - - - -	278
Iron ore, Green and Taylor counties, - - - - -	162
Iron ore, Hancock county, - - - - -	278
Iron ores, &c., of Hopkins county, - - - - -	295
Iron ore, Morgan county, - - - - -	534

Iron ores, of Nelson county,	-	-	-	-	-	-	95, 98, 341, 342
Iron ore, in Powell county,	-	-	-	-	-	-	135
Iron ore, in Rockcastle county,	-	-	-	-	-	-	155
Iron ore, in Rowan county,	-	-	-	-	-	-	129, 380
Iron ore, Russell county,	-	-	-	-	-	-	149
Iron stone beds, period of formation of,	-	-	-	-	-	-	426
Irvine sulphur spring,	-	-	-	-	-	-	56
Janes' mineral spring, Washington county,	-	-	-	-	-	-	51, 86
Jefferson county, soil and sub-soil,	-	-	-	-	-	-	300
Jessamine county, geology, soils, &c., &c.,	-	-	-	-	-	-	73, 302
Kenton county, soils and sub soil,	-	-	-	-	-	-	307
Kentucky river, bluffs of,	-	-	-	-	-	-	29, 104
Kentucky river, marble rock,	-	-	-	-	-	69, 73, 75, 76, 79	
Knobs, Casey county,	-	-	-	-	-	-	147
Knob lick, Estill county,	-	-	-	-	-	-	139
Knobs of Lewis county, section of,	-	-	-	-	-	-	120
Knobs, in Madison county,	-	-	-	-	-	-	141
Knobs, in Marion county,	-	-	-	-	-	-	101
Knobs, N. E. corner of Taylor county,	-	-	-	-	-	-	166
Knobstone,	-	-	-	-	-	-	449
Larue county, soils and sub-soil,	-	-	-	-	-	-	163, 310
Larue and Taylor counties, geology, &c., &c.,	-	-	-	-	-	-	163
Lead ore of Franklin county,	-	-	-	-	-	-	61
Lead ore, in Garrard county,	-	-	-	-	-	-	81
Lead ore, Henry county,	-	-	-	-	-	-	103
Lead and zinc ore, in Monroe county,	-	-	-	-	-	-	154
Lead ore vein, in Woodford county,	-	-	-	-	-	-	65
Lewis county, geology, soils, &c., &c.,	-	-	-	-	-	-	119
Lime, use of as manure,	-	-	-	-	-	-	201
Limestones from Bourbon county,	-	-	-	-	-	-	64
Limestones of the Coal Measures,	-	-	-	-	-	-	519
Limestones of Fayette county,	-	-	-	-	-	67, 259	
Limestone, magnesian, Harris' quarry, Fayette county,	-	-	-	-	-	-	259
Limestones of Mercer county,	-	-	-	-	-	80, 82	
Limestone, in Rowan county,	-	-	-	-	-	-	129
Limestones of Shelby county,	-	-	-	-	-	102, 103	
Limestones of Spencer county,	-	-	-	-	-	101, 102	
Limestone of the western coal-fields,	-	-	-	-	-	-	519
Limestones, Woodford county,	-	-	-	-	-	66, 409	
Lincoln county, geology, soils, &c., &c.,	-	-	-	-	-	-	142
Lingula umbonata,	-	-	-	-	-	-	576
Little Vein coal, of Union county,	-	-	-	-	-	-	14
Linsey's mineral spring, Christian county,	-	-	-	-	-	-	57
Lofland's coal,	-	-	-	-	-	-	16

Loxonema reguelaris, - - - - -	566
Macrocheilus gracilis, - - - - -	570
Madison county, geology, soils, &c., &c., - - - - -	141
Magnesium, chloride of, in water in Nicholas county, - - - - -	105
Magnesium, chloride of, probable cause of milk sickness, - - - - -	36, 54
Magnesian limestone, at Bardstown, &c., - - - - -	93, 94, 95, 96, 97
Magnesian limestone, in Bath county, - - - - -	130
Magnesian limestone, Clarke county, - - - - -	10
Magnesian limestone, Estill county, - - - - -	138, 140
Magnesian limestones, of Fayette county, - - - - -	69
Magnesian limestone in Lewis, Fleming, Bath, Rowan, Montgomery, Estill and Madison counties, - - - - -	118
Magnesian limestone, in Lewis and Fleming counties, - - - - -	119, 124, 126, 127
Magnesian limestone, Marion county, - - - - -	101
Magnesian limestone, in Montgomery county, - - - - -	134
Magnesian limestones of Spencer county, - - - - -	102
Magnesian limestone, Woodford county, - - - - -	409
Mammoth bones, &c., at Eminence, Henry county, - - - - -	103
Mammoth well, Nelson county, - - - - -	52
Marble, comparison of the Italian with Grimes' and Harris' limestones, - - - - -	260
Marls, soils and limestone of Bullitt county, - - - - -	227
Marly shales and marls, Nelson county, - - - - -	99, 358
Marl, soils, &c., Shelby county, - - - - -	384
Marl, of Spencer county, - - - - -	394
Marion county, geology, soils, &c., &c., - - - - -	99, 313
Mason county, geology, soils, &c., &c., - - - - -	107
Meade county, soils, - - - - -	316
Mercer county, geology, soils, &c., &c., - - - - -	79, 319
McCormick's coal, - - - - -	28
Milk sickness, in region of silicious mudstones, - - - - -	36, 54
Milk sick region mudstone, - - - - -	272, 360, 375
Mineral waters, Olympian, Bath county, - - - - -	208
Mineral waters, Estill springs, - - - - -	245
Mineral water, Lower Blue Lick, Nicholas county, - - - - -	361
Mineral water, Montmollin's mill, Fayette county, - - - - -	262
Mineral water, poisonous astringent, Garrard county, - - - - -	77
Mineral springs and well water, analyses of, - - - - -	51
Mineral springs, "alum," - - - - -	55
Mineral spring, Campbellsville sulphur, Taylor county, - - - - -	57
Mineral springs, Drennon's, - - - - -	53
Mineral spring, Eminence chalybeate, Henry county, - - - - -	53
Mineral springs, "Esculapian," - - - - -	55
Mineral springs, Estill, - - - - -	56, 245
Mineral spring, Hardinsville, Shelby county, - - - - -	52
Mineral spring, at Harmony, Owen county, - - - - -	54

Mineral springs, at Harrods-burg.	- - - - -	51
Mineral spring, R. B. Grogby's white sulphur.	- - - - -	52
Mineral springs, Irvine sulphur,	- - - - -	56
Mineral spring, Jones', Washington county,	- - - - -	51
Mineral spring, bed of Kettle creek, Cumberland county,	- - - - -	57
Mineral spring, Linsey's Christian county,	- - - - -	57
Mineral spring, Mammoth well, Nelson county,	- - - - -	52
Mineral spring, Mrs. Creel's sulphur, Marion county,	- - - - -	57
Mineral springs, Olympian,	- - - - -	55
Mineral spring, Russell sulphur,	- - - - -	56
Mineral springs, Sudduth's, Bath county,	- - - - -	56
Mineral spring, Washington Bell's, Nelson county,	- - - - -	52
Monroe county, geology, soils, &c., &c.,	- - - - -	152
Montgomery county, geology, soils, &c., &c.,	- - - - -	133
Morgan county coals, iron ores, and sandstones,	- - - - -	326
Morgan county, geology, &c., &c.,	- - - - -	156
Morgan county cannel coal,	- - - - - 29, 156 to 159, 326 to 332	
Muhlenburg county, shale, iron ore, limestone, pig iron, &c.,	- - - - -	335
Mulatto soil, of Nelson county,	- - - - -	94
Muldrough's hill, section on, Larue county,	- - - - -	163
Myalina pernaformis,	- - - - -	560
Nautilus canaliculatus,	- - - - -	575
Nautilus decoratus,	- - - - -	572
Nautilus ferratus,	- - - - -	574
Nelson county, geology, soils, &c., &c.,	- - - - -	87
Nelson county, iron ore, limestone, soils, sub-soils, marls, &c.,	52, 311, 360	
Nelson county mineral springs,	- - - - -	52, 360
Nelson furnace, Nelson county,	- - - - -	96
Nicholas county, geology, soils, &c., &c.,	- - - - -	105, 360
Nicholas county, sandstone, limestone and mineral water,	- - - - -	360
Oldham county, soils and sub-soil,	- - - - -	363
Olivianites angularis,	- - - - -	492
Olivianites Verneuillii,	- - - - -	487
Olympian springs, Bath county,	- - - - -	55, 131, 208
Owen county, geology, soils, &c., &c.,	- - - - -	104
Owen county, soils, sub-soil, limestone and sandstone,	- - - - -	373
Owingsville, Bath county, section near,	- - - - -	130
Orthis resuspinoides,	- - - - -	570
Palæontological characters of western coal-fields of Kentucky,	- - - - -	522, 526
Palæontological report on the Coal Measure mollusca,	- - - - -	557
Palæontological report of Sidney S. Lyon,	- - - - -	465
Palæontological report of fossil flora of Coal Measures,	- - - - -	499
Pasturage, influence of on the soil,	- - - - -	200
Pecten Providensis,	- - - - -	566

Pendleton county, soils and sub-soil,	377
Pentremites obesus,	469
Petroleum, Crocus creek, Cumberland river,	151
Pine knob, Boyle county,	145
Pittsburg coal bed, equivalent of in Kentucky,	15
Pleurotomaria Bonharborensis,	567
Pleurotomaria depressa,	569
Plicatula striato—costata,	568
Pomeroy coal, position of,	13
Powell county, geology, soils, &c., &c.,	134
Productus muricatus,	573
Public well at Bloomfield, Nelson county, analysis of water of,	51, 92
Puncheon Camp hill, section at, Cumberland county,	150
"Red Bud lands" of Madison county,	141
Red under-clay of Fayette county,	68
Richardson's knob, Garrard county,	77
Rochester springs, Boyle county,	145
Rockcastle county, geology of, &c.,	154
Rock-house knob, Estill county, section at,	138
Rock house, Russell county,	149
Rotation of crops,	199
Rowan county, geology, soils, &c., &c.,	129, 380
Rowan county, iron ores,	380
Russell county, geology, soils, &c., &c.,	148
Russell sulphur spring,	56
Salt river, Rolling fork, section near,	99
Salt water, Casey county,	147
Salt borings, Crocus creek, Cumberland river,	151
Salt water, in Morgan county,	159
Salt water, in Powell county,	135
Salt water, in Russell county,	149
Sandstones of the Coal Measures,	520
Sandstone, (mudstone from milk sick region,) Grant county,	272
Sandstone, Morgan county,	335
Sandstone, mudstone, of Owen county,	375
Sandstones, mudstones, Nicholas county,	360
Schoolfield's cannel coal, Morgan county,	156, 159
Scott county, geology, soils and sub-soil,	61, 381
Section on Alcorn creek,	418
Section at Airdrie shaft, Green river,	24
Section on Beech fork of Salt river,	86
Section at the "Big Lick," Nelson county,	97
Section on Boone's creek,	68
Section near Bradfordsville, Salt river, Marion county,	99
Sections at Buffalo and Raccoon furnaces, &c., Greenup county,	441

Section near Burksville, Cumberland county,	- - - - -	150
Section at Caroline furnace, Greenup county,	- - - - -	435
Section on Chaplin creek, Nelson county,	- - - - -	87
Section at Clay's ferry, Kentucky river,	- - - - -	69
Section at Clinton furnace, Greenup county,	- - - - -	436
Section on Coal creek,	- - - - -	440
Section of coal, &c., on the lands of Caroline furnace,	- - - - -	445
Section of coal, near Lewisport,	- - - - -	450
Section (connected) of upper and lower Coal Measures of Kentucky,	-	18
Section on Crider's hill, Russell county,	- - - - -	149
Section, Dick's river, edge of Garrard and Boyle counties,	- - - - -	78
Sections in eastern part of Estill county,	- - - - -	137
Section near Greensburg, Green county,	- - - - -	162
Section of 330 feet of rocks, on Grier's creek, Woodford county,	- - - - -	65
Section of hearth rock beds of Clinton and Bellefonte furnaces,	- - - - -	455
Section at Howard's lower creek, Kentucky river,	- - - - -	71
Section of Indian creek canal coal bank,	- - - - -	456
Section, southern part of Jessamine county, on Kentucky river,	- - - - -	73
Section at Kenton furnace, Greenup county,	- - - - -	428
Section on Kentucky river, at Rock house knob, Estill county,	- - - - -	138
Section on Kettle river, Cumberland county,	- - - - -	152
Section at Laurel furnace, Greenup county,	- - - - -	429
Section of the knobs of Lewis county,	- - - - -	120
Section of rocks below the black slate, Lewis county,	- - - - -	126
Section, limestone ore banks, Bellefonte furnace,	- - - - -	446
Section of Little Goose creek hill, Casey county,	- - - - -	147
Section, east side of Little Sandy river, Greenup county,	- - - - -	434
Section from west side of Little Sandy river, Greenup county,	- - - - -	433
Section in Monroe county,	- - - - -	152
Section on Muldrough's hill, Larue county,	- - - - -	163
Section at Mount Savage iron works, Carter county,	- - - - -	437
Section north branch of Oldtown creek,	- - - - -	449
Section one mile east of Owingsville, Bath county,	- - - - -	130
Section at Puncheon Camp hill, Cumberland county,	- - - - -	150
Section near Poplar Flats, Lewis county,	- - - - -	125
Section at Raccoon furnace, Greenup county,	- - - - -	430
Section at Railroad bridge (Danville and Lexington,) on Kentucky river	- - - - -	72
Section between Red river forge and Stanton, Powell county,	- - - - -	135
Section near Rolling fork Meeting house, Nelson county,	- - - - -	96
Section at Steam furnace, Greenup county,	- - - - -	432
Section of Weisel's coal mines,	- - - - -	461
Section on Whetstone creek,	- - - - -	438
Section on Withrow's run, Nelson county,	- - - - -	92

Shales, or roof slates, of coal, - - - - -	515
Shelby county, geology, soils, &c. &c., - - - - -	102, 384
Shell earth of Nelson county, - - - - -	91, 92, 381
"Sick Spots," Franklin county, - - - - -	60, 240
Siliceous mudstone, Fayette county, - - - - -	68
Silicious mudstone in Nicholas county, - - - - -	105
Silicious mudstone in Owen county, - - - - -	104
Silicious mudstone in Washington county, - - - - -	83
Silurian rock, upper and lower, boundary of, in Lewis, Fleming, Bath, Rowan, Montgomery, Estill and Madison counties, - - - - -	117
Slag from Airdrie furnace, Muhlenburg county, - - - - -	338
Slag, Iron furnace, from Nelson furnace, Nelson county, - - - - -	343
Soil in Adair, Green, Allen and Barren counties, - - - - -	160, 161
Soil analysis, - - - - -	177
Soils and sub-soils from Anderson county, - - - - -	62, 203
Soils of Bath county, - - - - -	131, 133
Soils, &c., of blue limestone, or Lower Silurian formation, - - - - -	31, 45, 36
Soils and sub-soils of Boone county, - - - - -	210
Soils, sub soils, under-clays and limestones, of Bourbon county, - - - - -	62, 213
Soils of Boyle county, - - - - -	144, 224
Soils of Bracken county, - - - - -	109, 116
Soils of Breckinridge county, - - - - -	225
Soils, sub-soils, marls and limestone, of Bullitt county, - - - - -	227
Soils and sub-soil of Campbels county, - - - - -	234
Soils and sub-soil of Carroll county, - - - - -	237
Soil, Casey county, - - - - -	147
Soils of Christian, Todd, Logan and Simpson counties, - - - - -	166, 167
Soils from Clarke county, - - - - -	72
Soils from Coal Measures, - - - - -	34, 38
Soil (sub-soil) of Crittenden county, - - - - -	240
Soils and sub-soil, Daviess county, - - - - -	241
Soils from Denovian formation, - - - - -	33, 42
Soil, Estill county, - - - - -	130
Soils of Fleming county, - - - - -	128
Soils of Franklin county, general remarks on, - - - - -	59
Soils, sub-soils, under-clays, limestones and marls, of Franklin county, - - - - -	246
Soil and sub-soil of Gallatin county, - - - - -	263
Soils and sub-soils of Garrard county, - - - - -	77, 78, 265
Soils, sub-soils and sandstones from Grant county, - - - - -	272
Soils, sub-soils, clays and iron ore of Hancock county, - - - - -	278
Soils and sub-soil of Hardin county, - - - - -	284
Soils and sub-soil of Harrison county, - - - - -	289
Soil, Henderson county tobacco, - - - - -	34
Soils and sub-soil of Henry county, - - - - -	103, 292

Soil and sub-soil, Jefferson county, - - - - -	300
Soils, sub-soil, limestone and shale, of Jessamine county, - -	72, 302
Soils and sub-soil of Kenton county, - - - - -	307
Soil over Kentucky marble, - - - - -	32
Soils of Kentucky, general remarks on, - - - - -	31
Soils from knob freestone, - - - - -	33
Soils and sub-soil of Larue county, - - - - -	310
Soil of Lewis county, - - - - -	123, 124, 126
Soils of Madison county, - - - - -	141, 142
Soils and sub-soil of Marion county, - - - - -	100, 101, 313
Soils of Mason county, - - - - -	107, 109
Soils of Meade county, - - - - -	316
Soils, sub-soils, under-clays and limestone of Mercer county, -	81, 82, 319
Soils of Montgomery county, - - - - -	133, 134
Soils, sub-soils, marls, &c., in Nelson county, 87, 88, 89, 90, 91, 92,	344
Soils in Nicholas county, - - - - -	105, 106
Soils from old field and virgin soils compared, - - - - -	35
Soil and sub-soil of Oldham county, - - - - -	368
Soils, sub-soil, limestone and sandstone of Owen county, - -	104, 373
Soils and sub-soil of Pendleton county, - - - - -	377
Soils from Quaternary formation, - - - - -	34, 37
Soil of Russell county, - - - - -	148
Soils and sub-soil of Scott county, - - - - -	381
Soils, sub-soil and marl of Shelby county, - - - - -	102, 384
Soil from silicious sandstones of Lower Silurian formation, - -	33, 36
Soils from sub carboniferous rocks, - - - - -	33, 39
Soils, sub-soil and marl, of Spencer county, - - - - -	102, 394
Soils, tables of composition of, arranged according to the geological formation, - - - - -	36
Soils of Taylor county, - - - - -	395
Soils in Taylor and Larue counties, - - - - -	164
Soils and sub-soil of Trimble county, - - - - -	397
Soils and sub-soil of Union county, - - - - -	400
Soil from Upper Silurian formation, - - - - -	33, 43
Soils and sub-soils, &c., in Washington county, - - 83, 84, 85, 86,	403
<i>Splenimya soleniformis</i> , - - - - -	573
Spencer county, geology, soils, &c., &c., - - - - -	101, 394
Steam furnace coal and ore, - - - - -	456
Stratigraphical geology, - - - - -	59
Sub-carboniferous rocks, in Lewis, Fleming, Bath, Rowan, Montgome- ry, Estill and Madison counties, - - - - -	117
Sub-soils and under-clays, general remarks on, - - - - -	32
Sub-soiling injurious, on Chaplin creek, Nelson county, - -	87, 88
Substratum, influence of on the soil, - - - - -	199

Subterraneous spring, Garrard county, - - - - -	78
Suddath springs, Bath county, - - - - -	56
Table A, soils, &c., from Quaternary formation, - - - - -	37
Table B, soils, &c., from Coal Measures, - - - - -	38
Table C, soils, &c., from sub-carboniferous formation, - - - - -	39
Table D, soils, &c., from Devonian formation, - - - - -	42
Table E, from Upper Silurian formation, - - - - -	43
Table F, soils, &c. from Lower Silurian formation, - - - - -	45
Table 1, soils, sub-soils, marls, &c., - - - - -	410
Table 2, limestones, &c., - - - - -	415
Table 3, (A) iron ores, limonites, - - - - -	416
Table 3, (B) iron ores, carbonate of iron, - - - - -	417
Table 4, coals, - - - - -	418
Table 5, sandstones and shales, - - - - -	419
Table 6, iron furnace slags, - - - - -	420
Table 7, pig iron, - - - - -	420
Taylor and Larue counties, geology, &c. &c., - - - - -	163
Taylor county, - - - - -	395
Tobacco land in Bracken county, - - - - -	109, 115, 116
Tobacco soil of Henderson county, - - - - -	34
Tobacco land of Mason county, - - - - -	107, 109
Tobacco land in Nicholas county, - - - - -	105
Tobacco land of Washington county, - - - - -	84
Topographical report—continued, - - - - -	423
Topography and geology of Greenup county, - - - - -	425
Trimble county, soils and sub soil, - - - - -	397
Union county, soils and sub-soil, - - - - -	400
Van Akin's quarry, Fayette county, - - - - -	67
Vasocrius sculptus, - - - - -	486
Vasocrius valens, - - - - -	485
Vineyards in Bracken county, - - - - -	109
Vineyards and manufacture of wine, - - - - -	83, 109, 123
Warren county, geology, soils, &c. &c., - - - - -	155
Washington county, geology, soils, &c. &c., - - - - -	83, 403
Water, from pond, Owen county, Burton Mather's pasture, - - - - -	54
Well water, Mr. Haskins', Garrard county, - - - - -	78
Well, Reuben Jessee's, Woodford county, - - - - -	65
Well water of Nelson county, around Bloomfield, - - - - -	51, 92
Wines and vineyards, remarks on, - - - - -	83, 109, 123
Withrow's run, Nelson county, section on, - - - - -	92
Woodford county, geology of, soils, &c., - - - - -	64
Woodford county, magnesian limestone, - - - - -	409
Zinc ore, Henry county, - - - - -	103
Zinc, sulphuret of, Estill county, - - - - -	139, 140