

2. DESCRIPTION of the IMPRESSIONS and FOOT-PRINTS of the PROTICHNITES from the POTSDAM SANDSTONE of CANADA. By Prof. OWEN, F.R.S., F.G.S. &c.

[PLATES IX. to XIV. A.]

OF the extensive series of foot-prints found under the circumstances described in the preceding communication, the originals of some and good plaster-casts of more have been brought over with much labour and expense by their discoverer, Mr. Logan, and of these I have selected the best-marked and most intelligible portions for the following descriptions.

1. *Protichnites septem-notatus*. Pl. IX.

The subject, which for the convenience of reference I have so named, consists of a series of well-defined impressions, continued in regular succession along an extent of 4 feet; and traceable, with an inferior degree of definition, along a further extent of upwards of 2 feet.

These impressions (see Plan, Pl. VIII. A. 6) are represented by plaster-casts.

In the first-selected extent of 4 feet there are thirty successive groups of foot-prints on each side of a median furrow, which is alternately deep and shallow along pretty regular spaces of about $2\frac{1}{2}$ inches in extent. The number of prints is not the same in each group; where they are best marked, as in Pl. IX. 1 *L*, we see 3 prints in one group, *a, a', a''*, 2 prints in the next, *b, b'*, and 2 in the third, *c, c'*, which is followed by a repetition of the group of 3 prints, *a, a', a''*. But, in some instances, the outer print of the third set is divided, as at 1 *R, c', c''*, making the numbers in the three successive groups 3, 2, 3, instead of 3, 2, 2: the three groups of impressions are, however, notwithstanding this occasional variety, recognizably repeated in succession along the whole series of tracks on both sides of the median groove*.

The principal foot-prints are disposed in pairs, placed with different degrees of obliquity, in each of the three groups, towards the median track; the innermost print in the second, *b*, and third, *c*, pairs, which are best marked, being usually rather more than half the size of the outer print, *b'* and *c'*.

The two foot-prints of the same pair are a little further apart from each other, in the three succeeding pairs, as at *a', a'', b, b', c, c'*, especially in the second and third groups of each set; the two forming the pair *a', a''* again approximating in the next series, and the pairs *b, b'* and *c, c'* diverging in the same direction and degree; and this alternate approximation and divergence is repeated throughout the entire series of the present tracks.

* Should these descriptions express more or less than is shown in the Plates, the reader will be kind enough to bear in mind that they were penned after repeated examinations of the originals by varied applications of artificial and natural lights, and express the sum of the results of such comparisons extended over the entire series of tracks; whilst the able artist has given the effects of one light and shade only, as seen on one portion of the track.

But what strikes the ichnologist, heretofore conversant chiefly with the foot-prints of bipeds or quadrupeds, is the occurrence in the present series of the third impression, *a*, which complicates the most approximated pair, being placed in front and a little to the inner side of the innermost impression, *a'*, of that pair. The superadded impression, *a*, is about the same size as the innermost in each pair, the average diameter of that impression being 5 lines.

Taking this view of the impressions, it appears that, whilst the innermost in each pair, *a', b, c*, are of equal size, the outermost, *a'', b', c'*, 1 *L*, progressively increase in size, from the most approximated to the most divergent of the three pairs; that of the first, *a''*, being narrow in proportion to its length, that of the second, *b'*, as broad as long, and the outermost, *c', c''*, of the third pair being oblong, but larger than that in the first pair. In some places where the most approximated pair of impressions, *a', a''*, are deeply marked, they are complicated by a fourth shallow and very small pit, *a'''*, 2 *L*, midway between the third, *a*, and the outermost, *a''*, of the pair of impressions.

The deepest parts of the middle track usually occur between the second, *b, b'*, of each of the three groups of foot-prints.

The first pair of impressions, *a', a''*, are included within a space of 1 inch 3 lines in diameter; the third pair within a space of 1 inch 9 lines in diameter. The longitudinal extent of the three groups of impressions, measured along the outermost, averages 3 inches 6 lines, and along the innermost 3 inches 3 lines: the extreme extent of the three sets of impressions averages 4 inches. The transverse interval between the innermost impressions, *a, a*, of the first pair is 3 inches, and between those of the third pair, *c, c*, 2 inches, measured from their innermost borders. The distance between the two outermost impressions of the first pair is 5 inches, and it is the same between the corresponding impressions of the third pair, measured from their outer borders; so that a line drawn along the outer margin of the impressions of one side would be parallel to the line drawn along the same parts on the opposite side, the difference in the distance from the midspace being presented by the innermost impressions.

The average breadth of the median groove is 5 lines, its depth at the deepest parts between 1 and 2 lines; the regular alternation of the deep and shallow parts of the median impression indicates the part that made it to have been alternately raised and depressed, an alternation which might affect a tail as well as the trunk, but is more likely to have affected the latter in an undulating mode of progression.

There are no clear or unequivocal marks of toes or nails on any of the impressions which form the lateral pairs or triplets. Their margins are not sharply defined, but are rounded off and sink gradually to the deepest part, which is a little behind the middle of the depression. There is a slight variation in the form and depth of the answerable impressions, but not such as to prevent their correspondence being readily appreciable through the whole of the extent here described; that is to say, the innermost of each of the three pairs here described as first, *A*, second, *B*, and third, *C*, may be identified with the corresponding innermost impression on the opposite side and

with the same impression of the same pair in the three preceding and the three succeeding pairs.

This power of determining the homologies, so to speak, of the several impressions is a strong evidence of their having been made by the successive application of the same instruments; whilst the equal distances at which they recur proves them to have been made in regular succession, as in the ordinary progression of an animal walking by means of limbs.

The question next to be resolved is,—how those instruments were disposed in the body of the creature that made and left the impressions?

It cannot be supposed that two limbs, answering to the fore and hind legs of a quadruped, could have made impressions so different in form and in their degrees of approximation as we see in each pair of the series of three sets on one side. In a quadruped we are accustomed to see the successive pairs of the same side resembling each other, the difference in the two impressions of such pairs indicating the difference between the fore and hind feet of the side to which they belonged; but in the present series of impressions each pair in the successive series of three so differs from the other two pairs in the form and size of the impressions, and their degree of divergence, as to render it scarcely possible to suppose that they could have been formed, either along the inner or the outer series of impressions, by successive steps of the same limb; and, were it contended that the animal by some peculiarity of gait more and more approximated its fore limbs in making three successive steps, and then divaricated them to commence another series of three steps, on the supposition that the inner impressions were formed by the same pair of fore limbs at each series of three steps, the difficulty would still remain of accounting for the third superadded impression, *a*, on the hypothesis of their being formed by a quadruped, with the additional difficulty of the difference in shape and size of the outer impressions of the same three pairs.

The first or most approximated pair, *a'*, *a''*, in each set of three pairs of impressions are the most equal in size. In the second pair, *b*, *b'*, which are nearly equally approximated, the outer impression is manifestly larger and broader than the inner one. In the third and most divergent pair, *c*, *c'*, the outer one is still larger, in length as well as in breadth, and is occasionally subdivided. Now, as the first pair in each series of three, *A*, 1 *L*, plainly answers to the same pair in the next series of three, *A*, 2 *L*, and the like in regard to the second pair and the third pair, it follows that the same instruments must have made the first pair in each of the three pairs, and so of the second and of the third pairs; or, in other words, each pair in a series of three must have been made by different members, or divisions of members; and the same must be inferred in respect to the small impression, *a*, which is superadded to the first pair in each triplet: whence it may be concluded either that the animal had seven pairs of ambulatory limbs, or that it had three pairs, of which two were bifid and the third trifold at the impressing extremity.

The impressions which are so clearly marked in the extent above described are continued less distinctly but uninterruptedly for more

than 6 feet. The most constant of the small impressions are those which are nearest the median track, *c*, and which have been described as the innermost of the third pair, but which first arrest the eye as superadded foot-marks, occurring pretty regularly at intervals of from 4 inches to $4\frac{1}{2}$ inches along the whole track.

There are three other series of tracks referable to the *Protichnites 7-notatus*.

2. *Protichnites octo-notatus*. Pl. X.

The series of foot-prints, here described as the *Protichnites 8-notatus*, extends for 5 feet 5 inches along a surface of hard sandstone, which has been rubbed by the ice. This track is represented by plaster-casts. It is seen on the Plan, Pl. VIII. B. 6. In this series the impressions of the feet are deeper and the median track is much fainter, yet it continues to show the alternately deep and shallow character, its traces being visible at regular intervals, which are, however, longer than those that divide the deeper parts of the same groove in the first-described series of impressions.

In the present series the small innermost impressions, *c*, are repeated at intervals of 5 inches; the distance between the right and the left of these impressions is 2 inches, being less than half their longitudinal interval; whereas in the former slab the transverse interval is exactly half the longitudinal one.

The larger and more exterior depressions present also a somewhat different arrangement from those first described. Where they are most clearly and regularly impressed it is as follows:—on the outside of the small innermost impression, *c*, there is a pair of larger impressions, *c'*, *c''*, closely approximated one behind the other, in the direction of the track, the longitudinal extent of this pair of impressions being 1 inch. The next pair of impressions, *b*, *b'*, answering to the middle pair before described, and here noticed in the contrary or retrograde course, are placed nearly transversely and are wider apart than the longitudinal pair, the innermost being the largest, and the diameter of the pair 1 inch 8 lines. Then follow three impressions, *a*, *a'*, *a''*, forming an inequilateral triangle, with a broad base turned inwards and the apex outwards, the impression forming which (*a''*) is the largest of the three, although they are of nearly equal size, having a diameter each of about half an inch. These three impressions answer to the three, *a*, *a'*, *a''*, Pl. IX., which have been described as forming the first pair of impressions with the accessory impression in the *Protichnites 7-notatus*; but the three are here so distinct and remote that the pair could only be chosen arbitrarily. The middle or second pair, *b*, *b'*, answers to the same in the impressions first described, with the difference of direction above noted: the third pair differs in the more constant and complete division of the larger outermost impression into two pits, *c*, *c'*. In none of these impressions are there distinct and unequivocal traces of claws or digital divisions; they seem rather to have been impressed by one limb, or division of a limb, terminating in a hard, obtuse, subangular point.

The arrangement of the impressions just described is repeated with little modification throughout this series of tracks; that is to say, taking them in the order in which those of the first series were de-

scribed, we have the group of three impressions, a, a', a'' , the transverse pair, b, b' , and the widest pair, c, c' , in which the outer and larger impression is divided into two, c', c'' .

Neither in this nor in the preceding series does any impression appear to be modified or in any degree obliterated by the print of another foot coming into the same place.

The median interval between the right and left of the first pit in the group of 3 impressions, a' , is 3 inches 9 lines; between the two pits in the same sets forming the apex of the triangle, a'' , 4 inches 8 lines, and between the third, a , 3 inches 2 lines. These measurements are taken from the inner border of the right and left impressions respectively. The interval between the innermost, b , of the transverse pair of impressions is 3 inches 2 lines, and between the outermost, b' , from their outer borders 5 inches 8 lines: the interval between the longitudinal pairs, c', c'' , from their outer border is 5 inches 3 lines. The length of each series of three sets of impressions is from 5 inches to 5 inches 3 lines, and this distance is very regularly preserved throughout the series of tracks. Thus each series presents eight distinct impressions on each side, 1 *L*, 1 *R*, and tallying impressions of each of the eight can be determined in each successive series, 2 *L*, 2 *R*.

From this it is to be inferred that they were made by the same parts respectively; that is, that the impressions were repeated by the same limbs or impressing instruments at each successive series. Consequently if we regard each series as indicating the nature of the individual that impressed them, we must conclude it to have possessed either eight pairs of impressing instruments, or three pairs of limbs so divided as to leave 3 prints, 2 prints, and 3 prints in longitudinal succession on both the right and the left sides, and sufficiently long and flexible to make a step co-extensive with the space occupied by the entire series of such limbs; these impressions severally presenting characters so distinct in the same series of *A, B, C*, as to forbid the conclusion that they were made by the same instruments differently applied at regularly alternating intervals or distances in such series.

We have clearly, therefore, indications of the same kind or genus of animal in the present, as in the preceding series of tracks, but the difference in the proportions and arrangements of the individual impressions in the determinable groups indicates a difference of species. There are two other series of tracks of the *Protichnites 8-notatus* repeating very recognizably the characters above described.

3. *Protichnites latus*. Pl. XI.

A slab of the sandstone 8 feet long* by 2 feet wide shows three series of the impressions, two extending lengthwise and crossing each other very obliquely, and the third crossing both the others transversely. In the track which traverses the whole length of this slab the impressions of the feet are deeper and larger, whilst the median

* This track has a still greater extension on the plaster-casts taken from the sandstone-surface of which the slab here referred to is a portion. See the Plan, Pl. VIII. B. 12.

impression is much shallower and fainter than in the foregoing foot-prints, but it still shows the alternate deep and shallow parts. Although the impressions are less regular than in the before-described series, and the small innermost ones are less recognizable, yet they are discernible in certain parts, as at *c*, *c*, and they, in like manner, mark the boundaries of three sets of impressions on each side of the median one.

The first set consists of a pair, *a'*, *a''*, of nearly equal impressions, with occasional indications of a third print forming an inequilateral triangle. The second set of impressions is a transverse, more widely parted, pair, *b*, *b'*, the innermost being the smallest, the outermost the largest and sometimes, as in 1 *L*, divided into two, which are, however, included in a common circumference. Then that impression, *c'*, *c''*, which has been described as the outermost of the pair to which the small innermost impression, *c*, belongs, is very large and more distinctly bilobed than the outermost of the preceding pair, and its long axis is turned at right angles to that of the preceding outermost impression. The longitudinal extent of the three sets of impressions on one side is 5 inches. The transverse interspace between the two small innermost impressions, *c*, *c*, is 2 inches 2 lines, between the outermost, *a''*, *a''*, of the three sets of impressions from their outer borders 7 inches. The general resemblance of these successive series of three sets of impressions with those of the better-defined tracks before described leave no doubt of their having been made by the same genus of animal, but it would seem to be by a different species having a body broader in proportion to its length.

The sandstone allows a character of the lateral impressions to be seen which was not so distinctly recognizable in the casts, namely the great depth and angular figure of the bottom of the impressions, with some irregular angular notches towards its circumference, indicating them to have been made by a limb shod with a hard substance terminating in a somewhat obtuse point with angular processes from its base. This character of the impressions is irreconcilable with their having been formed by the convex sole of the foot of a Chelonian or by the more flattened foot of a Batrachian or Saurian reptile, or by the hooved or padded foot of any mammal.

4. *Protichnites multinotatus*. Pl. XII. ($\frac{1}{2}$ nat. size.)

Casts of impressions along an extent of $4\frac{1}{2}$ feet, forming part of a series which was traced for an extent of 10 feet uninterruptedly, exhibit a strong deviation of the intermediate continuous groove from the mid-line between the two lateral series of impressions. The breadth of this track from the outer border of the outer impressions nowhere exceeds $3\frac{1}{2}$ inches. The impressions are subcircular with smooth, rounded, ill-defined borders, of varying depth, but most of them faint and shallow. Commencing at the end of the series, where they are least distinct, the intermediate groove inclines to the left and soon gets upon the innermost of the impressions along the left side. At about halfway from the other end it becomes deeper, obliterates many of the prints on that side, and has been impressed so strongly as to force up a ridge of the sand upon its left side. Some faint

impressions of the outer prints may be seen on this ridge. The impressions of the right side opposite the deeper part of the ridge are unusually deep, and are more numerous and closer together than in the shallower parts of the tracks. In no part of the series are the impressions so distinct and well-defined as to allow a recognition of the groups of threes repeating each other; but in a few parts, as they approach the deep excentric groove, the small innermost pits may be observed. There are few places where two contiguous pits are divided by an interspace equal to their own breadth. Although many of the foot-prints on the same side are in pairs, more or less oblique, groups of three occur not unfrequently. Nothing like claws or digital divisions can be discerned where the impressions are deepest. The intermediate groove becomes shallow and gains the mid-space in the last two feet of the present series. Where the impression is deepest the tracks bend slightly in a different direction from the preceding part, making about an angle of 162° . This deviation of the middle impression would seem to indicate that it had been formed by some appendage which continued to incline to the left after the body had begun to bend to the right side, and the greater depth of the impression where the bend is greatest would show that there had been an increased exertion on the part of the animal at the time of making that bend.

5. *Protichnites lineatus*. Pl. XIII. ($\frac{1}{2}$ nat. size), and Pl. VIII. A. 3.

In a continuous track of the median impression, traceable along an extent of 13 feet, this impression preserves in some parts for an extent of between 2 and 3 feet a considerable and equable depth; it is also accompanied by a remarkable modification of the lateral impressions, which are rather represented by continuous grooves than by a succession of pits, although these are sufficiently evident in many parts of the lateral grooves, forming partial depressions in the grooves. Along an extent of 13 inches, where the deep median impression is equidistant from the two narrow and shallow impressions on each side, the outermost of these impressions is deepest on the left side, and the innermost is deepest on the right: a little further on the lateral grooves become broken up into a series of shallow foot-prints and then again become continuous in shallow grooves. After an uninterrupted course of 5 feet from one end of this series of impressions, the middle groove, after bending slightly to the right, terminates in a point, the impressing part appearing there to have been raised obliquely above the sand; but the impression recommences to the left and a little behind this point and somewhat more obtusely, and, again becoming shallower, it seems to have been partially reimpressed to the right of this, and then to have continued uninterruptedly, a little varied in its depth, for some feet further.

None of the impressions in this extent of tracks are sharply defined, the borders both of the grooves and pits being much rounded off, as if they had been partially effaced, either as having been made under water, or by water having passed over them soon after they were made. They give the idea of the animal having been partly supported by water whilst making them, so as to have occasionally

dragged its lateral appendages along, and thereby to have made a continuous groove with faint impressions, interrupted where the feet have been applied to the sand in the usual successive way.

The breadth between the outer margins of the outermost tracks is 5 inches 6 lines; between the inner border of the innermost tracks 3 inches 10 lines; the breadth of the median track is 10 lines. For a short distance there is a shallow longitudinal depression on the left border of the median track, and here and there are faint indications of small impressions inside of the innermost of the lateral tracks. The name indicative of this series of tracks is one of convenience only, and is not to be regarded as the sign of a species recognized as actually distinct from the differently-marked and better-defined impressions of the same size and breadth.

6. *Protichnites alternans*. Pl. XIV. ($\frac{1}{2}$ nat. size), and
Pl. VIII. A. 7.

In a series of impressions in which the middle groove is represented by a succession of interrupted shallow longitudinal channels, with unimpressed or slightly marked intervals of nearly their own extent, the lateral impressions are deep, small, and more or less of an angular character. In some parts there appears only a single impression, as at *a* on the left side, 1 *L*; an inch in advance of this there will be a pair, *b*, *b'*, placed rather obliquely, the innermost much larger than the outer one. One inch and a half in advance of this is a third more widely parted pair, *c*, *c'*, also placed obliquely, the inner impression being smaller than the outer one. Then at the same distance follows a triplet, *d*, *d'*, *d''*, or a pair, *d*, *d'*, of nearly equal size, and on the same transverse line, but wider apart than the rest. About 2 inches in advance of this is a pair, *e*, *e*, which are nearer together, and then comes either a very large single impression or one composed of a confluent pair, *f*. The outer impressions of the series describe a curve, with the convexity turned outwards, but the opposite impressions of the series are not symmetrical; for where the impressions are widest apart on the left side, those of the right, as in 1 *R*, are nearest together, or, being confluent, appear single; and where the right pair of impressions are widest apart, those of the left side are nearest together. The innermost impressions of both lateral series preserve best their regular distance from the middle tracks. The outer impressions differ most in this respect, and consequently describe an undulating line, but so that when the convexity is turned from the middle line on the left side it is turned to the middle line on the right, and *vice versa*. Some of the innermost impressions are elongated transversely and become gradually shallow outwards, as if the foot impressing them had been moved from within outwards.

These impressions indicate a waddling gait, or an alternate oblique movement from side to side of the animal, with an alternate raising and depressing of the part of the animal which has left the middle impression. Here and there groups of three impressions are interposed between the impressions in pairs. The shape of the impressions indicates them to have been made by hard, pointed, subangular extremities.

The average breadth of the track from the outermost side of the outer impressions is 5 inches. From the median track to the outermost of the outer impressions is 3 inches, and to the innermost of the same pair of impressions 1 inch 3 lines. The longitudinal extent of one of the curves which includes five sets of prints is 7 inches. The interrupted impressions of the median track show a slight deviation from the straight line.

The modifications presented by this series of impressions equally militate against their having been left by a vertebrate animal, but differ so much from those already described as to clearly indicate a distinct genus of many-limbed animal.

There are four series of impressions on a great extent of ripple-marked sandstones, in one of which the median track has cut through the ripple-marks along an undulating curved line of nearly equal and considerable depth, not showing the alternate rise and fall which is seen in so many of the other sets of impressions. The margins of this median track are rounded off, and it is more rounded at the bottom. The lateral tracks are large, shallow, and faint, as if they had been partially obliterated by the action of water; yet the prints can be still distinctly traced, indicating a total and regular breadth of 6 inches across the whole of the impressions.

Along another extent of ripple-marked slab, a narrower median impression cuts through the ripple-risings for an extent of 7 feet in nearly a straight line. Here also the lateral impressions are faintly indicated, their borders being rounded off and as it were expanded, showing a total breadth of 5 inches, across the tracks. As the sand appears to have been of a dense siliceous character, the ripple-marks could have only been ploughed through to the depth shown by these impressions, by a pretty considerable momentum, either of velocity or of weight, occasioned by the moving animal.

Along a third extent of ripple-marked surface the median impressing part of the moving body has left only a narrow and shallow impression upon the summits of the successive sand-waves, the direction of the animal being shown by that in which the sand had been pushed into the intervening valleys of the ripples.

With these varied and well-marked evidences of the number, form, grouping, and arrangement of the foot-prints impressed upon the Potsdam sandstone, in the more clearly impressed specimens, now submitted, both in the original sandstones and in good plaster-casts, to our inspection, we may readily discern a general correspondence with them, of those comparatively more confused and obscurely marked impressions (Pl. XIV. A.), the casts of which were first brought over by Mr. Logan during the preceding year. The foot-print occasionally occurring on the inner side of the pairs of prints, may now be recognized as answering to that marked *c* in Pl. X., which forms the innermost impression of the regularly recurring group of 3, viz. *c*, *c'*, *c''*. It is not, as I at first supposed, the result of the fore-leg being applied to the ground a second time, on the inner side of the first step, during a temporary stop in the animal's progress.

The recognition of the real nature of this superadded print also leads to the recognition of the succession of the prints in progressive series of three groups, two of which seem to consist of a pair of prints, as in the *Protichnites 7-notatus**. That peculiarity could not, I believe, have been recognized, or satisfactorily confided in, without the aid and light of the analogies furnished by the more numerous and extensive, clearer and better-marked, impressions which have now been submitted to us by their zealous and indefatigable discoverer and collector. I need scarcely say, therefore, that although the foot-prints of a Tortoise are those to which the original series of the Potsdam sandstone impressions bore the closest resemblance, I have now the conviction that they were not made by a Chelonian reptile, nor by any vertebrated animal.

The impressions selected for Plates IX. and X. clearly demonstrate that the animal, progressing in an undulating course, made at each action of its locomotive members, answering to the single step of the biped, and the double step of the quadruped, not fewer than, in *Protichnites 7-notatus*, fourteen impressions, seven on the right and seven on the left; and in *Protichnites 8-notatus* sixteen impressions, eight on the right and eight on the left; these seven and eight impressions respectively being arranged in three groups; viz. in *Protichnites 7-notatus*, 3, 2, and 2; in *Protichnites 8-notatus*, 3, 2, and 3; the groups being reimpressed, in successive series, so similarly and so regularly as to admit of no doubt that they were made by repeated applications of the same impressing instruments, capable of being moved so far in advance, as to clear the previous impressions and make a series of new ones at the same distance from them, as the sets of impressions in the series are from each other. What then was the nature of these instruments? To this three replies may be given, or hypotheses suggested:—they were made, either, 1st, as in the case of quadrupedal impressions, each by its own limb, which would give seven and eight pairs of limbs to the two species respectively; or, 2ndly, certain pairs of the limbs were bifurcate, as in some insects and crustaceans, another pair or other pairs being trifurcate at their extremities; and each group of impressions was made by a single so-subdivided limb, in which case we have evidence of a remarkably broad and short hexapod creature; or, 3rdly, three pairs of limbs were bifurcate, and the supplementary pits were made by small superadded limbs, as in some crustaceans; or, 4thly, a single broad fin-like member, divided at its impressing border into seven or into eight obtuse points, so arranged as to leave the definite pattern described, must have made the series of three groups, by successive applications to the sand.

The latter hypothesis appears to me to be the least probable; first, as being most remote from any known analogy, and secondly, because there are occasional varieties in the groups of foot-prints which would hardly accord with impressions left by one definitely subdivided instrument or member. Thus in the group of impressions marked 1 L,

* This will be seen, on a comparison of the original and entire series of foot-prints, more satisfactorily than in the small portion figured in Plate XIV. A.

in Pl. IX., the outer impression, *c'*, is single, but in the preceding set it is divided: whilst the impressions *a*, *a'*, are confluent in that set, and are separate in *l L*. The same variety occurs in the outer pair, *c*, *c'*, in *Protichnites 8-notatus*.

Yet, with respect to the hypothesis that each impression was made by its own independent limb, I confess to much difficulty in conceiving how seven or eight pairs of jointed limbs could be aggregated in so short a space of the sides of one animal. So that I incline to adopt as the most probable hypothesis, that the creatures which have left these tracks and impressions on the most ancient of known seashores belonged to an articulate and probably crustaceous genus, either with three pairs of limbs employed in locomotion, and severally divided to accord with the number of prints in each of the three groups, or bifurcated merely, the supplementary and usually smaller impressions being made by a small and simple fourth, or fourth and fifth pair of extremities.

The *Limulus*, which has the small anterior pair of limbs near the middle line, and the next four lateral pairs of limbs, bifurcate at the free extremity, the last pair of lateral limbs with four lamelliform appendages, and a long and slender hard tail, comes the nearest to my idea of the kind of animal which has left the impressions on the Potsdam sandstone*.

The shape of the pits, so clearly shown in the ice-rubbed slabs, impressed by *Protichnites 8-notatus*, accords best with the hard, sub-obtuse, and subangular terminations of a crustaceous ambulatory limb, such as may be seen in the blunted legs of a large *Palinurus* or *Birgus*; and it is evident that the animal of the Potsdam sandstone moved directly forwards after the manner of the *Macrura* and *Xiphosura*, and not sideways, like the Brachyurous Crustaceans.

The appearances in the slab impressed by the *Protichnites multino-tatus* favour the view of the median track having been formed by a caudal appendage, rather than by a prominent part of the under surface of the trunk.

What further conjectures the contemplation and comparison of the several series of foot-prints from the Potsdam sandstone have originated in my mind, I do not deem it very helpful to their full understanding at present to record.

The imagination is baffled in the attempt to realize the extent of time past since the period when the creatures were in being that moved upon the sandy shores of that most ancient Silurian sea; and we know that, with the exception of the microscopic forms of life, all the actual species of animals came into being at a period geologically very recent in comparison with the Silurian epoch.

The deviations from the living exemplars of animal types usually become greater as we descend into the depths of time past; of this the Plesiosaur and Ichthyosaur are instances in the reptilian class, and the *Pterichthys*, *Coccosteus*, and *Cephalaspis* in that of fishes. If the Vertebrate type has undergone such inconceivable modifications

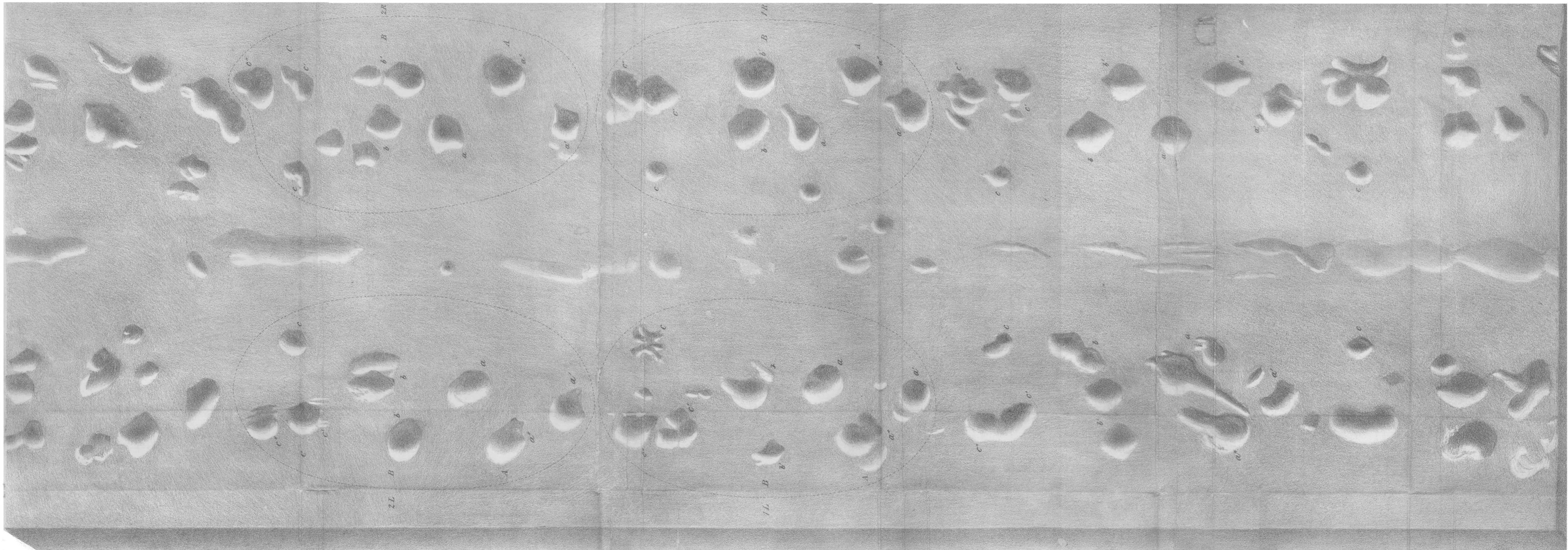
* [This paragraph was added whilst the paper was being prepared for the press. May 13, 1852.—R.O.]

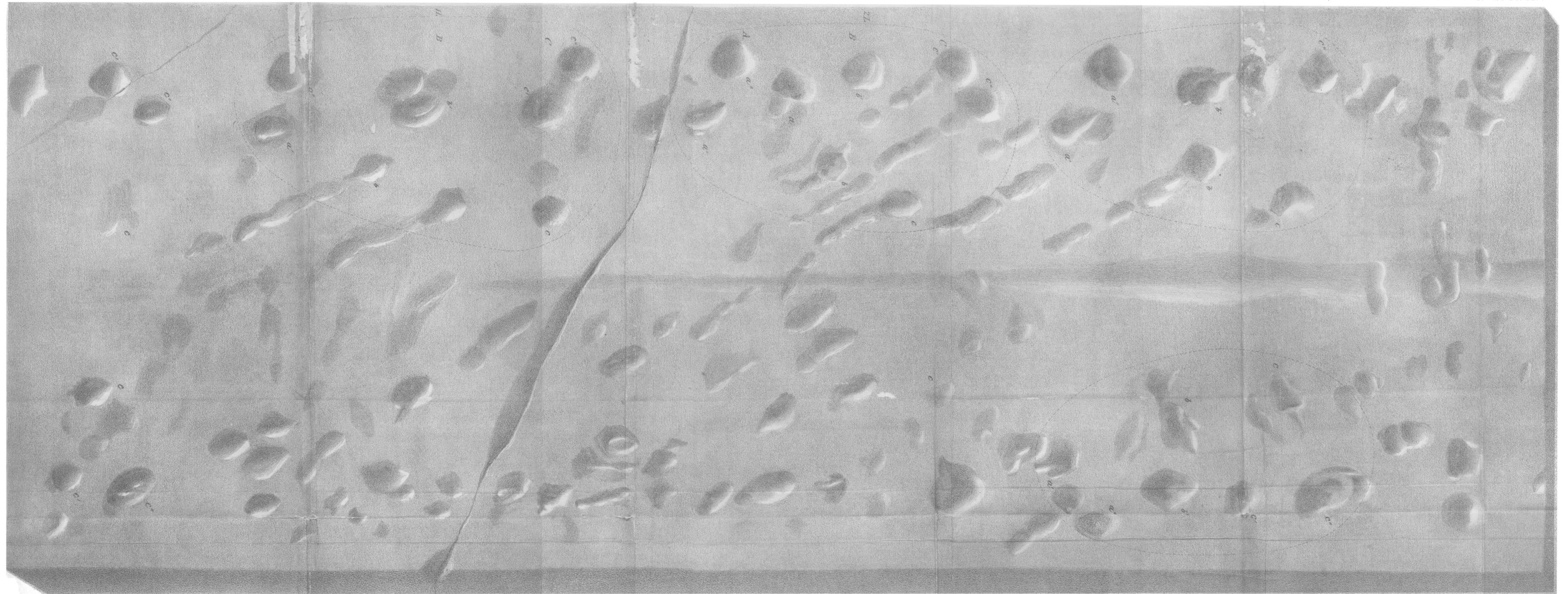


Jos. Dinkel, del. et lith.

Ford & West, Imp., 54, Hatton Garden.

PROTICHNITES SEPTENNOTATUS.





Dinkel, del et lith.

PROTICHNITES LATUS.

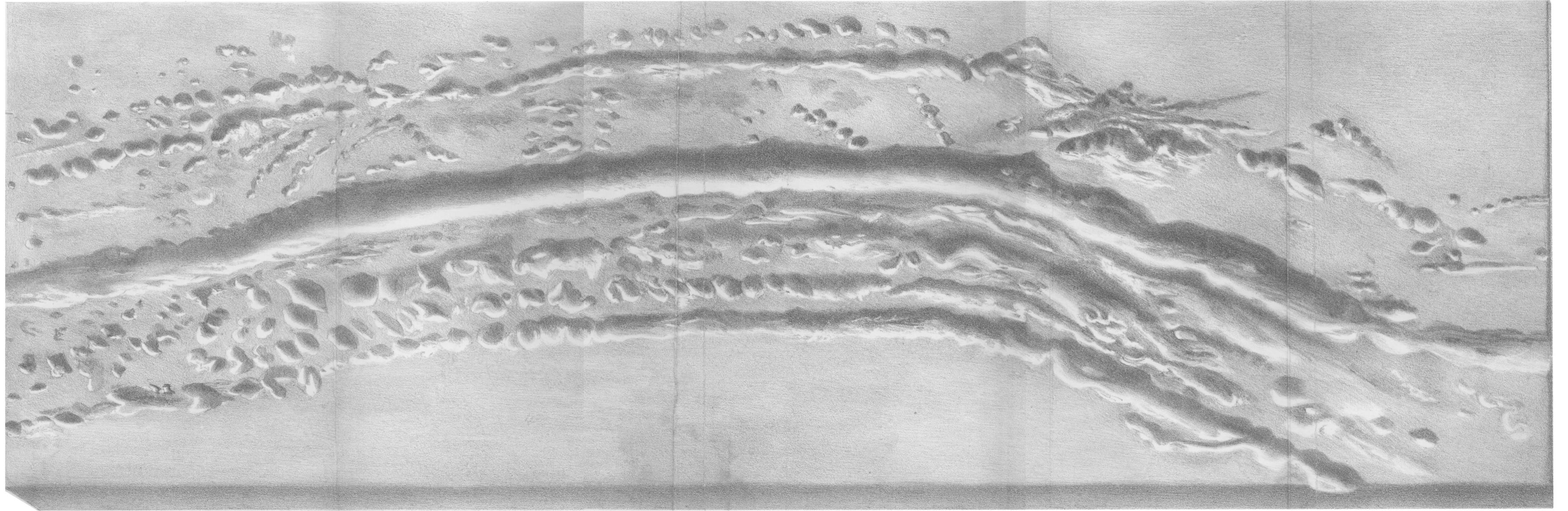
Printed by F. Rees.



Jos Dinkel, del. et lith.

Ford & West, Lithographers, 54, Hatton Garden.

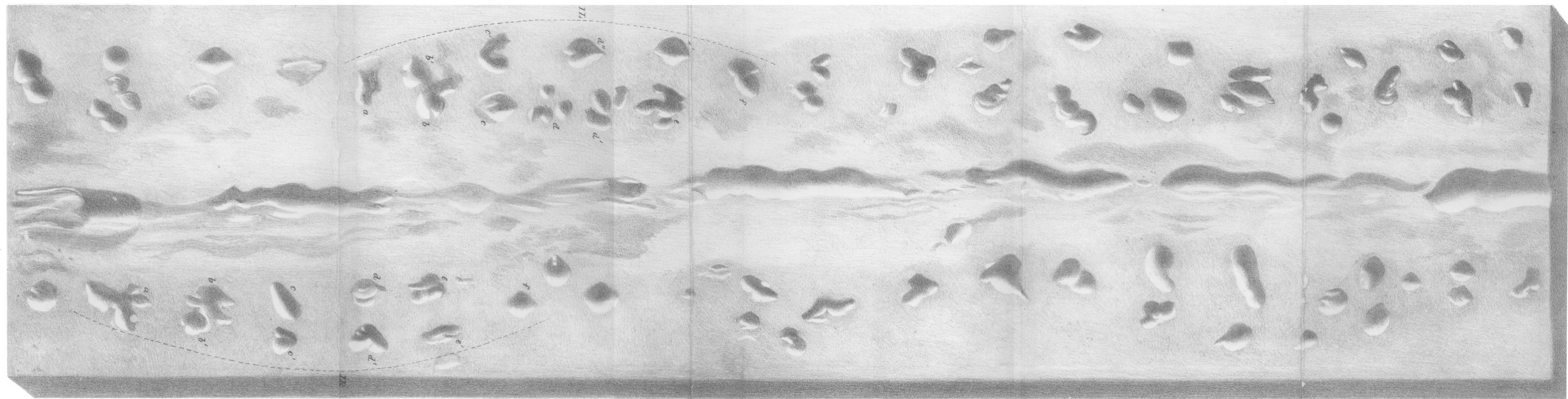
PROTICHNITES MULTINOTATUS.



Jos. Dinkel, del. et lith.

Ford & West, Lithographers, 54, Hatton Ga

PROTICHNITES LINEATUS.



Jos Dinkel, del. et lith.

Ford & West, Lithographers, 54, Nation Garden

PROTICHNITES ALTERNANS.

during the Secondary and Devonian periods, what may not have been the modifications of the Articulate type during a period probably more remote from the Secondary period than this is from the present time! In all probability no living form of animal bears such a resemblance to that which the Potsdam foot-prints indicate, as to afford an exact illustration of the shape and number of the instruments and of the mode of locomotion of the Silurian *Protichnites*.

These most precious evidences of animal life, locomotive on land, of the oldest known sedimentary and unmetamorphosed deposits on this planet, have been, I am well aware, far too inadequately described in the paper which I have had the honour to submit to the Society. They offer characters which require more time for their due scrutiny and greater acumen and powers of interpretation than have hitherto been bestowed upon them. The symbols themselves are distinct enough. Old Nature speaks as plainly as she can do by them; and if we do not fully thereby read her meaning, the fault is in our powers of interpretation. In the present attempt I can, however, truly aver, that I have bestowed upon it all the leisure at my command, and have applied my best abilities in the endeavour to fulfil my obligations to their discoverer, and to satisfy the generally expressed wishes of the Society.

APRIL 7, 1852.

Lieut. Julius Roberts, R.M.A., and the Hon. D. F. Fortescue were elected Fellows.

The following communications were read:—

1. *On some of the EFFECTS of the HOLMFIRTH FLOOD.*

By JOSEPH PRESTWICH, Jun., Esq., F.G.S.

THE broad tract of hilly country, which stretches north and south on the borders of Lancashire and Yorkshire, rises, in some places between Manchester and Huddersfield, to the height of nearly 2000 feet. The central ridge is here composed of the Millstone Grit Series, the elevated surfaces of which form extensive barren moors, and from which, owing to their lithological character and the large fall of rain, the surface-drainage is very considerable. On its eastern slope, the water is carried off by numerous small streams, falling into the various tributaries of the Humber. Their usual course is through narrow and picturesque valleys, which penetrate deep into the hills; amongst them is that of the Holme, which commences in the central range of hills, winds for nine miles east and north, and then joins the valley of the Colne at Huddersfield: it is well-wooded, and the scenery is generally bold and fine. At a short distance from the top of the valley, the Holme is joined by the Digley streamlet; the latter, however, being apparently the main stream, and draining, according to