

with the second, so that the accordance of the off-shoot with its parent (at least in the Giessen larvæ) by no means appears to be so complete as was affirmed by previous observers and also quite recently by Von Siebold*, who has received a number of the larvæ for examination from Meinert.

The species to which the larva belongs can only be determined hereafter, when we have the sexual animal before us. For the present we can only say that it is different from Wagner's species (with which, according to Siebold's statements, Meinert's species is identical).

XX.—*Notice of Torynocrinus and other new and little-known Fossils from the Upper Greensand of Hunstanton, commonly called the Hunstanton Red Rock.* By HARRY SEELEY, Esq., F.G.S.

THE curious new crinoid genus here described was one of the first found of the Red-Rock fossils. One species, chiefly known from the separated joints of the column, is the *Apiocrinite* of old writers on the Hunstanton section; while the other, rarer and more obscure, with a column fused into a rod, has passed unnoticed. This latter, which is the type species, commonly occurs as short fragments of a slender cylindrical stem of uniform thickness, and broken at both ends. But in the Woodwardian Museum there may be seen three examples of the head, several of the base, one of a dichotomous stem, and some showing the column to consist of thick joints. On these data the genus is founded.

The *calyx*, like the column, is soldered into one mass, and is inseparable from the stem, on the side of which it is placed, exactly like the bowl of a ladle, at right angles to the usual position, instead of being at the summit of the column. It is relatively small, hemispherical exteriorly, smooth, and, as in *Millericrinus*, appears to be made by two circles of five plates each (with the addition, I think, of five interradials). The cup is relatively large, with well-marked radiating vascular impressions. In each of the five compartments of the narrow brachial margin there are, on the inner part of the plate, two articular facets for arms. In one example, three of these compartments are confluent and regular, but the other two are irregular and separated by calcareous interspaces. In *Eugeniocrinus* the calyx is sometimes set obliquely on the column, but in no other crinoid except the Palæozoic *Cheirocrinus* has it the singular spoon-like position shown in the specimens described.

* Zeitschr. für wiss. Zool. Bd. xv. p. 115.

The *column*, which is about half the diameter of the calyx, slightly enlarges for four or more times the length of the cup, and, then contracting a little, terminates in a hollow cone. There is also one remarkable specimen, unfortunately imperfect, which appears to show a branching division in the column.

The *base* varies; but in all specimens it expands near the bottom as it descends, either conically or into a thin plate like the base of a *Gorgonia*. The upper columnar end, at a variable length, seems to terminate in a conical cavity like that of the headpiece, with which the cylindrical stem corresponds in diameter. In this cavity I notice a circlet of twenty-five granules. The ordinary plates of the column are twice as wide as high, but near the articular end get deeper. There is nothing to indicate how the two parts were connected, or how the dichotomous part of the column came on.

On the whole it seems most nearly related to *Millericrinus*. The species may be marked *Torynocrinus canon*. It is the *Koninckocrinus Agassizi*, mihi, of my list in the 'Annals' for Oct. 1864.

Another species from Hunstanton, which is doubtfully placed in the same genus, should be named ?*Torynocrinus variolarius*. It is the *Apiocrinus* of authors, the *Bourguetocrinus ellipticus* (Mill.) of Mr. Rose [Ann. Phil. 1836], *Bourguetocrinus rugosus* (D'Orb.) of Mr. Wiltshire [Geologist, 1859], and the *K. rugosus* of my list [Ann. Nat. Hist. 1864].

Of this I only know the base and parts of the column. The base is an expanded plate contracting conically to the size of the thick cylindrical cheese-like pieces forming the column. These vary in thickness, but are rarely more than half as high as wide. The articular surfaces are ornamented with concentric rows of pustules, generally very close together; the outer surface is smooth.

Ammonites ochetonotus (Seeley).

A compressed shell with subparallel sides, a back widely channelled, and moderate umbilicus. It is often a foot in diameter. The umbilicus is as high as the mouth is wide, moderately deep, varying with the variety, flat at the periphery and oblique, making an obtuse angle with the side. It commonly shows at its outer limit a few large tubercles, in which in the young state the close, rounded, flexuous ribs which then ornamented it were knotted.

The ratio in which the height of the side increases, taken at each half whorl, is $1\frac{1}{2} : 2 : 3$; and the whorls are coiled nearly parallel to the back. In large specimens the sides are smooth, gently inflated, slightly converging, and round rapidly on nearing the back.

The back is hollow—not ploughed, to use a carpenter's term, as in *A. falcatus*, but with a central concave channel, shallow and wide, occupying a third of the width. In some varieties it is margined with distant slightly elevated tubercles.

Specimens in which the mouth is wide have the ribs more strongly marked, and continued to a larger diameter. About five appear to collect in each tubercle, and one or two between, all dying off insensibly towards both back and umbilicus. In these thicker forms the sides converge more rapidly near the back. It is essentially an inflated form of *Ammonites lautus* in which the ribs and tubercles are obliterated.

In the more inflated varieties the umbilicus becomes very large, and the sides round into it. In these the base of the side is margined by eight or nine rather sharp large tubercles. In a young state there were on the sides many close straight ribs, but they disappear with a diameter of 2 inches.

The septa are complicated. The upper lateral lobe is much notched and digitated, and divided by a five-fingered branch into two parts, of which the outer one is the longer. The lateral saddle, in the middle of the side, is large, has one major branch on each side much digitated, and behind it two or three minor branches, which probably vary with age: it terminates in a large central branch, with three or four fingers on each side and one in the middle, all well notched. There are two inferior lateral lobes and an inferior saddle.

Diameter 6 in.; greatest height of mouth $2\frac{3}{4}$ in., height of side $2\frac{1}{2}$ in., height of umbilicus $2\frac{3}{4}$ in., height of whorl opposite mouth $2\frac{3}{4}$ in. The back has no real limit, but may be stated as an inch wide.

I am not acquainted with any Cretaceous Ammonite having a channeled back and smooth sides. Hence this is readily distinguished from all described species. *A. solenonotus*, mihi, of my list in the 'Annals,' Oct. 1864, was the name then used for the inflated, ribbed, tubercled variety of this species.

Ammonites sphærotus (Seeley).

A compressed shell with flat converging sides, a round back, and small umbilicus; devoid of ornament. Height 4 inches, height of mouth $2\frac{1}{8}$ inches, greatest height of umbilicus $\frac{5}{8}$ inch; width of base of mouth $1\frac{1}{16}$ inch, width of back $\frac{3}{8}$ inch.

The small umbilicus is bordered by a flat and but slightly inclined periphery, which makes a sharp angle with the side. The inner halves of the sides are nearly parallel, and converge slightly, but the outer halves converge more rapidly. The width of the base of the mouth, where the shell is half a whorl smaller, is $\frac{11}{16}$ inch, and the back is relatively wider than at the larger

diameter. There are on the sides of a whorl about eight or nine narrow flexuous ribs but little elevated and only appearing on the outer or converging parts of the sides. The back is perfectly rounded into the sides, so that it cannot be said to have a limit.

The septa are complicated, apparently with many saddles and lobes.

I suppose this shell to be that hitherto included in Hunstanton lists as *A. complanatus* (Mant.), with which it has no near affinity, rather recalling the *A. bicurvatus* of Michelin; but its nearest relations appear to be with *A. Austini* (Sharpe), pl. 12, Palæont. Cret. Moll., from which it is distinguished by its small umbilicus, compressed form, and smooth shell, which at the utmost separate it as a variety. The *A. alternatus* of S. Woodward had a round back.

Ammonites proboscideus (Sow.).

The species is given by Morris as from the Gault of Cambridge. I have neither found nor heard of it there. One specimen has been obtained from the Gault in the Ely pit.

Nautilus simplex (Sow.).

I only know this fossil by the figure of a cast in the 'Min. Conch.;' and with that this very beautiful Hunstanton fossil agrees in the straight distant septa and the size of the umbilicus. It corresponds well, too, with Ooster's figure. Externally it is much like *N. Bouchardianus*, for which recent figures of it might well pass. The two species are probably varieties of each other.

Plicatula minuta (Seeley).

A small shell attached by the umbo, with an oblique axis; one valve flat and the other convex.

Length $\frac{1}{4}$ inch; width $\frac{3}{16}$ inch.

Form ovate, lower valve moderately inflated. It is ornamented with numerous fine ribs, which radiate from the umbo, are sometimes dichotomous, and vary greatly in the degree of their elevation and continuity, occasionally appearing as pseudo-spines laid flat on the shell. The attached part is generally small, and I have never seen it equal to a third of the length of the shell; in the upper valve it produces a corresponding elevation, which is generally worn off, giving specimens the look of *Anomia*. The upper valve is flat or a little concave, sometimes *very* finely marked with radiating striæ, otherwise imbricated.

It might be supposed that this is the young of *Plicatula inflata*; but the fact that specimens in the Cambridge Greensand, where it is not rare, all occur of the same size and quite resembling this of Hunstanton, seems to point conclusively to these being adult shells.

Mantell's *Plicatula spinosa*, which is the young of *P. inflata*, is a very different shell. Woodward's *Plicatula sigillina* is attached by the entire lower valve, and is of a different form.

Spondylus gibbosus (D'Orb.).

This may be described as an attached form of *Lima obesa*. In the early state the shell was attached, but afterwards became free. It is symmetrical, about two-thirds as wide as long. The upper valve is remarkable for a degree of inflation unusual in the genus, its height being equal to about half the length. From the apex it expands in a wedge-form for three-fifths of its length, and then contracts semicircularly. The ribs are small, close, without spines, and seemingly one elevated and one depressed alternately; but as the surface of the shell is not well preserved, this is not certain. Length 1 inch. It may be regarded as a variety of *S. gibbosus* (D'Orb.). The same shell occurs in the Cambridge Greensand.

Ostrea vesicularis (Lam.).

A small shell, quite flat, attached to a *Perna*.

Ostrea curvirostris (Nills.).

This shell differs a little from Upper-Chalk forms in being broader and less round posteriorly, but it is matched exactly with specimens from the Lowest Chalk of Burwell.

Exogyra conica (D'Orb.).

This is the shell figured in 'T. Crétacés,' pl. 478. figs. 5-8. I fail to see the advantage of associating it with Sowerby's shell. It is the fossil mentioned as *E. conica* in my list of Greensand Bivalves, and is not uncommon in the Cambridge Greensand.

Exogyra Rauliniana (D'Orb.), var. *arcula*.

This may be described as an *Exogyra* with the mode of growth of *Ostrea hippopodium*. The shell is a broad ellipse, with the spire slightly coiled in, and the free valve increasing in growth at its base, the lines being curves, which extend from the apex round by the base for nearly half the circumference. The attached valve increases by a nearly equal amount of growth all round, and projects above the upper valve. Attached by the whole of the base. It wants both the ridging and folding of *E. laciniata*, and in the regular growth of the side resembles *E. Rauliniana*. Similar shells occur in the Cambridge Greensand, and differ from *E. Rauliniana* sufficiently to make a distinct name a convenience.

Hinnites trilinearis (Seeley), var.

An irregular shell, about 6 inches long and nearly as wide, which has the convex valve very moderately inflated, the other valve flat or concave; so that the shell has a compressed aspect. In the young state it nearly resembled Cambridge examples of *H. trilinearis* in the aspect of the convex valve; but the ribs begin to disappear before the shell is half grown, so that the greater part of it is nearly smooth, being marked with the eccentric lines of growth and faint prolongations of the ribs. The concave valve resembles the flat valve of *H. trilinearis* in having the ribs with which it is ornamented much more dense than on the large valve; they are rather more dense than in Cambridge specimens, and, instead of getting wider apart with age, get rather closer; they extend to the margin of the shell.

Hinnites Salteri (Seeley).

Another large species of this genus is known by a convex valve of growth more regular than usual, measuring 4 inches in each diameter. It is about as much inflated as the large valve of *Pecten maximus*, and ornamented by a large number of (about twenty-five) primary ribs, which radiate from the umbo, are little raised, and sharp. Commonly between each two ribs there is another in the middle of the intercostal space, much less elevated; and on each side of this are frequently seen one or two tertiary ribs. The whole intercostal space is densely marked with fine radiating striæ. *H. trilinearis* is the species to which it comes nearest.

Perna sulcata (Sow.).

Two distinct varieties occur—one the common typical form, the other that partly sulcated shell occurring in the Grès Vert, which in its young state is quite smooth. I suspect that the shell described from the Cambridge Greensand as *Arca sulcata* may be a dwarf race of this species.

Perna lissa (Seeley).

Fragmentary valves, indicating a very peculiar species about four inches long. Both valves are moderately convex, about as much so as in *P. Crispii*; the right valve seemingly most inflated. The anterior side of the shell is truncated. Its axis is oblique, like that of an *Avicula*. It is gradually more compressed posteriorly, and quite smooth, or only marked with a few regular imbrications of growth like those in the Chalk shell *Perna striata*. Its affinities are with *P. tenuis* on the one hand, and with *P. transversa* on the other.

Perna transversa (Seeley).

Had this shell occurred in the Oolites there would have been a strong temptation to refer it to *Myacites*. It is transversely oblong, with the two pairs of sides subparallel. The umbo on the anterior margin is recurved. The anterior side is short and inflected; the hinge-line is at right angles with it. The posterior side is moderately compressed. The thin shell, which is not quite regular in its growth, is only ornamented with regular imbricated lines, which, at distances of about four of these, have a tendency to thicken into ridges. It is 2 inches long, and $1\frac{3}{4}$ inch deep.

Avicula cuneata (Seeley).

A small species, with an anterior ear. Anterior side straight; hinge-line short; posterior side depressed, lunate; seemingly traces of a small posterior ear; base round. Smooth, being only marked by faint lines of growth. Length $\frac{1}{2}$ inch; width rather more than $\frac{1}{4}$ inch. From the middle the shell narrows to the apex.

Terebratula biplicata (Brocchi, Sow.).

There probably does not exist in the kingdom such materials for the study of this species as may be found in the boxes of Messrs. Westmoreland and Hammond, the keepers of the light-house at Hunstanton (March 1863). My largest specimen is 2 inches long and $1\frac{3}{4}$ inch wide.

Kingena lima (Def.).

The largest specimen is $1\frac{1}{8}$ inch long, $\frac{3}{4}$ inch wide, and $\frac{5}{8}$ inch thick. It shows the pustules well; they are distant and arranged in lines of growth. The fossil is not rare, and is perhaps more variable than in any other locality.

Cardiaster suborbicularis (Def.).

Of this fossil, besides the typical form, two very marked varieties occur.

β . In this the length is $1\frac{5}{8}$ inch, and width the same. The outline of the side is more orbicular. The apex is nearer the middle of the shell, and consequently the anterior sulcus is a little longer. The shell is more depressed, and a transverse section is a large curve; so that the sides are more inflated, and there is no apical prominence. It much resembles *C. granulatus*.

γ . The other variety reminds me of *Epiaster gibbus*. The apex is just behind the anterior third of the shell; and from it the upper surface slopes down in every direction, conically. In transverse section the sides make more than a right angle and in

longitudinal section an angle of 130° . It is as wide as long, widest at the anterior third. Posterior side short. Height $1\frac{6}{16}$ inch; length $1\frac{3}{16}$ inch, and as wide. Another example gives $1\frac{1}{16}$ long, and as wide; height $1\frac{1}{16}$ inch. In this latter the apex is more anterior. Having examined about sixty specimens, I believe these three varieties may be traced into each other; but it is necessary to have the means of distinguishing any part of the series.

Salenia (Hyposalenia) Wiltshirii (Seeley).

Round, moderately depressed; disk small and convex; anus protuberant, oval; mouth deeply sunk.

The *disk* is smooth, punctate, graven with short lines, and notched round the circumference.

An *ocular* plate is nearly semicircular, marked on its outer margin by two small notches (one on each side of the ambulacral granules), and separated from the genital plates by deep narrow notches, which are in a line with the interambulacral tubercles and terminate in a large puncture. At the inner apex of the plate, in a line with the ambulacra, is a large puncture, which divides the semicircular margin of the plate into quadrants, each of which is crossed in the middle at right-angles by a short narrow *slit*. The inner halves of these quadrants are again divided by a mesial puncture, which is just as distant from the slit as the puncture on its other side terminating the sutural notch. The transverse slits mentioned are so arranged that they radiate opposite to each other in fives round the genital openings, which are in the centre of the genital plates.

There are six *tubercles* in each of the two interambulacral rows, of which three large ones are on the side and three small ones on the base. The plates of each row are confluent, not being separated by granules; but the rows are separated from each other by a sinuous double row of very large granules, between which appears to be another double row much more minute. There are also a few large granules on the ambulacral border of the plates. The bosses of the tubercles are not greatly larger than these large granules; they are placed on elevated conical bases, the tops of which are crenulate. Ambulacra very narrow and straight, consisting of two rows of twenty dense granules, rather smaller than those between the ambulacra.

Width 1 inch; height $\frac{5}{8}$ inch, height to the margin of disk $1\frac{1}{16}$ inch; width of disk nearly $\frac{3}{4}$ inch.

I have named this beautiful species in honour of the excellent Secretary of the Palæontographical Society, who, in 1859, was the first to make known the fossil wealth of the Red Rock.

Bernericea contracta (Seeley).

This species nearly resembles *B. Clementina* (D'Orb.), of which it is a good variety. It is attached, orbicular, and has the cells arranged like an expanded fan; they are very distinct and narrow, being about twice as long in proportion to their width as in *B. Clementina*, and contract from the point where they first appear to the aperture, which is very small. This tapering character of the cells suffices to distinguish it from all other forms.

Proboscina dilatata (D'Orb.), var.

This fossil is about intermediate between D'Orbigny's figures of *Idmonea dilatata* and *I. virgula*, being nearer to the former. It appears to differ a little, too, in having the mouths more contracted.

Cellulipora sulcata (Seeley).

The form of the colony in this species is similar to that in *C. spongiosa*, with which it is most nearly related. It is similarly composed of undulating bosses and depressions. Each sub-colony is placed on a boss, from which the cells, which are depressed, not very distinct, rather wide, and contracted at the mouth, radiate. The intermediate spaces, which are thus in most cases depressed, and never elevated, are smooth, being formed of abortive cells. *Diastopora Sowerbia* (Lonsd.) belongs to this genus, and is nearly related and may even be this species; but, from the important characters being overlooked in the description and figure, I cannot determine the point.

Reptomulticava.

A form nearly related to *R. collis* and *R. mamilla*, but irregular in growth, twice as high as wide, and twice the size of those species, more resembling D'Orbigny's *Ceripora digitata*. The cells are more dense than in *collis*, and generally separated by walls so thin as to be hexagonal except at the contracted top, where they are distant, round, and protuberant. It is a common fossil, and may be marked *R. favius*.

Chenendopora expansa (Benett), var.

This fossil differs much from Miss Benett's figure, being an elongated cone the cup of which extends nearly to the base; but I have Warminster specimens intermediate between the type and this fossil, which, I suppose, bears to it much the same relation as those lobed varieties of *Hallirhoa* which are united under the specific name *costata* (Lamx.) do to each other.

Scyphia tessellata (Seeley).

In form and general characters this species resembles *S. cri-*

brosa (Phil.) and *S. Zeppei* (Reuss). It is tall, subcylindrical, tapering slightly basewards, more or less irregular, occasionally contracting, sometimes expanding. Ornamented by cell-like apertures, which are nearly square, being higher than wide, arranged in longitudinal lines, and also necessarily forming circles. As it increases in size these longitudinal columns give off at intervals lateral branches, so that the cell does not increase in size very rapidly. At a diameter of $\frac{3}{4}$ inch one example has twenty-eight columns of pores.

Grinding a specimen down, it is seen to be a hollow tube, the walls keeping about an even thickness from base upwards, at a diameter of $\frac{3}{4}$ inch being nearly $\frac{1}{4}$ inch thick. The pores on the outside pass through the walls and open on the inside. Intertubular tissue extremely fine and reticulated. A specimen from Hunstanton bed no. 2 is 4 inches long and nearly an inch and a quarter wide. It is not rare in the Cambridge Greensand.

Edaphodus Huxleyi of my list (Annals, Oct. 1864) is only *E. Sedgwicki* (Ag.). The other new fossils from Hunstanton are eminently Cambridge species, and will appear in the 'Catalogue of Cretaceous Invertebrata in the Woodwardian Museum.'

With these descriptions ends the series of papers in which I have attempted to illustrate the literature, the rock, and the fossils of the Red Limestone of Hunstanton. The considerations on which I have chiefly relied in determining its place among rocks are the following:—To the north of Cambridgeshire, between the Chalk and the Kimmeridge Clay, there are but two formations instead of three. Hunstanton Red Rock and Speeton Clay in Yorkshire, and Hunstanton Red Rock and Carstone in Norfolk, correspond to Greensand, Gault, and Shanklin Sands in Cambridgeshire and the south. The rocks are divided differently, and are clearly the result of two very different series of causes acting in distinct geographical areas. And as the changes of level in which the geological periods terminated were on so grand a scale as to change the rock-making material and to cause the immigration, emigration, and partial extinction of life in what was then the sea of much of Europe, it is almost certain that even this little area of the Wolds must have participated to some extent in such vast heaving undulations. And therefore the Hunstanton Rock, graduating into both of the deposits on which it rests, and into that one (the Chalk) which is over it, is far more likely to have been parted from the beds below by one of those great changes of level which made the Greensand and the Gault than by any independent oscillation, which would have been exactly confined to its own little area. Therefore it follows that the Carstone formation will be the equivalent

of the Speeton Clay*, and either that this latter bed in its newest part represents the Shanklin Sands, while the Red Rock represents the Gault and Upper Greensand, or that the Red Rock is Upper Greensand, and that the upper part of the Speeton Clay is Gault. There is no other alternative. Now, as the Clay deposit was (as is admitted on all hands) continued through the Shanklin-Sands period at Speeton, very much more would it be continued through the Gault period, which was but a return to the geographical conditions of the Kimmeridge Clay. So the Speeton Clay must, in its upper part, be Shanklin Sands and Gault; and the Red Rock can only be Upper Greensand, as its fossils indicated.

I had hoped to give some indications of the subsequent history of these fossil species after they disappeared before the encroaching Chalk; but as soon as may be those remarks will appear, in a lecture given before the Yorkshire Philosophical Society in December 1864, "On the Origin of the Superposition and Sequence of British Strata, and the Laws which have determined the Distribution of Life in Space, through Time, up to actual Nature."

XXI.—*Notulæ Lichenologicæ*. No. III.

By the Rev. W. A. LEIGHTON, B.A., F.L.S.

By the generous liberality of Prof. Santo Garovaglio of Pavia, Italy, I have been favoured with a copy of his 'Tentamen Dispositionis Methodicæ Lichenum in Longobardia nascentium,' 4to, Mediol., 1865. Of this elaborate work only a portion has been as yet published, containing the unilocular and bilocular spored *Verrucariæ*. It is the result of a very comprehensive examination of specimens in a living state and in their native localities, and also of all the published collections since the time of Acharius, as well as of extensive collections in his own herbarium and those of many continental lichenologists. The work is illustrated with five large plates of microscopical details most carefully prepared by his learned coadjutor, Dr. Joseph Gibelli, and is to be accompanied with actual specimens so far as practicable.

The Professor limits his genus *Verrucaria* to those angiocarpous Lichens which have a simple homogeneous nucleus, with a carbonaceous black epithecium and a crustaceous thallus, thus excluding all those whose thallus is foliaceous or squamose, which have been comprised in the genus by the celebrated Dr. W. Nylander and others.

He regards the spore and the number of its cells as furnishing the

* Geological Magazine, No. 12, p. 262, &c.



Seeley, H. G. 1866. "XX.—Notice of Torynocrinus and other new and little-known fossils from the Upper Greensand of Hunstanton, commonly called the Hunstanton Red Rock." *The Annals and magazine of natural history; zoology, botany, and geology* 17, 173–183.

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