ancient colonists of Greece. But according to actual knowledge, and any positive records of zoology, the Serpent, between 10 and 12 feet in length, from the tertiary deposits of Salonica, must be deemed an extinct species. The fossil may be provisionally indicated as *Laophis crotaloïdes**.

EXPLANATION OF PLATE IV.

Fig. 1. Middle trunk-vertebra of *Palæophis typhœus*, Ow., from the Eocene of Bracklesham, Sussex.
2. Trunk-vertebra of *Laophis crotaloïdes*, Ow., from near the Promontory of Karabournou, on the eastern coast of the Gulf of Salonica.
3. Front view of the same vertebra.
4. Two middle trunk-vertebræ of *Crotalus durissus*.
5. Middle trunk-vertebra of a *Python tigris* 17 feet long.
6. Front view of the same vertebra.
7. Middle trunk-vertebra of the *Coluber Histrio*.

(All the figures are of the natural size.)

c. Anterior articular cup.
o. Posterior articular ball.
h. Hypapophysis.
d. Diapophysis with articular convexity for the rib.
d'. Lower diapophysial process.
d''. Upper diapophysial process.
z. Anterior zygapophysis.
z'. Posterior zygapophysis.
zs. Zygosphene.
n. Hinder border of neural arch.
ns. Neural spine.

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3. *On* Annelide-burrows *and* Surface-markings *from the* Cambrian Rocks *of the* Longmynd†. No. 2. By J. W. Salter, Esq., F.G.S., and of the Geological Survey.

[Plate V.]

In a former communication (March 1856) I described a few obscure traces of animals from these old rocks in the Longmynd, and have now to add some further information, gathered during the last summer in the same locality.

The markings which were in that paper referred to the burrows of Annelides have been found in the greatest profusion, and through a much greater thickness of strata than before, not less than a mile in vertical measure; and they have been detected too in places considerably to the south and west of the localities before given.

I am glad of the opportunity of again drawing attention to the subject, partly because the woodcut-section in the former paper, at page 247, Journ. No. 47, was accidentally made so as to exclude the most important beds, and partly because these annelide-markings have, during the present year, been sedulously searched for, and similar ones found, by my friend, Dr. J. R. Kinahan, of Dublin, in the undoubted Cambrian beds of Bray Head, Wicklow. His paper

* Gr. λᾶας, a stone, ὄφις, a serpent.

† For the former communication on Fossil Remains in the Cambrian rocks of the Longmynd, see Quart. Journ. Geol. Soc. vol. xii. p. 246.

appeared in the January Number for 1857 of the Proceedings of the Dublin Geological Society.

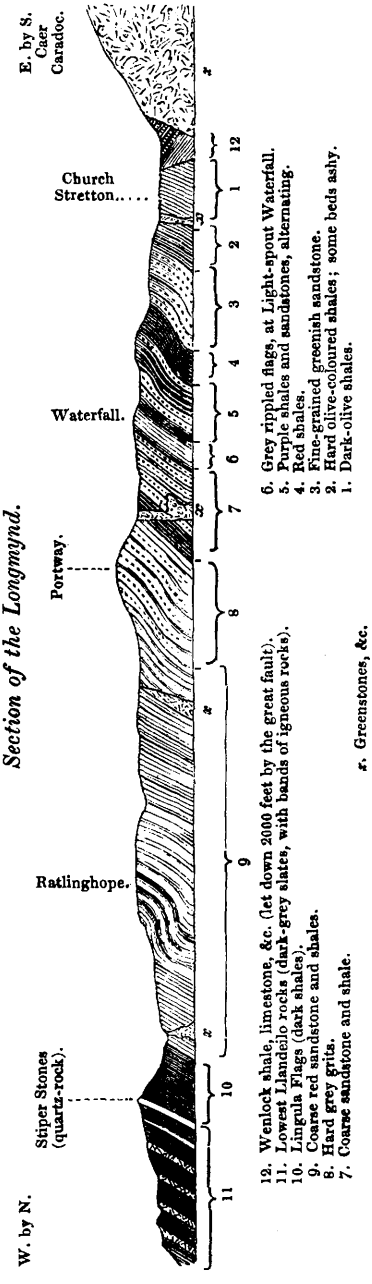
The section here given has numbers corresponding to the beds enumerated in the former paper; and the overlying Silurian strata (10, 11, 12) are introduced to show their relations to the highly inclined Cambrian beds under notice.

No. 1. The dark-olive shales have not yielded any trace of fossils; but in one place the harder beds of the same series, which are designated No. 2, have traces of the *Arenicolites didymus*.

No. 3. The same fossil (*A. didymus*) was found in the lower part of the Oakham Dingle, considerably below the beds in the Carding-mill Brook, from whence it was figured before. Of their existence at this place there can be no doubt.

The higher parts of No. 3 were carefully searched by myself and an assistant (Mr. John W. Rhind), and yielded an unexpected abundance of the worm-burrows, both large and small. The best localities appear to be at the head of Oakham Dingle, where the brook* flows N.E.–S.W. on the strike of the beds, and also along the same line in the next valley, viz. on the west side of Yearling Hill, on the brook that flows down to the "Ashes." The latter locality was very prolific, and nearly all our best

* This brook (of clear sparkling water, like all the "gutters" of the Longmynd) is intended to yield a water-supply to the town of Church Stretton.



specimens came from thence. There are evidences of the burrows of *Arenicola* (*Arenicolites*), of a different species from that formerly described, and it occurs both of large and small size. They are found on the wave-marked surfaces in the greatest profusion, hundreds of burrows being often crowded in the space of a square inch; or they are more widely set and of a larger size, when they frequently are placed most distinctly in pairs, indicating the exit- and entrance-holes to the burrows.

We have evidence in these beds too of the action of the waves in obliterating the burrows; and in fig. 1, Pl. V., may be seen a not unfrequent case, where the rasping action of the surf has only spared those burrows which lay in the shelter of the ripple-hollows.

That the strand was a level shore left dry at low tides, and that the surface was dried by the sun, is abundantly shown by the innumerable sun-cracks (figs. 9 & 10) which traverse the surfaces. These cracks when broad, as they often are, reveal the lighter-coloured sand beneath the filmy coating of dark mud on which the Annelide holes show themselves. There are, besides, rain-prints in abundance on some of these surfaces.

No. 4. The same phænomena, at least the wave-marks and the annelide-holes, are observable in the bands of red slate which overlie the beds No. 3; scarcely a fragment could be broken in the rocky knolls a little above the Carding-mill without showing them in profusion. It is the same further north in the Batch valley, and southwards in several localities, even as far as Choulton bridge, on the Onny River.

No. 6. Again, in the hard, grey, and rippled beds of Light-Spout Waterfall, mentioned in the former paper, Mr. Rhind found the annelides.

In a journey across the eastern portion of the Longmynd, in company with my friends, Messrs. Lightbody and Cocking, of Ludlow, we found them at intervals all the way, until they ended with the sandstones of the Portway itself. The total thickness, therefore, of the fossiliferous beds cannot be less than a mile, as above stated.

In one particular we have been unfortunate. No further traces of the crustacean called *Palæopyge* (vol. xii. pl. 4. f. 3) have been met with, though they were diligently sought for in the locality which produced them last year. I do not on that account consider there is any reasonable doubt as to the nature of the fossil. I have shown it to many scientific observers, and all agreed that it was organic: the evidence therefore remains as before.

Wave-marks and (Wind?) Ripples. Pl. V. figs. 5–8.

The marks of tidal flows or currents are very numerous and perfect, generally in broad hollows and elevations, but occasionally in quite regular transverse ridges which alternate or inosculate, as they do now on the sea-shore (fig. 5).

Besides these larger undulations, the surface is frequently rippled by smaller and finer ridges, which either represent the quiet action

of the surf on a level strand, or possibly the agitation of the water by wind: both causes may have operated (figs. 6, 7). I prefer the first explanation, because there are so many instances in which the direction of the lines of surf can be easily traced; and the interference of one small current with another is often apparent in the intersection of these sets of lines (fig. 8). They appear generally to have been slight ridges, and the subsequent compression of the rock has changed them into sharp-edged tabulæ, and the furrows into narrow depressed lines. It is to these wave-ripples, or surf-lines, as they may be called, that I would now refer some of the markings which before I thought were drainage-lines or runnels* (*loc. cit.* pl. 4. f. 5). The specimens at command then were far less perfect than those since obtained, and much more altered by pressure. To any one familiar with the mode in which the tide creeps in or out among the ripple-hollows on a very level strand, this explanation will not be deemed unsatisfactory. Many specimens show the direct action of the water producing straight, close, transverse ridges, and fig. 8 shows the contending currents, caused probably by slight obstructions, which were poured into the hollow in various directions during the advance or retreat of the tide.

In some cases the holes of the burrowing annelides have modified the shape of the surf-ripples, in others they have been modified by them.

Sun-cracks. Pl. V. figs. 9 & 10.

These were most unexpectedly found in great plenty on the west side of Yearling Hill. The rock there is closely laminated, a hard green flagstone of exceedingly fine grain (almost flinty), and the rippled surfaces are covered with a filmy coating of dark-brown oxide of iron.

The sun-cracks do not differ to any great extent from those ordinarily met with in newer rocks (the Permian of Coventry, for instance). They divide the surface into areolæ of various sizes and shapes (fig. 9); and when, as is most common, the superficial layer of mud is darker than the stone, show themselves well in relief by exposing the lower stratum. The edges of the areolæ are most generally curved upwards, the heat of the sun having caused shrinkage. Sometimes this is so much the case, that casts of them in relief, having a semicylindrical form, and cut across by other smaller cracks, look very like jointed portions of Crustacea; and the resemblance is heightened by frequent tubercles, which are the projecting casts of the annelide-holes above noted.

Rain-prints. Pl. V. figs. 1 & 10.

If the ripple-marks and the marks of shrinkage from sun-drying be preserved upon these old surfaces, it is not unlikely that rain-prints should be also present; and accordingly numerous traces of the action

* Not, however, those with branched or dichotomous furrows; they must still be considered as drainage-lines.

of rain have been observed, which appear to be quite the same as those we meet with at the present day, or in strata newer than those under consideration.

The traces consist,—1st, of numerous scattered impressions of drops of large and small size (fig. 10), intermingled upon the rippled and sun-dried surfaces of half-a-dozen specimens from a particular bed; 2ndly, of a close set of prints, more uniform in size, upon another surface; 3rdly, of numerous marks of drops occurring upon a ripple-marked slab, which shows too the annelide-holes in part abraded by the surf, or sheltered in the hollows (fig. 1).

In the first series we have round, or slightly oval, well-marked hollows, with a raised border, more conspicuous on one and the same side in all the prints than on the other. They indicate a somewhat slanting direction for the rain, an inference strengthened by the elongated form of the prints in that direction. In fact, the phænomena so well explained by Sir C. Lyell in his Manual (5th ed. p. 384) are here repeated. The drops were of irregular size; some, much larger than the rest, having apparently fallen after the smaller ones had impressed the surface, and having nearly obliterated their impressions. In other cases, two or three drops of more equal size have fallen nearly on the same spot, and made a compound impression.

These rain-prints are at first sight not easy to distinguish from the larger annelide-holes. But, besides that they are not in pairs (a very important point, since all the annelide-burrows show this character distinctly), there is a marked difference in the regular even outline and clean hemispheric impression of the rain-print, and the less regular shape and uneven bottom of the half-filled burrow. In rare instances the two occur on the same slab.

The prints upon the abraded surface (fig. 3) are somewhat different, much shallower, and closer together, and frequently impressed the one over the other. In this case the rain appears to have fallen vertically and on a harder surface than in the other case; and the bottom of the hollows is flat or occasionally slightly raised in the middle, a character usually considered decisive of rain-prints.

Organic Remains.

The new species of *Arenicolites* above mentioned I propose to designate

ARENICOLITES SPARSUS, sp. nov. Pl. V. figs. 1–4.

Sp. char. A. gregarius, fodinarum oribus circularibus binis, sese remotiusculis.

Junior (figs. 1 & 4), fodinis minutis, aggregatis.

Major (fig. 2), fodinis $\frac{1}{2}$-lineam latis, sparsis.

These burrows of annelides, once recognized, are to be found in great profusion, chiefly on the surface of the finer sandstones or shales. The larger ones are more scattered, nearly a line broad, and with the edges of the holes a little raised. They are most distinctly in pairs,

often not more than a line apart, but sometimes a quarter of an inch from one another.

The smaller ones (fig. 4) are in myriads close together, but still plainly in pairs. They occur on the same surfaces with the larger ones, but still oftener are met with in groups; all of the same size, or nearly so (about the size of a pin's head), and particularly on the red shales before mentioned. On the upper surfaces of the beds they are, of course, depressions (fig. 1); on the lower surfaces casts of them project (fig. 4) as tubercles.

It is a very common thing to meet with them only in the hollows of rippled surfaces, the wave having erased them on the more elevated portions. Sometimes this occurs in the most distinct and marked manner (fig. 1).

This species appears to be distinct from the so-called *A. didymus* of the former paper, by the holes being remote, not close together nor parallel to each other. They occur rather higher up in the series too; but it is, of course, possible that all may be one species.

Localities.—The small variety has a very wide distribution, as before stated. The larger ones are found in tolerable plenty in Oakham Dingle, at Yearling Hill, the Packet Stone, Minton, and at the Light-Spout Waterfall above Church-Stretton.

It does not appear necessary to insist on the value of such numerous though imperfect vestiges of the oldest fauna known. I am perfectly convinced that the Cambrian rocks contain treasures yet to be discovered, and that a holiday spent at the rising town of Church Stretton would be well rewarded, and might produce new facts for science.

I lately found that burrows similar to the above-described, but of a much larger size, were common in the Stiper Stones of Shropshire; and these bear the strongest resemblance to the long vertical tubes described by Hall under the name of *Scolithus linearis*.

It is almost certain that these are identical; but, as the name *Scolithus* does not convey any definite meaning, there can be no objection to the term *Arenicola*, as used by Binney, who first explained the nature of these double holes. Perhaps the termination *-ites* would make the name more symmetrical with other terms of general import, and *Arenicolites* might stand for all worm-burrows with double openings, while *Scolithus* or *Scolites* might be retained for those which appear to be single tubes or burrows, vertical or horizontal*.

Cololites has long been in use for worm-casts on the surface, and perhaps *Helminthites* would answer best for those long sinuous tracks upon the surface, usually considered as referable to Annelides. *Vermiculites* has been applied to shorter forms†. Some of these, however, are unquestionably trails of small Crustacea, and others of spiral shell-fish.

* *Foralites* has been used by M. Rouault for this kind of burrow. See Bull. Soc. Géol. Fr. vol. vii. 1850, p. 742.

† Ibid. *l. c.* p. 744.

In connexion with the facts above mentioned, which go to show the great prevalence of Annelides having the same habits as those of the Lob-worm (*Arenicola*) of our coasts, it is worth while to remark on the extraordinary abundance of animals of this class in Palæozoic times.

In the Cambrian rocks of Ireland they are in almost as great plenty as in Britain, and are there associated, as I have seen in company with Dr. J. R. Kinahan, who discovered them, with the matted layers of *Oldhamia*.

In the Lingula-flags of North Wales, *e.g.* near Maentwrog and Ffestiniog, they abound wherever sandy sediment has been thrown down; but I have only yet seen them in the form of *Scolites* or *Helminthites*, and have not yet found the double burrows in this formation.

In the Stiper Stones, as above noted, the *Arenicolites* (*Scolithus*) *linearis* of Hall is the common fossil, occurring as long vertical tubes with trumpet-shaped openings in the quartz-rock. And in the Tremadoc slates, the Llandeilo flags, and indeed all the Silurian series, worm-tracks and burrows are frequent in strata which were once sabulous mud. In the Upper Silurian rocks of Dingle, County Kerry, I found the *Arenicolites* in flaggy sandstone.

More lately these double burrows have been found in company with fragments of land-plants in the Devonian fish-beds of Caithness, and in those beds, of somewhat doubtful age, which Prof. Nicol has described as carboniferous, on the borders of Loch Assynt in Sutherlandshire*, while they have now been long known as most plentiful in the sandstones of the coal-measures.

It is in the Carboniferous system, indeed, that they appear to have attained their maximum in size and number. Throughout all the lower beds of that system, as exhibited in Pembrokeshire, North Devon, or the South of Ireland, the burrows of marine worms are conspicuous, chiefly in the form of cylindrical masses, *upon the surfaces* of the beds or permeating them in all directions. They are of various sizes, from the thickness of a crow-quill up to 2 or 3 inches in diameter! and often of great length; and they frequently constitute of themselves massive beds, the sabulous matter left behind as ejected from the worm penetrating the more argillaceous beds in a way that produces an exceedingly tough mass—not easily acted upon by the waves—in shore-sections.

The large annelide-tubes or casts in the carboniferous strata of Cumberland, and the tracks upon the coal-measure flags at Kilkee, County Clare†, are well known, and are of a size greatly larger than would be produced by the majority of living species. There is much yet to be done in the study of marine worms, with a view to ascertain the kind of impressions they leave in both sandy and argillaceous sea-beds.

* Quart. Journ. Geol. Soc. No. 49. p. 32. The arrangement of these burrows appears to have led Prof. Nicol into the belief that he had found fragments of *Stigmaria*, and may have influenced him in determining the age of the beds.

† Edinb. New Phil. Journ. new ser. vol. i. p. 278.

EXPLANATION OF PLATE V.

(The specimens are reversed in the lithograph.)

Fig. 1. Rain-prints on rippled surface, with Annelide-burrows (*Arenicolites sparsus*; young) in the hollows of the ripple. } From Yearling Hill,
2. *Arenicolites sparsus* (adult); on the upper surface of the slab. } From Yearling Hill,
3. *Arenicolites sparsus* (adult); } raised casts of the burrows, on the lower surface of the slabs. } From Church Stretton.
4. *Arenicolites sparsus* (young); } raised casts of the burrows, on the lower surface of the slabs. } From Church Stretton.
5. Rippled surface. } Waterfall, above Church Stretton.
6. Rippled surface. } Waterfall, above Church Stretton.
7. Rippled surface. } Waterfall, above Church Stretton.
8. Surf-ripple on current-marks. } Yearling Hill.
9. Sun-cracked surface. } Yearling Hill.
10. Rain-prints and sun-cracks. } Yearling Hill.

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4. *On some species of* ACIDASPIS *from the* LOWER SILURIAN BEDS *of the* SOUTH OF SCOTLAND.

By WYVILLE THOMSON, LL.D., F.R.S.E., Prof. Geol. Queen's Coll. Belfast, &c.

[Communicated by Sir R. I. Murchison, F.G.S.]

[PLATE VI.]

HAVING occupied part of my leisure for the last year or two in examining the fossils of the Silurian beds of the south of Ayrshire, described by Sir Roderick Murchison in 1851, I have met with many species and not a few generic types additional to those included in Mr. Salter's list accompanying Sir R. Murchison's paper on the Silurian Rocks of the South of Scotland*. As most of the known British species of the genus *Acidaspis* have either been already described or are now in process of description, I take an opportunity of adding the few new forms which have hitherto occurred during the course of my investigations.

The specimens are few, and in many cases fragmentary. The first two species are an addition to a little group already represented among our Lower Silurians by *Acidaspis Jamesii* and *A. bispinosa*. The group is formed of minute species, usually rather meagrely ornamented, and having a tendency to the fusion of the various prominent parts of the head; a tendency which reaches its maximum in the subgenus *Trapelocera*, between which subgenus and *Acidaspis* proper (represented by *A. mira*, Barrande, and *A. Brightii*, Murch.) this group may be considered a link.

ACIDASPIS LALAGE, sp. nov. Pl. VI. figs. 1–5.

A. lata, ovata; capite brevi, transverso; glabellâ triangulari, utrinque duobus lobis lateralibus ovatis, a lobo mediano cerviceque alto, et a

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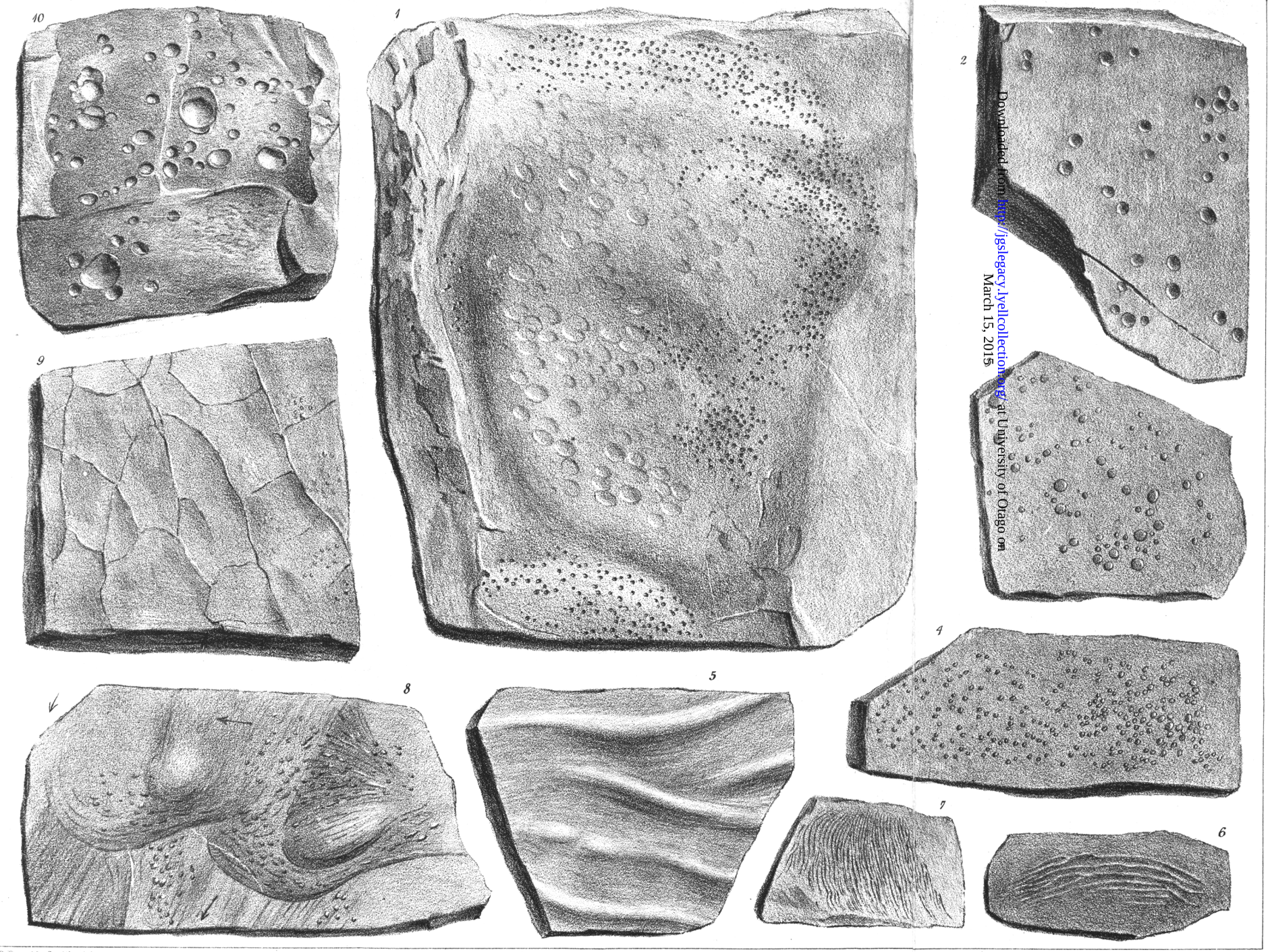
* Quart. Journ. Geol. Soc. vol. vii. p. 137. I shall not enter into a consideration of the detailed section of the district at present. Following Sir R. Murchison, I regard the whole of the fossiliferous Girvan beds as belonging to the very top of the Lower Silurians. The Pinwhapple flags, however, I consider to be the lowest of the series, equivalent to the Upper Bala, and passing through the Mullock Hill sandstone and the Craighead limestone into the Saugh Hill sandstone = Upper Caradoc.



C.R. Bone del. Geo. West lith.

W. West Imp.

ANNELIDE-BURROWS & SURFACE-MARKINGS
from the Longmynd Rocks