

dicate the probability of an immensely lengthened period during which there was gradual sinking, followed by as gradual an uprising of the sea-bottom, unaccompanied by any of those violent volcanic eruptions so common during the Carboniferous era? Several reasons, in my opinion, concur in rendering this by no means improbable. That these deposits were accumulated during a period of comparative quiescence is shown by the entire absence of intercalated traps or other igneous rocks. The Forfarshire sandstones are very frequently found disrupted, they are often overlain by large flows of igneous matter, intruded traps are found all over the county; but in no place have I ever yet seen these traps again overlain by the sandstones, thus evidently proving the trap-rocks to belong to a later geological epoch. A gradual submergence is, I think, equally clearly indicated during the period while the lowermost rocks were being laid down; the very undermost of our fossiliferous beds with their beautifully preserved ripple-markings, Crustacean trails, and even rain-prints, evidently point to a sea-beach left frequently dry by the ebbing tides. Above these the shales, mixed up with the sandstones full of Vegetable and Crustacean remains, still indicate ebb-waters; but now the ripple-markings, although yet to be seen, are much less distinct, Crustacean or other tracks become exceedingly rare, and rain-imprints cease to be recognized; the *Cephalaspis*, a fish evidently having a wide range in time and space, is found, all showing a sinking of the sea-bottom. Still rising in the series, we find that the sea has further deepened; the conglomerates, only formed near a shore, cease, and sandstones, having no organic remains except an occasional *Cephalaspis* or *Pteraspis*, take their place; still the sea deepens and the land recedes until almost no deposit, and what there is barren of organic remains, takes place. A long period intervenes during which the Caithness beds form the bottom of shallower, or at least much more life-sustaining waters. At last this depression comes to a close, and as gradual an upward movement takes place; and again sediments are accumulated, now entombing a new class of animals, the *Holoptychius* and his allies taking the place of *Cephalaspis* and the *Crustacea* of the more ancient ocean. This upheaval continues, violent volcanic commotions take place, and Forfarshire from being a sea-bottom becomes high land, while in the lower districts the coal-measures are being accumulated.

3. On the LUDLOW BONE-BED and its CRUSTACEAN REMAINS.

By J. HARLEY, M.B. Lond.

[Communicated by Prof. HUXLEY, Sec. G.S., &c.]

[PLATE XVII.]

It is well-known to geologists, that between those two great systems of rocks the Silurian and Old Red Sandstone, there occurs an intermediate series of relatively small development, which, as it partakes

of the lithological and palæontological characters of both systems, has been well called "Transition-beds."

Transition-beds with contained Bone-beds.—That part of these beds which immediately overlies the Upper Ludlow Rock is composed of soft argillaceous shales; and that which immediately underlies the Old Red, of a soft, yellow, fine-grained sandstone—the Downton Sandstone.

Just below the Downton Sandstone, and therefore in the lowest part of these transition-strata, appears that remarkable animal-deposit called the "Ludlow Bone-bed"; and just above the Downton Sandstone, standing indeed within the threshold of the Old Red, another animal-deposit occurs, rarely, however, as an isolated conglomeration of organic remains as in the bone-bed, but most commonly having these more or less freely diffused throughout argillaceous and arenaceous strata, or a gritty calcareous conglomerate which often becomes a compact bluish limestone. Thus, to speak generally, we have a lower bone-bed more appertaining to the Silurian system than to the Old Red; and an upper, more diffuse one, much more closely associated with the Old Red than with the Silurian Rocks. Both have their types at Ludlow,—the former in Ludford Lane and the north-eastern slopes of Whitcliffe; the latter in the strata exposed on the south bank of the Teme, opposite to the Gas-works and Paper-mill.

Ludlow Bone-bed.—It is to the older and lower, or Bone-bed proper, that I would draw attention, premising a few general remarks. The Ludlow Bone-bed was at first considered to be a local deposit; but later researches have shown that it extends interruptedly over an area of forty or fifty miles*, a fact which renders probable that it will be found to have a still more general distribution. As it occurs at Ludlow and in its neighbourhood it forms a thin seam, varying in thickness from half a foot to the eighth of an inch, or rather to nothing; for it gradually thins away, and here and there disappears altogether, and we consequently fail to trace it for a distance. Interruptions which thus occur locally and on a small scale may probably occur on a large one throughout these early rocks, and so account for the absence of the bone-bed in wide geological areas. Whenever it does occur, it becomes an infallible guide to the geologist.

Sir R. Murchison has described the bone-bed as being composed of "a matted mass of bony fragments, some of which are of a mahogany hue, but others of so brilliant a black, that, when first discovered, they conveyed the impression that the bed was a heap of broken beetles" ('Siluria,' second edit. p. 148). The bed is often very compact and of a lighter colour, and closely resembles the cake from which linseed-oil has been expressed.

All that we know of the constituents of this remarkable deposit is contained in about two pages of the text and an illustrative plate of the 'Silurian System.' There we learn that, with the addition of a few molluscan shells†, it is composed of the remains of *Sclerodus*, *Plec-*

* 'Siluria,' and Quart. Journ. Geol. Soc. vol. ix. p. 11.

† The remains of Molluscs occurring in this bone-bed belong to *Discina*
202

trodus, and *Thelodus*, which are stated to be fishes*. Length of time has rendered us familiar with these names, but has failed, except perhaps with regard to one of them, to extend our very imperfect knowledge of the animals which they serve to designate. And this is not to be wondered at; for the remains are so very fragmentary, brittle, and coherent, that the utmost patience and no little labour are required to enable one to succeed in obtaining any definite results. Difficulties, however, do but enhance the interest which naturally attaches itself to this deposit; for, whenever and wherever animal life may have been first endowed with forms which characterize that highest type of it called vertebrate, it is in this bone-bed that we find the first assurances of the varied existence of this type. I say "varied;" for the Ludlow rocks have furnished a single species of *Pteraspis*, which seems to have appeared in almost solitary dignity to proclaim the dawn of a higher existence to a world of Crustaceans and Molluscs. To ascertain in what forms this higher existence, as we find it in the bone-bed, begun—whether it was some creation distinct from both that which preceded and that which succeeded it, or whether it is one of the necessary connecting links in a progressive development of life which runs uninterruptedly throughout the older rocks, are the inducements to the careful study of this complex mass. In examining this deposit, however, there are other and more preliminary questions which require to be answered first; and it is the solution of one of these which is the chief object of this paper.

Crustacean life in the Silurian age.—The Silurian was essentially a Crustacean age, and one that maintained its full vigour throughout the transition-strata to which I have referred. My first endeavour, therefore, was to ascertain whether the bone-bed contains Crustacean remains. I find that it does, and in no inconsiderable quantity; and I now proceed to lay the evidences before you.

Crustacean remains in the Ludlow Bone-bed.—On making diligent examination of the broken and washed deposit, with the aid of a pocket-lens, I find a number of minute bodies of various but often related forms, which, for convenience of general description, I will divide into three classes.

1. Of the bodies which I have placed in the first class, some resemble the minute conical teeth of osseous fishes, others appear to be made up of two, or occasionally of three such teeth (figs. 1-4). Rarely, one meets with what at first sight appears to be a very minute jaw set with a row of conical teeth (fig. 15), and more rarely still, with microscopic curved fangs or spines (fig. 16).

rugosa, *Lingula cornea*, *Orthis lunata*, *Rhynchonella navicula*, and some indeterminate genera.

* I have submitted all the remains which are thus designated to careful microscopical examination, and find that they possess a true bony or dentinal structure. While I thus disprove Prof. McCoy's supposition that *Plectrodus* and *Sclerodus* are Crustacean fragments (Quart. Journ. Geol. Soc. vol. ix. p. 14), I agree with him that the parts figured in the 'Silurian System' under these names cannot be teeth or jaws; they are, I believe, the posterior spines of the cephalic plate of some Cephalaspidean fish.

These last two varieties are very interesting as being in external form, and, as I will show, in all other respects, identical with Pander's "Conodonts."

In an elaborate monograph on the fossil fish of the Silurian system of the northern part of Russia, Dr. Pander has described a host of tooth-like bodies which he has assumed to be the teeth of Fishes, and to which collectively he has given the term "Conodonts," and subdivided them into 13 genera, comprising 56 species. They are of two kinds, simple and compound. The simple resemble minute spines about a line in length; under a magnifying power many of them look like the stout curved thorns of a rose-stem; they are plane, or furrowed longitudinally, more or less compressed and hollow at the base, which is expanded with an everted margin. The compound ones are larger, and resemble small jaws, each beset with a row of conical teeth, which may be equal or unequal, the row being often terminated and sometimes interrupted by larger fang-like elevations. These Conodonts were at first stated to be composed of pure carbonate of lime; but on re-examination, they were found to contain phosphate of lime also, which strengthened Dr. Pander in his supposition that they were fish-remains. As described by him, they are white and opaque, with transparent edges,—or reddish-yellow, transparent and horny looking, and under a high magnifying power show nothing but homogeneous superimposed layers.

2. To return to my own forms. The second class of bodies may be likened to the crown of a bicuspid or molar tooth, and especially as we should find them beneath the gums of a new-born child (figs. 5, 6, 9). The upper surface presents three more or less elevated and rounded cusps; the lower surface is excavated into depressions corresponding to the cusps. This form, on the one hand, by losing elevation, becomes a mere tuberculated plate or scale; and on the other, by lateral extension of the ridges joining the cusps, the little bodies present a V-shaped elevation (fig. 11). By the combination of two such, we have an undulated plate surmounted by a W-shaped elevation (fig. 12).

The bodies included in the first and second classes are very hard, have a rich brownish-red or amber colour, and are semitransparent, and highly polished. When possessed of but little colour, they appear to be composed of discoloured ivory, and occasionally present longitudinal converging striæ, due to coloured lines traversing the semitransparent substance; sometimes it is difficult to say that these are not linear elevations.

From their external form and ivory-like consistence and appearance, I was at first induced to think that some of these tooth-like bodies were teeth, probably of Fishes; but the variations presented by others, and their declination into mere tuberculated plates, ultimately persuaded me that this could scarcely be a correct supposition.

3. In the third class we find small thick plates of a somewhat oblong form, not exceeding two lines in length, and about a fourth of a line in thickness. There are three pretty distinct varieties. The first is distinguished by having one of its surfaces raised into three nearly

equal rounded tubercles, bounded (at least in one direction) by the slightly elevated margin of the plate (fig. 18). The second is somewhat pyriform in outline, and presents usually one small tubercle at the narrow end; sometimes there are two, and occasionally three, more or less separate and distinct (figs. 19, 20). The third variety occurs as oblong or rounded plates either plane or with one surface slightly concave and the other slightly convex.

The bodies placed in this class are commonly of a greyish or blackish-brown colour; and a fractured edge presents an excessively fine fibrous structure.

All the forms included in the above three classes, and all their varieties, possess the same ultimate microscopical structure and chemical composition.

Structure.—The structure, which is perfectly preserved, is unmistakably Crustacean. A microscopic section presents a vertical tubular, and a horizontal laminated structure. In the flattened bodies these two structures are strictly perpendicular to each other; but in the conical bodies, except about the apices, they have a more or less oblique relation (figs. 12 *b*, 12 *c*).

The tubes are excessively fine, varying from about the $\frac{1}{40000}$ to the $\frac{1}{25000}$ th of an inch in diameter. In most specimens they appear to be injected with a reddish-brown material; but this rather stains the walls of the tubes than fills up their cavities; for in transverse section they appear as clear dots with a discoloured circumference, and on placing the bodies in hot turpentine, minute air-bubbles are freely displaced. The above is therefore probably an overstatement of their real size. The tubes are so crowded, that there appears, in vertical sections, to be little or no intertubular substance; they lie parallel to each other, and never branch; and when the surfaces between which they pass are parallel, they take a straight course; but whenever an elevation occurs, the tubes, instead of converging towards the apex, take a slight bend outwards to either side of it. Minute, rounded or oval, calcareous corpuscles, measuring about the $\frac{1}{3000}$ th of an inch in diameter, are often present. In horizontal sections, the tubes appear to be arranged in systems forming rounded sinuosities separated from each other by clear tortuous lines of intertubular substance (fig. 20 *a*).

The horizontal lamination presents the appearance of a great number of excessively fine, and usually faintly marked, wavy lines, the undulations of which are very minute, regular, and parallel to each other (fig. 12 *d*). The Conodonts possess the same structure. The form called *Gnathodus Mosquensis*, tab. 2 *a*, fig. 10 in Pander's work, of which I have found several specimens in the bone-bed (one is delineated in fig. 15), shows both the laminated and tubular structure; the tubes, however, are rarely stained or injected.

In the fang-like form, of which, strange to say, I have only found a single specimen (fig. 16), and which corresponds to the genus *Acodus* of Pander, the same structure is recognizable. But the tubuli are rarely injected; and, since in these forms they have a direction almost parallel to the laminæ, it is difficult, if not impossible, to

distinguish between them. The injection, however, of a few tubuli here and there manifests their presence and direction.

General remarks on arrangement of tubuli in Crustacean shell.—This alteration of the relative directions of the laminae and tubuli is what occurs in the other forms of Crustacean fragments to which I have referred; and I also find a corresponding obliquity of their arrangement in the spines of recent *Limuli*. The same rule, in fact, applies to both the recent and fossil integument; viz., whenever the surface is elevated into a tubercle, the tubes have a direction a little oblique to its surface; on the sides of a conical eminence the tubuli lie at an acute angle; and when the eminence is included between lines that are parallel, or nearly so, then the tubuli, as in the spine-like Conodonts, take a direction almost parallel to the surface. Calcareous corpuscles also occur in the Conodonts, and are, I presume, the “nuclei or cells,” which have been mentioned in the description of these bodies. I am much indebted to Professor Huxley for two specimens of Conodonts received from Dr. Pander. They have proved a most valuable donation, since they have enabled me to investigate their structure and determine their identity with my own solitary specimen.

Chemical constitution.—Chemical analyses of each of these three classes of bodies prove that they have the same composition; and as far as the eye can judge of the results of operations on small quantities, the proportion of their constituents appears to be equal in all. They are composed of phosphate and carbonate of lime, the former being, contrary to my anticipations, the more abundant constituent. The colour is due to sesquioxide of iron.

Relationship.—Having thus determined that the bodies above referred to, including the Conodonts of Pander, are Crustacean fragments, it remains to determine, as far as possible, to what particular genus or genera they belong.

So great is the number, and so varied the forms of the parts of a Crustacean, that it would be quite allowable to suppose that all the forms figured in the first four plates of Dr. Pander's work (which include representations of all the thirteen genera into which he has subdivided the Conodonts) may belong to a single individual; and the same may be said of all the forms which I have figured; but perhaps it would be nearer the truth to assume that they have a more distant relationship than this. May they not belong to several or all of the orders and genera common to the strata in which they lie?

Structure of Pterygotus.—The question may be restricted somewhat by ascertaining the structure of some of these. First, with regard to that widely diffused genus *Pterygotus*. I infer that its integument was very soft, and almost wholly composed of animal matter, from the fact that it invariably occurs as a carbonaceous film. We find the bony plates of *Pteraspis* and the testa of *Trilobites* and *Phyllopod*s well preserved in the mudstone-shale of the Lower Ludlow strata; but even in the calcareous seams of the Upper

Ludlow, *Pterygotus* still remains as a flimsy trace, or dark stain*. I am not justified, therefore, in referring any of these fragments to this genus or its allies, unless, indeed, they have such forms as are represented in figs. 11, 12, and 13, which may possibly be stomach-teeth.

Structure of Trilobites.—As to the Trilobites, they have a structure altogether different from that above described. I have examined the integument of *Calymene Blumenbachii*, *Harpes macrocephalus*, and *Phacops latifrons*: Mr. Salter kindly furnished me with material for examining the last two genera. They all agree in structure; and as this is best seen in the dark-coloured *Calymene* from the Lower Ludlow strata, I will take this as the type. The integument of this genus is seen in vertical section to consist of two distinct portions, an inner and an outer; and both are traversed by wide straight tubes, from $\frac{1}{500}$ th to $\frac{1}{100}$ th of an inch in diameter, placed at a distance of about $\frac{1}{500}$ th of an inch apart, so as to be quite isolated from each other. The outer part of the integument has a coarsely fibrous appearance, the fibres having a horizontal direction, and uniting obliquely to form a coarse network with narrow elliptical meshes. I question whether this is a true structural appearance. Magnified 300 times, this part of the integument presents obscure indications of a finely laminated structure. In specimens from the limestone the inner part of the integument has a prismatic structure; but I believe that this is due to crystallization of the infiltrated carbonate of lime; for I do not observe it in specimens from the mudstone. Moreover, the Trilobites do not appear to have possessed articulated appendages.

Structure of Ceratiocaris.—On the other hand, the structure of the bodies in question has a great resemblance to, if not a complete identity with, that of *Ceratiocaris*. In a section of one of the tail-spines of this genus from the Upper Ludlow rock, I find both the tubular and laminar systems well displayed; but the laminae, instead of being faintly marked, are clearly and sharply defined, and the tubuli are perhaps less crowded, and sometimes beautifully zigzagged near their termination at the outer surface. There is another and more general agreement between the bodies compared. The Phyllopoes of the Ludlow rocks are small, many being not much larger than big prawns; and they possessed a very hard integument, as is proved by their remains. Further, these little animals were very spiny, for even the tail-spines themselves were armed with minute secondary spines disposed in longitudinal rows.

Discrimination.—Now, while their microscopic size and extreme hardness separate the little bodies referred to in this paper from *Pterygotus* and its allies, and their structure from the Trilobites, these characters all serve to associate them with the Phyllopoes.

* In the large *Lesmahago* specimens, in which the integument is best developed and preserved, it appears in vertical section as a black line, the $\frac{1}{500}$ th of an inch only in thickness, and no structure can be made out either in this or in a horizontal section.

Indeed, I am almost convinced that many of the simple Conodonts are really the minute spines which were attached to the tail-spines of *Ceratiocaris*. Some of these are repeatedly grooved in the longitudinal direction; so are many of the Conodonts. Some tail-spines in my possession possess rows of little oval apertures which correspond to the attachment of the secondary spines, which were no doubt moveable; and these apertures correspond in size to the bases of the Conodonts. Further, the Conodonts are most abundant in those strata where, in this country at least, the Phyllopods are most common, viz. in the Lower Ludlow.

While I would thus dispose of the spine- and tooth-like bodies, I am much puzzled about a reference for the plates or scales. They look at first sight like fragments of Trilobites; but, apart from their difference of structure, the irregularity of their tuberculation and their isolated entirety separate them from these animals. Are they the disunited and symmetrical pieces of such a tessellated carapace as is found in the recent genus *Birgus*? (figs. 18, 19).

Both the Conodonts of Pander, and the fragments which I have described in this paper, have resemblances to the recent genera *Squilla* and *Limulus*. In structure they exactly agree with the latter, the carapace of which shows no differentiation into outer and inner portions; and the whole thickness is traversed by simple, uniform and straight, or slightly bending tubes.

Bodies similar in form to many of those figured in tab. 1 and 2 of Dr. Pander's work are to be found articulated with the margins of the carapace of *Limulus*, and fringing the caudal appendages of some species of *Squilla*. Indeed figs. 22 and 23, tab. 2, are exact representations of the posterior margin of the caudal segment of a species of *Squilla* in the Museum of Comparative Anatomy at King's College.

Astacoderma.—In order to facilitate the recognition of the bodies mentioned in this paper, I propose to form them into one provisional genus, from which, as each is more particularly identified, it may be withdrawn. *Astacoderma* is the name I would give this genus, in which I would also include the whole of the so-called Conodonts, and thus give them at once a natural association, and a more appropriate name.

I will now briefly describe such of the more typical forms as often occur in the Bone-bed.

ASTACODERMA TERMINALE. Pl. XVII. figs. 1 & 14.

About a line in length, conical, round or compressed and sub-angular, hollow, the cavity usually extending about two-thirds the length. Fig. 14 is an irregular form.

A. BICUSPIDATUM. Pl. XVII. figs. 2, 3, 4, 7.

Rarely exceeding a line in length, and about as broad; cusps usually equal, vertical or oblique, each hollowed at the base into a little conical cavity. In fig. 7 the cusps are confluent.

These two species were probably the hard extremities of limbs.
Loc. Ludlow and Norton.

A. SERRATUM. Pl. XVII. fig. 15.

Very minute (fig. 15 does not exceed a line in its greatest dimension); the cusps are sometimes unequal and irregularly arranged; dark streaks indicate cavities at the bases of the cusps.

This is the *Gnathodus* of Pander. It is doubtless the serrated margin of some carapace or body-ring.

Loc. Ludlow.

A. SPINOSUM. Pl. XVII. figs. 16 *a*, 16 *b*.

The simple Conodont of Pander, corresponding to the genus *Acodus*. Spines of *Ceratiocaris*, or of some Squilloid Crustacean.

Loc. A solitary specimen in the Bone-bed, Ludlow.

A. TRIANGULARE. Pl. XVII. figs. 5 *a* & 5 *b*.

Triangular, subpyramidal, broader than long, terminated by three cusps, two anterior, the third posterior and intermediate, more prominent than the anterior; inferior surface (5 *b*) presents three depressions in a general concavity, corresponding to the cusps.

Var. diffusum (fig. 6).

Var. contractum (fig. 8).

Loc. Ludlow and Norton (common).

A. DECLINATUM. Pl. XVII. fig. 9.

Odd cusp anterior, depressed, forming the termination of a ridge running downwards and forwards from the left posterior cusp; between this ridge and the right posterior cusp is a deep depression which slopes downwards to the right side. Inferior surface concave, presenting a general concavity with three depressions corresponding to cusps.

Var. depressum.

Var. expansum. Anterior cusp carried towards the right side, so as to be nearly in front of the right posterior; depression almost transverse, wedge-shaped.

Var. expanso-acuminatum (fig. 10). This variety serves to connect, through fig. 8 (*A. triangulare*, var. *contractum*), the last two species described. I am at a loss where to affix these bodies; but the varieties delineated in figs. 8 & 10 are identical in form with some of the stunted spines articulated to the margins of the abdominal plate of *Limulus*.

Loc. Ludlow and Norton (frequent).

A. UNDULATUM. Pl. XVII. figs. 11, 12 *a*—12 *d*, 13.

Cusps obsolete or nearly so; the two intervening and diverging ridges forming a V-shaped elevation, from which the rest of the surface declines. This is only a declens of variety *expansum*.

Var. compositum. A combination of two or even three such forms, making a zigzag plate, bounded by a smooth, slightly elevated margin. The under surface presents usually, but not invariably, depressions corresponding to the elevations. This form is not unlike the stomach-teeth of the common Lobster.

Loc. Ludlow and Norton (not very common).

A. PLANUM. Pl. XVII. figs. 18, 19, 20a, 20b, 20c.

Flat smooth plates, with rounded polished, or straight (sometimes polished, sometimes unpolished) edges, often as much as $\frac{1}{4}$ of a line in thickness. Superior surface slightly concave, or distinctly included within a raised margin, occasionally marked just within the margin with minute pits or radiated linear depressions; inferior surface also slightly concave, and partially bounded by a smooth elevated border.

Var. *monotuberculatum* (fig. 20). Sometimes the linear depression here shown, but which is not present in the typical form, becomes very wide; and then the one-half of the plate is occupied by two tubercles (fig. 19).

Var. *trituberculatum* (fig. 18). Oblong or pyriform; the superior surface presents three pretty equal rounded tubercles, bounded in one direction by the elevated margin of the plate. These forms resemble the valves of some species of *Beyrichia*; and had they possessed a more delicate structure and a greater concavity of one surface, one would have been induced to refer them to these Entomostracans.

Loc. Ludlow and Norton.

This form and its varieties are very common, and make up a considerable proportion of the "black scales," of which the bone-bed appears to be in great part composed. They may possibly belong to some Limuloid Crustacean.

A. REMIFORME. Pl. XVII. fig. 17.

Flat, triangular; superior surface convex; inferior a little concave. The superior surface presents near the base a transverse depression, alternately convex and concave, apparently for ginglymoid articulation.

I have met with this form twice only. It resembles some of the little paddle-like appendages to the posterior limbs of *Limulus*.

Loc. Ludlow and Norton.

Dr. Volborth's discovery of Conodonts in the Ludlow Bone-bed.—I would mention in conclusion, that I had, last summer, the pleasure of showing my specimens of Conodonts from the Bone-bed to Dr. Volborth of St. Petersburg, a very eminent authority in this matter, and that he unhesitatingly confirmed the view I had taken of these bodies, as to their being identical with Dr. Pander's Conodonts.

On the 30th of May last, and a short time after I had given in my paper to the Society, I received an obliging letter from Dr. Volborth, which, as it contains information not only corroborative of some statements made in this paper, but also of general interest, I feel that I cannot do better than transcribe.

"St. Petersburg, May 12, 1861.

"DEAR SIR,—According to my promise, I beg leave to inform you that on my return home I found hundreds of Conodonts in the decomposed part of the bone-bed of Ludlow. They have probably undergone metamorphic action, being white, opaque, very brittle, and not of so brilliant a lustre as ours. But they are certainly Cono-

donts, as Mr. Pander has been able to trace in them the same microscopical structure, with the aid of glycerine.

"I found Conodonts, too, at the Isle of Oeland (Sweden), and succeeded in detecting fish-remains at the Isle of Gothland, in marls that coat the natural divisions of the limestones of the Thorsberg, in the south-east of the isle, close to Oestergarn. They belong to those shagreen-scales that are so abundant in the bone-bed of Ludlow (*Thelodus*, Agass.), described by Mr. Pander as *Cœlolepis* from Oesel, and confirm the views of Sir Roderick about the younger age of the strata in the southern part of the Island.

"DR. ALEXANDER VOLBORTH."

EXPLANATION OF PLATE XVII.

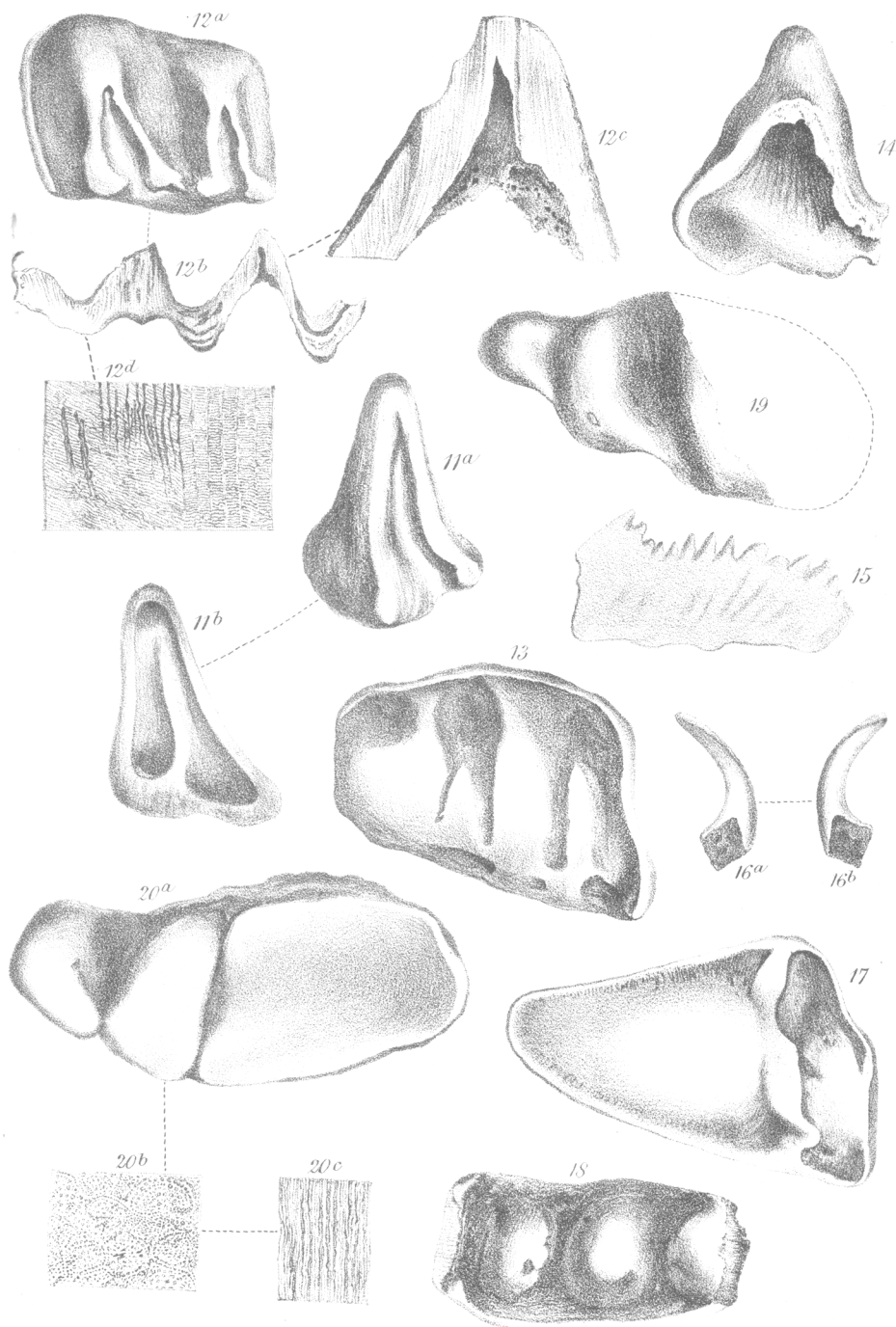
- Fig. 1. *Astacoderma terminale*; $\times 25$.
 14. *A. terminale*, var. $\times 15$.
 2, 3, 4. *A. bicuspidatum* and varieties; $\times 25$.
 7. *A. bicuspidatum*, var. $\times 15$.
 5 a. *A. triangulare*.
 5 b. *A. triangulare*, under surface. } $\times 25$.
 6. *A. triangulare*, var. *diffusum*. }
 8. *A. triangulare*, var. *contractum*; $\times 15$.
 9. *A. declinatum*; $\times 25$.
 10. *A. declinatum*, var. *expansio-acuminatum*.
 11 a. *A. undulatum*: vel *declinatum*, var. *expansum*. } $\times 15$.
 11 b. *A. undulatum*, under surface. }
 12 a. *A. undulatum*, var. *compositum*. }
 13. *A. undulatum*, var. *compositum*, under surface. }
 12 b. *A. undulatum*, var. *compositum*, vertical section, $\times 25$. }
 12 c. *A. undulatum*, var. *compositum*, vertical section, $\times 60$, showing the
 tubular structure.
 12 d. *A. undulatum*, var. *compositum*, vertical section, $\times 250$, showing the
 laminar structure (a few tubuli are injected).
 15. *A. serratum*; $\times 15$.
 16 a & 16 b. *A. spinosum*; $\times 15$.
 17. *A. remiforme*; $\times 15$.
 18. *A. planum*, var. *trituberculatum*; $\times 15$.
 19, 20 a. *A. planum*, var. *monotuberculatum*; $\times 15$.
 20 b. *A. planum*, var. *monotuberculatum*, horizontal section, $\times 250$, showing
 tubuli cut across and arranged in systems.
 20 c. *A. planum*, var. *monotuberculatum*, vertical section through part of the
 thickness, $\times 250$, showing the tubuli.

4. On the OUTBURST of a VOLCANO near EDD, on the AFRICAN COAST of the RED SEA. By Capt. R. L. PLAYFAIR, Officiating Political Resident, Aden.

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

(Abstract.)

At Edd, lat. $13^{\circ} 57' N.$, long. $41^{\circ} 4' E.$, about half-way between Massouah and the Straits of Bab-el-Mandel, earthquake-shocks occurred on the night of the 7th of May or the morning of the 8th, during about an hour. At sunrise fine dust fell, at first white, afterwards red; the day was pitch-dark; and the dust was nearly knee-deep. On the 9th the fall of dust abated; and at night fire and smoke were seen issuing from Jebel Dubbeh, a mountain about a day's journey



W. West, imp.