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1. *The* CEPHALOPODA-BEDS *of* GLOUCESTER, DORSET, *and* SOMERSET.

By J. BUCKMAN, Esq., F.G.S., F.L.S., late Prof. of Geology and Rural Economy, R. A. Coll. (Read June 21, 1876.)

EVERY student of the geology of the Cotteswolds has recognized a band at the base of the Inferior Oolite under the name of the "Cephalopoda-bed," so named from the important list of Ammonites, *Nautili*, and Belemnites which it has been found to contain.

To quote from Mr. Hull's 'Memoir on the Geology of the Country around Cheltenham,' "This bed had been long known to geologists as 'the ammonite bed;' but the ammonites were supposed characteristic of the Inferior Oolite, and its true importance was overlooked. Dr. Wright, however, found that the species were identical with specimens from the Upper Lias of Whitby, in Yorkshire. About the same time the work of M. D'Orbigny made its appearance, wherein nearly all the cephalopoda from the ammonite bed are figured and described as '*Toarcien*,' or Upper Lias forms, while even in our own district several of the species..... were known to be characteristic of the Upper Lias Shale" (p. 26).

Mr. Hull refers to a paper by Dr. Wright in the 'Proceedings of the Geological Society,' vol. xii., in support of the view that the Cotteswold Cephalopoda-bed belongs to the Upper Lias and not to the Inferior Oolite, and, further, that the learned Doctor had traced it to the Dorsetshire coast; and, indeed, in this very paper we find the following remarks upon sections at Half-Way House and Brad-

ford Abbas, which we quote, as showing that Dr. Wright had at this time identified the Dorset Cephalopoda-bed with the one in Gloucestershire.

"Between Yeovil and Sherborne" *the* "Cephalopoda-bed is well developed and extensively exposed; and at the Halfway House its relations to the Sands below, and the Limestone of the Inferior Oolite above, may be satisfactorily made out. Here it contains a great many large *Ammonites*, *Nautili*, and *Belemnites*,—as

Ammonites dorsetensis, *Wright*.
—— jurensis, *Zieten*.
Nautilus inornatus, *D'Orb*.
Belemnites breviformis, *Voltz*.
—— compressus, *Voltz*.

"*Section* VI.—*At Bradford Abbas, near Yeovil, Dorsetshire.*

"*Inferior Oolite.*

ft. in.

"A. Coarse, hard, brown ragstone, slightly oolitic, very irregularly bedded, and containing few fossils: about..... 2 0

B and C. Absent.

"*Cephalopoda-bed.*

"D. A coarse, brown, oolitic ragstone, composed in part of hard, calcareous, sandy layers, grey and brown, and having softer marly sandy seams running through the rock; it breaks with an uncertain fracture, and sometimes has a flinty hardness: the ragstones are speckled with dark brown flattened oolitic grains of hydrate of iron, and contain many fossils: about..... 2 6"*

It was then clearly Dr. Wright's view (in which he was, indeed, both preceded and followed by other geologists) that the Dorset Cephalopoda-bed was identical with that of Gloucestershire; and indeed we have seen fossils from the Bradford bed just described labelled as from Upper Lias.

Mr. Strickland, in 1850, considered the ironshot oolite of Dundry the equivalent of the Cephalopoda-bed of the Haresfield Hill. He says, "A few miles to the south the Pisolite disappears and is replaced near Painswick and at Haresfield Hill by strata containing ferruginous oolitic grains in a brown paste. This is the precise equivalent of the well-known oolite of Dundry, near Bristol, which may be recognized as far off as Bridport, on the Dorset coast"†.

Now this view was quoted by Dr. Wright in a paper published in the 'Quarterly Journal' for 1860, only to be dissented from; for he says of the above, "a comparison, however, of the species of *Ammonites* and other shells collected in these different localities shows that, besides a similarity in lithological structure, there is nothing in common between the strata"‡; and he accounts for the appearances by supposing that the *Ammonites-Murchisonæ* zone, by thinning out, has brought the zone of *Ammonites Humphresianus* into close relation with the sands of the Upper Lias‡.

* Quart. Journ. Geol. Soc. vol. xii. (1856) p. 309. † *Ibid.* vol. vi. p. 250.
‡ *Ibid.* vol. xvi. p. 18.

As, however, the shells of the 2 feet 6 inches bed, described as the Cephalopoda-bed at Bradford and other places in Dorset, are identical with those at Dundry, and at both Bradford and Dundry it contains with others

Ammonites Parkinsoni, *Sow.* (A. dorsetensis, *Wr.*),
—— Humphresianus, *Sow.*
Ammonites Murchisonæ, *Sow.*
—— jurensis, *Ziet.*

we conclude that the Cephalopoda-beds at Bradford and Dundry are on the same horizon, and, further, that neither the one nor the other has the slightest connexion with the Cephalopoda-bed of Gloucestershire; and if this be so, the fact that the four Ammonites just quoted have been made representatives of four distinct zones, will be a difficult problem to solve for those who implicitly believe in zones.

One of the more recent papers, "On the Correlation of the several subdivisions of the Inferior Oolite in the middle and south of England," is by Dr. Holl, who concludes that the true position of our Dorset and Somerset beds is higher in the series than is stated by the geologists just quoted, and "that they are, in fact, the southern extensions of the Upper and Lower Ragstones of Mr. Hull, the uppermost of which is not represented in the typical section at Leckhampton, having risen above the level of the country, and cropped out before reaching the brow of the hills"*.

We agree with this view, except that we consider the Dorset Cephalopoda-bed the equivalent of the *Gryphite Grit* at Leckhampton, and that the roughly bedded stone above is the representative of the *Trigonia Grit* of Cold Comfort. The constant presence of the same typical Ammonites on the top of Leckhampton hill and in the Bradford Abbas quarries seems to prove this assertion, such as

Ammonites Sowerbyi, *Miller.*
—— Brocchii, *Sow., M.C.*
—— Humphresianus, *Sow., M.C.*
—— Parkinsoni, *Sow., M.C.*
Ammonites concavus, *Sow., M.C.*
—— subradiatus, *Sow., M.C.*
—— Murchisonæ, *Sow., M.C.*

and others.

From this, then, it follows that, while the Gloucestershire Cephalopoda-bed is at the base of the Inferior Oolite or top of the Upper Lias, the Dorset Cephalopoda-bed is near the top of the former; and yet they have not only been confounded the one with the other, but this position has been supported by the *similarity*, not identity, of the Cephalopods, which, indeed, have been held to point to Lias rather than to Oolite.

Dr. Holl's view of the case seems to be, that while we have thus the Upper Ragstones, the lower members of the Inferior Oolite are deemed to be absent; for he says:—

"On the southern side of the Mendips the Inferior Oolite nowhere

* Quart. Journ. Geol. Soc. vol. xix. (1863) p. 307.

exceeds 28 or 30 feet in thickness, of which from 8 to 10 feet belong to the lower subdivision. The upper subdivision immediately underlies the Fuller's Earth; and its light colour, lithological structure, and general poverty in organic remains readily distinguish it from the hard, brown, more or less massive or rubbly limestone beneath, which is everywhere very fossiliferous"*.

Now we take it that, although the learned Dr. Holl is right as regards the position of the Dorset Cephalopoda-bed, he is not so in supposing that the lower members of the Inferior Oolite all thin out in Dorset—our view being that quite 100 feet of the sands, with its occasional bands of shelly oolite, as these occur at Bradford Abbas, really represent the lower oolitic mass of Leckhampton and Crickley, in Gloucestershire; and, in fact, our Dorset sands represent the lower freestones of Gloucestershire.

The connexion between the sands of one place (Babylon Hill) and the building-stones on the same horizon at Ham Hill is shown in the accompanying section (fig. 1).

At Ham Hill the equivalent of the sand-bed at Babylon Hill is a reddish brown freestone, apparently made up of comminuted shells. At Babylon Hill the brown sandy beds present occasional courses of comminuted shelly oolites.

The two sections here placed in juxtaposition (fig. 2) are remarkable for their dissimilarity at first sight; but if the brown sands were a little more indurated (and the presence of a few more shells or a little more lime might well

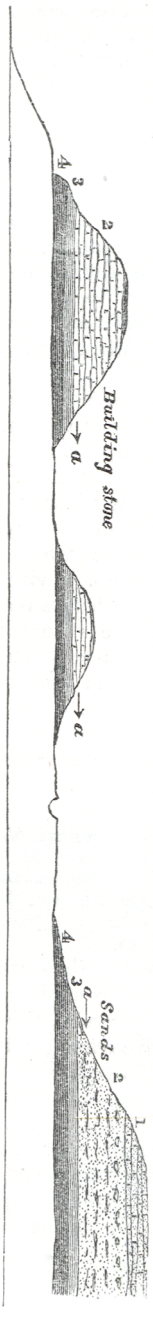


Fig. 1.—*Section from Ham Hill to Babylon Hill.*

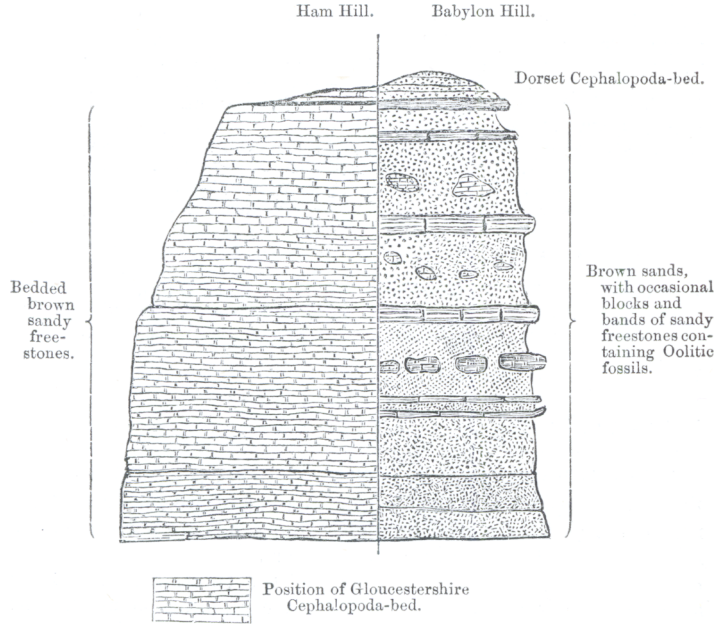
1. Cephalopoda-bed of Dorset.
2. Sands and bands of Oolitic rock at Bradford, building-stones at Ham Hill.
3. Upper Lias.
4. Lias Marls.

a. Position of Cephalopoda-bed of Gloucestershire.

* Quart. Journ. Geol. Soc. vol. xix.

bring that about), there would not be much difference between the Ham-Hill section and several other sections near Sherborne.

Fig. 2.—*Comparative Sections of Beds at Ham Hill and Babylon Hill.*



Ham Hill has always been a puzzle to the geologist; but if we place it on the same horizon as the so-called "Lias Sands" at Bradford, the difficulty is at once cleared up.

Mr. Moore, in his paper "On the Middle and Upper Lias of the South-west of England," speaking of Ham Hill says:—

"The workable freestone at this spot is 58 feet thick, and almost entirely composed of comminuted shells, united by an irony cement, and is a remarkable deposit; for though attaining so considerable a thickness, it does not appear to be represented in any other locality. It has been largely worked for centuries, and yields a very excellent stone, of a light-brown colour, due to the presence of carbonate of iron, an analysis of the deposit proving it to contain 14 per cent of metallic iron" *.

The best Gloucestershire equivalent of this bed is to be seen in the straight wall of rock at Crickley Hill, which latter section we consider the equivalent of the freestone-beds at Ham Hill, and the

* Proceedings of the Somersetshire Archæological and Natural-History Society, vol. xiii. 1865-66.

sands with shelly oolite interpolated in slabs at Bradford Abbas, Babylon Hill, and the adjacent district.

The following list of fossils from the freestone at Ham Hill and the shelly oolites of Dorset can nearly all be matched in the lower beds of the Inferior Oolite of Gloucestershire.

Belemnites compressus, *Blainv.*
—— tricanaliculatus, *Ziet.*
—— subtenuis, *Simps.*
—— abbreviatus, *Mill.*
Nautilus latidorsatus, *D'Orb.*
—— inornatus, *D'Orb.*
Ammonites jurensis, *Ziet.*
—— Moorei, *Lycett.*
—— opalinus, *Rein.*
—— Edouardianus, *D'Orb.*
—— Murchisonæ, *Sow.*
——, other species.
Ostrea bullata, ?
—— Buckmanni, *Lyc.* (?) (Gryphæa).
—— subloba, *Desh.*
—— Marshii, *Sow.*, = flabelloides, *Lam.*
Lima densipunctata, *Röm.* t. 14. f. 3.
—— grandis, *Röm.* t. 13. f. 10.
—— rigida, *Sow.*
Pecten lens, *Sow.*
—— annulatus, *Sow.*
—— discites, *Goldf.*
——, other species.
Gervillia Hartmanni, *Goldf.*
Pinna Hartmanni, *Ziet.*
Avicula complicata, *Buckm.*
Astarte elegans, *Sow.*
—— pullus, *Röm.*
—— obliqua, *Desh.*
——, other species.
Trigonia, costated species.
——, clavellated species.
Lucina bellona, *D'Orb.*
Ceromya (Isocardia) concentrica, *Sow.*
Tancredia donaciformis, *Lyc.*
Spines of Cidarides.
Ossicula of Apiocrinus.
Serpulæ, &c. &c.

Now this list of fossils is sufficient to mark the oolitic nature of these thick beds below the Cephalopoda-bed of Dorset; and if this new reading of the matter be correct, our sands are not the equivalents of the Gloucester sands, or rather the Cotteswold sands, but the representatives of the lower beds of the Inferior Oolite, which at Ham Hill is a good freestone, from containing so much lime, while at Bradford it is hard, in bands consisting of a shelly oolite, with thick beds of sand between, not sufficiently indurated to be used as stone.

If this be so, then it is clear that the name of "Upper Lias Sands" cannot be retained for *these* sand-beds.

The most recently published notion upon the sands is from the pen of Professor Phillips, in which he proposes to name them the "Midford Sands"*, as they were studied by Smith at the village of Midford, and decided by him to be "sands of the Inferior Oolite." If, however, the sands of the west be really of Inferior-Oolite date, they ought not to be correlated with the sands of the Cotteswolds, as these are in a considerably lower position.

Leaving then this question for further consideration presently, we will now more particularly describe the Cephalopoda-bed of Dorset; and in doing this, it will perhaps be well to first give a section of the oolitic rocks in the middle station at Bradford Abbas, premising that the Ammonite-bed is the most constant in the district.

* 'Geology of Oxford,' p. 109.

Section of Bradford-Abbas (East-Hill) Quarry.

	ft.	in.	
1. Soil	0	4	Trigonia Grit of Buckman, Geol. of Cheltenham.
2. White oolite with irregular cleavage	6	0	
3. Band of marl, with *Astarte* and *Lima, Belemnites*, &c.	0	3	Cephalopoda - bed = Gryphite Grit of Buckman.
4. Hard ironshot rock, with *Ammonites, Belemnites*, &c.	1	0	
5. Band of brownish stone, marly at top, full of Univalves and *Ammonites*	0	6	
6. Ironshot oolite, a mass of Cephalopods	1	0	
7. Marl with *Astarte trigonalis*	0	3	
8. Bed with *A. aalensis*	0	9	
9. Blue-centred oolite, with *Isocardia concentrica*.	1	2	

10. Reddish sands, commencing the lower freestone system of the Cotteswolds.

How far the term Cephalopoda-bed for the fossiliferous portion of this section may be justified will at once be seen from the following list of the family of fossils after which it has been named, the whole of which have been found at Bradford Abbas, or the equivalent bed near Sherborne.

List of Cephalopoda from the Dorset equivalent of the "Gryphite Grit."

Belemnites compressus, *Blainv.*
—— ellipticus, *Miller.*
—— giganteus, *Phill.*
—— abbreviatus, *Sow.*
—— canaliculatus, *Schl.*
—— Blainvillii, *Voltz.*
—— terminalis, *Phill.*
—— anomalus, *Phill.*
—— sulcatus, *Mill.*
Ammonites Truelli, *D'Orb.*
—— subradiatus, *Sow.*
—— læviusculus, *Sow.*
—— Murchisonæ, *Sow.*
—— Sowerbyi, *Miller.*
—— cadomensis, *D'Orb.*
—— Parkinsoni, *Sow.*, including A. niortensis, *D'Orb.*, and A. dorsetensis, *Wright.*
Ammonites Garantianus, *D'Orb.*
—— polymorphus, *D'Orb.*
—— Martinsii, *D'Orb.*
—— ooliticus, *D'Orb.*
—— Eudesianus, *D'Orb.*
—— zigzag, *D'Orb.*
—— Tessonianus, *D'Orb.*
—— Edouardianus, *D'Orb.*
—— discus, *Sow.*
—— Blagdeni, *Sow.*
—— Humphresianus, *Sow.*
—— Braikenridgii, *Sow.*
—— linguiferus, *D'Orb.*
—— Brongniartii, *Sow.*
—— Kaumontii, *D'Orb.*
—— Sauzei, *D'Orb.*
—— Gervillii, *Sow.*
—— dimorphus, *D'Orb.*

and others, with some undescribed forms.

Ancyloceras annulatum, *D'Orb.*
—— bispinatum, *D'Orb.*
Ancyloceras subannulatum, *D'Orb.*

(From D'Orbigny's Lias list.)

Nautilus latidorsatus, *D'Orb.*
—— striatus, *Sow.*
—— semistriatus, *D'Orb.*
—— inornatus, *D'Orb.*
—— truncatus, *Sow.*
—— excavatus, *Sow.*
—— lineatus, *Sow.*
—— sinuatus, *Sow.*
—— clausus, *Sow.*
Ammonites candidus, *D'Orb.*, aalensis, *Ziet.*
—— cornucopia, *Young.*
—— jurensis, *Ziet.*
—— Germainii, *D'Orb.*
—— insignis, *Schubler.*
—— variabilis, *D'Orb.*
—— concavus, *Sow.*
—— torulosus, *D'Orb.*

and others.

Here then we have designedly tabulated about sixty species of Cephalopoda from D'Orbigny's 'Paléontologie Française, Terrains Jurassiques,' as this author has referred fully one quarter of the species to the Lias. It is an extraordinary list (even though not yet fully made out) for about two feet of rock.

If we inquire how it is that so many of the species have been allocated to the Lias, we shall find that *some* few of them have undoubtedly ascended upwards from the lower stratum; but most of them have been called Liassic upon the assumption that our Bradford Cephalopoda-bed and our sands were the equivalents of those beds in Gloucestershire, and both supposed of Lias age. This we know, not only from references by D'Orbigny himself, but also from having seen fossils from my own quarry of the age of the Gryphite Grit labelled as from "the Upper Lias."

From all this it appears evident that while some English geologists have confounded two beds fully 100 feet apart, and made their lists of fossils harmonize with this view, both some foreign and home savans (taking, be it observed, these two beds to be one) have, in the same way, made them to harmonize with the Upper Lias of the Continent.

Now I have not had the pleasure of a personal examination of foreign oolites, but I can plainly see that they have been interrogated to support theories no less than have those at home; and I can well believe that if they at all harmonize with our Dorset strata, foreigners, like ourselves, may have confounded two beds widely apart.

That they do so harmonize we are strongly inclined to believe from D'Orbigny's drawings of Cephalopoda, as in Dorset we have not only a large number of species referred for the first time to our home rocks, but they are for the most part in a fine state of preservation—so much so, that the terminations of the Ammonites have in many cases been clearly made out.

It may be further remarked upon this list of Cephalopods, that although the bed in which they occur has been made out over a wide district, and in all cases it preserves its peculiar character, yet it differs at various points as to the prevalence of species.

Thus at Bradford Abbas the *Ammonites subradiatus* prevails. At Babylon Hill the *A. Murchisonæ* is more common, while midway the *A. Sowerbii* takes the lead. At Halfway House the *A. Parkinsoni* is the characteristic fossil for a part of the quarry, and the *A. subradiatus* for another part. Further to the east, at Sherborne, the *A. Humphresianus* assumes importance; whilst at Clatcombe, a mile from there, the *A. Braikenridgii* is not only a common but a most perfect fossil.

Now if it be assumed that this Cephalopoda-bed at these different points occupies a different horizon, of course we can recognize them as different zones, and name them after their prevailing Ammonites; but it is not so; and it is a remarkable fact that from 2 to 3 feet of the oolite rock in a limited area should present not only so great a crowd of individuals but such a variation in species.

We have hitherto confined our attention to the Cephalopods; but the Gasteropods tell the same tale. In the Bradford-Abbas quarry alone have been found as many as fifty species of univalves, many of which belong to the Cotteswolds*. There is, however, a large array of new forms in the genera *Pleurotomaria*, *Chemnitzia*, *Turbo*, *Trochus*, *Natica* and *Solarium*; and others abound.

These, like the Ammonites, are in a wonderful state of preservation.

The Brachiopoda are not so numerous as in the Cotteswold district; still the forms met with in the Cephalopoda-bed point also to the high position it occupies in the Inferior Oolite; such are

Terebratula Phillipsii, *Mor. & Dav.*
—— perovalis, *Sow.*, and var. ampla, *Buckm.*
—— Buckmanni, *Dav.*
Terebratula sphæroidalis, *Sow.*
Rhynchonella spinosa, *Schl.*
—— media, *Sow.*
and others †.

And others abound.

The Conchifera afford a list for our limited area as large as is to be met with in the whole of the Cotteswolds, numbering over 150 species. Amongst them the following genera—*Trigonia*, *Lima*, *Pecten*, *Cucullæa*, *Modiola*, *Perna*, *Cardium*, *Astarte*, and others, present a most interesting assemblage of forms.

Neither the *Echinodermata* nor the *Zoophyta* present the same number of species as the Cotteswolds; but in places a few species occur abundantly.

Taken then as a whole, we may conclude that the Dorset Cephalopoda-bed is one of the richest deposits in the country, although as yet we cannot pretend to have exhausted or to have made out all its treasures; but it would seem that within this thin stratum are stored up most of the important forms which make up the mass of the Cotteswold fauna.

It would appear, indeed, that out of about 250 species of shells tabulated by myself in the second edition of Murchison's 'Geology of Cheltenham,' fully 200 belong to the Cephalopoda-bed of Dorset; whilst in this latter county are found many specimens of which the Cotteswolds cannot boast, most of which, so far as the Cephalopoda and Gasteropoda are concerned, are figured in D'Orbigny's 'Terrains Jurassiques.'

* These have since been increased to nearly 100 species.

† Since the above was written the Brachiopoda from the district have been sent to Mr. Davidson, and he has made out nearly 30 species.