tioned as the "*Dioplodon* of Hemixem" in a notice published by M. Van Beneden in the tenth volume of the second series of the 'Bulletin.' On referring to the page of that volume cited, I find, unfortunately, no statement of the distinctive characters of the *Ziphirostrum*; and the description of *Placocetus* also is not yet published.

EXPLANATION OF PLATE XIX.

Rostrum of *Belemnoziphius compressus*, one-third the natural size, viewed—A, laterally; B, from below; C, from above; D, the anterior fractured end.

JUNE 8, 1864.

Christopher Oakley, Esq., 10 Waterloo Place, Pall Mall, S.W.; George Edward Roberts, Esq., Geological Society, Somerset House, W.C., and 7 Caversham Road Villas, N.W.; and The Rev. Henry W. Watson, M.A., Harrow, were elected Fellows.

The following communications were read:—

1. *On the* RHÆTIC BEDS *and* WHITE LIAS *of* WESTERN *and* CENTRAL SOMERSET; *and on the* DISCOVERY *of a new* FOSSIL MAMMAL *in the* GREY MARLSTONES *beneath the* BONE-BED. By W. BOYD DAWKINS, Esq., B.A. (Oxon), F.G.S., of the Geological Survey of Great Britain.

CONTENTS.

PART I. *On the* RHÆTIC BEDS *and* WHITE LIAS *of* WESTERN *and* CENTRAL SOMERSET.

§ I. *Introduction.*

IN the year 1861 I spent some time in examining the interval between the Red Marls and the Upper Lias in Central and Western

Somerset, taking, in the course of my examination, upwards of seventy sections. The results of this exploration, so far as relates to the Rhætic beds and the White Lias, are embodied in the following paper.

The suites of fossils collected, and numbered on the spot, have been examined by my friend Mr. Etheridge, F.G.S., without whose able assistance and corrections I should have felt diffident in my own determination of the Invertebrata.

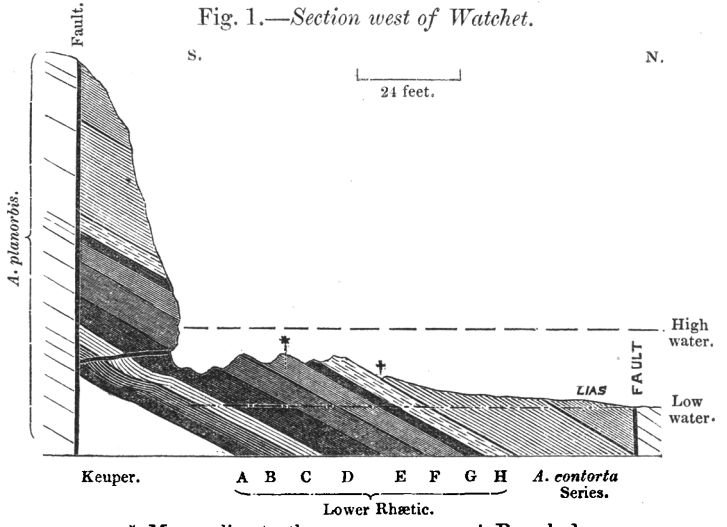
§ II. *Description of the Sections.*

1. *West of Watchet.*—The sea-shore in the neighbourhood of Watchet, in West Somerset, affords perhaps one of the very best sections in England of the beds between the Red Marls and the zone of *Ammonites Bucklandi*. In the high cliffs the relations of the Gypsiferous and Red and Grey Marls are clearly shown. Seawards, the Rhætic beds, and the limestones of the zones of *Ammonites planorbis* and *A. Bucklandi*—here forming saddles, or with but gentle dip, there vertical and standing up like tombstones—afford suites of fossils remarkable for their beauty and their numbers. Immediately to the west of Watchet Harbour, the Watchet Fault appears, throwing down the Lias to the south, and causing the *Ammonites planorbis* shales, having a dip of 45° N.N.E., to abut against the Red Marls, which dip 25° S.S.W. Thence the fault runs nearly parallel to the coast-line, disappearing in the sea—westward at Blue Anchor, eastward in the Bay of Donniford. To the north of this, and near low-water mark, is a second, running parallel to the first, and throwing down the shales with *A. planorbis* to the north. Between these two faults lie the sections which I am about to describe—the one to the west, the other to the east of Watchet.

Immediately to the south of the *Ammonites planorbis* shales, on reaching the eastern side of the point that divides the small Blue Anchor Bay from that of Watchet, is a series of Red and Grey Marls, with a dip of 13° to the north, increasing westwards to 30°. The lowest of these, at the base of the cliff, is a soft slate-coloured marl (A), passing into black at the bottom: 4 feet. Above this are some dark-grey and black slaty beds (B), with layers of black shale, and highly charged with flesh-coloured gypsum, besides containing a little of the white fibrous variety: 4 feet. Then occurs a dark slate-coloured homogeneous marlstone (C), 4 feet thick, with a little flesh-coloured gypsum. The latter is deposited in the fissures, and, from their obliquity in some places, it gives the appearance of "false bedding." It occurs also in the true bedding. Above this is a coal-black shale (D), presenting a marked feature in the section, and containing gypsum: 10 feet. This is overlain by gypseous grey sandy marls (E), much indurated: 10 feet. Up to this point I was unable to detect the least fragment of any organism. In the grey, ripple-marked, fissile, sandy marlstones, 6 feet in thickness (F), immediately above, organic remains were very abundant. The Annelida are represented by very numerous holes and tracks; of the Mollusca, the Bivalves by *Modiola minima*, *Pecten Valoniensis*, *Myacites*

striatogranulata, *Gervillia præcursor*, *Pullastra arenicola*, and *Cardium Rhæticum*, the Univalves by a cast of a *Chemnitzia* or *Turritella*,

Fig. 1.—*Section west of Watchet.*



* Mammalian tooth. † Bone-bed.

the Cephalopoda by the fragmentary pen of a dibranchiate octopod closely allied to the Liassic *Belotеuthis* (Münst.) or *Geoteuthis* (Münst.); of the Fishes, the Ganoids by *Saurichthys apicalis*, *Gyrolepis Alberti*, and *G. tenuistriatus*, the Sharks by *Acrodus minimus*; *Sargodon Tomicus* was also found. Two rolled fragments of large bones, of dense texture, indicate the presence of the Reptilia; while one crushed and hollow bone, in fineness of texture, polish of surface, and thinness of walls, reminds me of the Pterodactylian wing-bones of the Stonesfield slate. And lastly—to pass over the long branching casts, probably of Fucoids, and the fragments of fossil wood—the Mammalia are represented by a small animal closely allied to the Kangaroo-rat, which I purpose to describe in Part II. of this paper under the name of *Hypsiprymnopsis Rhæticus*. These beds are overlain by 2 feet of soft grey shaly (G) marlstone, without fossils. Above this again are 6 feet of a greenish-grey sandy fissile marlstone (H), containing numerous casts of Fucoids and trails of Annelids, with *Pullastra arenicola*, *Acrodus minimus*, *Gyrolepis tenuistriatus*, and *G. Alberti*. In this, as in the fossiliferous bed below, the ripple-marks indicate a littoral condition of deposit; and the surfaces of the beds into which the stone splits are traversed by irregular cracks from exposure (as it seems to me) to the heat of the sun. These were in many cases filled up with organic remains. Upon the water-worn upper surface are superimposed the limestones, sandstones, and shales of the *Avicula contorta* series, of which the following is a detailed section.

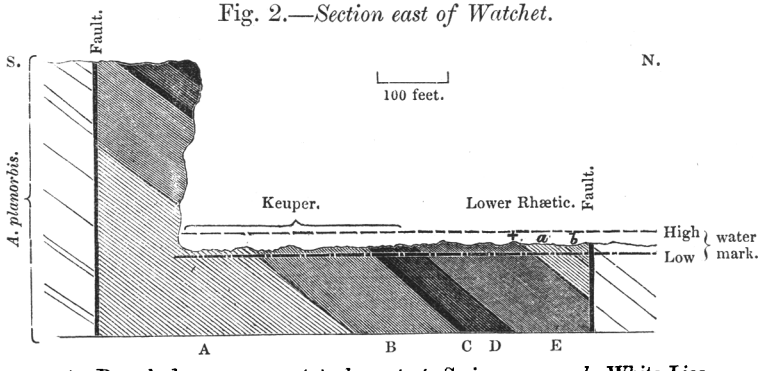
Section of Rhætic Beds to the West of Watchet.

No.	Thickness.	Description.	Fossils.
	Inches.		
1.	1	A thin film of conglomerate, composed of the pebbles of the rock below, and full of fossils.	*Desmacanthus cloacinus.* *Saurichthys apicalis.* *Acrodus minimus.* *Acrodus acutus.* *Gyrolepis Alberti.* *Gyrolepis tenuistriatus.* *Avicula contorta.* *Cardinia?* *Anatina?*
2.	24	Greenish-grey indurated sandy marl, full of *Avicula contorta*, passing imperceptibly into the bone-bed.	Remains the same as No. 1, with the exception of the *Desmacanthus cloacinus* and the equivocal *Cardinia*.
3.	1	Hard, compact, grey limestone.	Fragments of shells. *Acrodus minimus.* *Acrodus acutus.*
4.	9	Black shale, containing nodules.	
5.		Compact grey micaceous sandstones.	*Axinus cloacinus.* *Axinus elongatus.* *Anatina præcursor.* *Pleurophorus elongatus.* *Cardium Rhæticum.* *Chemnitzia Henrici.*
6.		Indurated grey marl.	
7.		Dark micaceous sandstone.	*Acrodus minimus.* *Acrodus acutus.* *Gyrolepis Alberti.* *Gyrolepis tenuistriatus.*
8.		Dark shale.	
9.		Limestone full of Shells: compact, dark, earthy, micaceous inferiorly.	*Avicula contorta.* *Axinus elongatus.* *Pleurophorus elongatus.*
10.	1	Black shale.	
11.	2	Grey limestone full of Shells, which occur in nests, very hard, and traversed with cracks filled with carbonate of lime.	Composed in great part of *Avicula contorta.* *Axinus cloacinus.* *Cylindrites elongatus.*
12.		Dark shale with calcareous nodules.	*Hybodus.*
13.	12	Earthy and sandy limestone, nodular, irregular, and micaceous.	
14.		Shale.	
15.	6	Hard, ripple-marked blue limestone, full of cracks filled with carbonate of lime, divided into irregular laminæ by shale.	*Pullastra arenicola.* *Axinus cloacinus.*
16.	24	Dark shale.	
17.	6	Hard, irregularly bedded micaceous and calcareous sandstone, pyritous, ripple-marked.	*Hybodus.* *Acrodus minimus.* *Acrodus acutus.* *Gyrolepis Alberti.* *Gyrolepis tenuistriatus.* *Avicula contorta.* Hollow Pterodactylian bone.
18.	18	Dark shale.	
19.		Dark shelly limestone, with layers of fibrous carbonate of lime.	

From this point upwards to the fault, the beds are so dislocated that I was unable to determine their true sequence.

2. *East of Watchet.*—The second section, about a quarter of a mile to the east of Watchet Harbour, between high- and low-water marks, shows the higher beds, which I failed to make out to the west.

Fig. 2.—*Section east of Watchet.*



+. Bone-bed. *a. Avicula contorta* Series. *b.* White Lias.

	Thickness, feet.	
A.	70	At the base of the cliffs, and with a dip of 35° to the north, decreasing further eastwards to 15° or 20°; it is a deep-red marl with but few bands and spots of grey. In Watchet Harbour and Donniford Bay it abuts against the *Ammonites planorbis* shales that have been thrown down to the south.
B.	84	A series of red and grey marls. The former predominate; the latter are very much indurated.
C.	1	Black shale.
D.	30	Grey and red marls in nearly equal proportions.
E.	84	Grey indurated marlstones and black shales, with but two or three faint bands of red.

The latter of these, representing the fossiliferous beds F and H of fig. 1, yielded no fossils, perhaps from my being unable to devote so much time to its examination as in the former case. But its barrenness was amply compensated for by the richness of the strata above the bone-bed.

Section of Rhætic Beds and White Lias to the East of Watchet.

No.	Thickness.	Description.	Fossils.
	Inches.		
1.	1–2	Bone-bed—a thin film of conglomerate deposited upon the water-worn surface of a greenish-grey sandy marlstone, pebbles of which are included in it.	*Acrodus minimus.* *Acrodus acutus.* *Gyrolepis Alberti.* *Gyrolepis tenuistriatus.* *Avicula contorta.*
2.	24	Sandy marl, passing into shale in its upper part.	Organic remains the same as 1.
3.	1–2	Shelly limestone, somewhat irregular.	*Pleurophorus elongatus.*

No.	Thickness.	Description.	Fossils.
	Inches.		
4.	6	Black shale.	
5.	4	Black muddy incoherent sandstone, ripple-marked, pyritous.	
6.	6	Black shale.	
7.	2	Limestone, with layers of fibrous carbonate of lime, hard, dark, pyritous, sandy.	
8.	6	Black shale.	
9.	1	Shelly limestone.	*A. contorta.* *Pleurophorus.*
10.	40	Black shale, containing nodules and calcareous seams.	
11.	3–4	Irregular shelly limestone.	*Avicula contorta.* *Modiola minima.*
12.		Black shale.	
13.	20	Six thin layers of arenaceous limestone, ripple-marked, micaceous, sandy, with layers of fibrous carbonate of lime.	*Avicula contorta.* *Pullastra arenicola.* *Pleurophorus elongatus.*
14.	2–3	Bone-bed, sandy, with quartz-pebbles and limestone-nodules. On tracing it, I found that it passed into an impure micaceous limestone.	*Acrodus minimus.* *Acrodus acutus.* *Gyrolepis Alberti.* *Gyrolepis tenuistriatus.* *Axinus elongatus.* *Axinus depressus.*
15.		Black shale.	
16.	2–3	Bone-bed—a hard sandy limestone.	*Saurichthys apicalis.* *Saurichthys acuminatus.* *Sargodon Tomicus.* *Hybodus minor.* *Gyrolepis Alberti.* *Gyrolepis tenuistriatus.* *Acrodus minimus.* *Acrodus acutus.* *Lepidotus.* *Squaloraia.* *Pullastra arenicola.* *Myophoria postera.* *Axinus cloacinus.*
17.		Black shale.	
18.	1–2	*Pleurophorus* limestone.	*Pleurophorus angulatus.* *Pteromya Crowcombeia.* *Cardium Rhæticum.* *Chemnitzia nitida.*
19.		Black shale.	
20.	1–2	Earthy micaceous limestone, composed in great part of *Cardium Rhæticum.*	*Hybodus plicatilis.* *Hybodus pyramidalis.* *Avicula contorta.* *Avicula solitaria?* *Myophoria postera.* *Pleurophorus elongatus.* *Anatina Suessi.* *Cypricardia suevica.* *Cardium Rhæticum.* *Trigonia curvirostris.* *Pecten Rhæticus.*

No.	Thickness.	Description.	Fossils.
	Inches.		
21.	3–6	Dark shale, with comminuted Shells.	
22.		Earthy limestone, dark and irregular.	
23.		Dark shale, with shelly layers.	*Lima præcursor.* *Modiola minima.* *Avicula contorta.*
24.	24	Pecten-bed—dark earthy limestone, irregularly bedded, and containing irregular layers of fibrous carbonate of lime.	*Avicula contorta.* *Pecten Valoniensis.* *Placunopsis alpina.*
25.		Black shale.	
26.	3–4	Pecten-bed, passing into compact limestone.	*Avicula contorta.* *Pecten Valoniensis.* *Cardium Rhæticum.*
27.	24	Black shale.	
28.	24	Earthy limestone, black, with layers of fibrous carbonate of lime, capped with a fine earthy sandstone, ripple-marked, and containing Devonian pebbles.	*Pleurophorus elongatus.* *Pleurophorus angulatus.* *Axinus cloacinus.* *Pecten Valoniensis.* *Chemnitzia?* *Chemnitzia Henrici.*
29.		Black shale.	
30.	8	Hard blue limestone.	
31.	36	Dark shale, with nodules.	
32.	6	Two beds of grey lias.	
33.	4	Indurated shale.	
34.	8	Two beds of grey lias.	
35.	12	Shale.	
36.	13	Three beds of compact bluish-grey limestone.	
37.		Shale, with nodules.	
38.	9	Grey lias.	
39.		Shale.	
40.	7	Grey lias.	*Lima pectinoides.*
41.		Five beds of grey lias, alternating with dark shales.	

From this point to the fault the beds are too much disturbed to admit of any accurate determination. Those ranging from 32 to 41, inclusive, contrast strongly with the arenaceous beds below, in their poverty of organic remains, in the purity of the limestone, and the absence of sandstone. There can be little doubt that they represent the White Lias, the relative position of which they occupy, and to which they are lithologically allied.

3. *Coast to River Parrett.*—Along the coast further to the east the *Avicula contorta* series is exposed in the cliff at St. Audries, and yields *Acrodus minimus*, *A. acutus*, *Cardium Rhæticum*, and *Avicula contorta*. From this point to the mouth of the Parrett, though faults are very numerous, there are no good Rhætic sections exposed.

4. *Outliers of Wedmore and Pen Knowle.*—On the north-east side of the great triangular Liassic outlier of Wedmore we again meet

with the series, of which the deep sunken road, "Snake Lane," leading from Pamborough to Wedmore, affords an excellent section.

Section at Snake Lane.

	Thickness, inches.
A. Deep-red marls.	
B. Grey marls.	
C. Fine-grained friable grey marlstone.	
1. Grey shale "race"	48
2. Dark shale "race"	48
3. A hard shelly limestone of five or six irregular beds: "Wedmore stone"—*Avicula contorta*	36
4. Grey-ferruginous and dark marls, sandy at the top, and highly charged with carbonaceous matter	48
5. Compact blue limestone—*Cardium Rhæticum*, *Acrodus minimus*	4
6. Grey marl	6
7. Compact grey limestone	3
8. Grey marl	5
9. Compact grey micaceous limestone	1
10. Dark and ferruginous shale, passing into a sandy, micaceous, laminated marl	48
11. Irregularly bedded sandstone—*Acrodus minimus*	14
12. Iron-grey and ferruginous marls	?

At this point the section is obscured; but at a distance of a few yards, in a field, the White Lias presents the following section:—

	Thickness, inches.
1. Hard pinkish-grey compact lias, irregular at the top (old sea-bottom)	5
2. Marly grey lias, soft and irregular: *Modiola minima*, *Cardium Rhæticum*, *Serpulæ*, *Lima* (sp.), *Ostrea interstriata*	5
3. Two beds of compact limestone, blue inside, grey on exposed faces of joints: *Ostrea liassica*, *Modiola minima*, *Cardium Rhæticum*, *Astræa*	9
4. Irregular grey marly stone, with *Modiola minima* and *Cardium Rhæticum*	?
5. Hard grey lias	7
6. Grey lias, hard and compact	2
7. Light grey marly stone	36

The slight dip of the beds to the south-west, coupled with the few yards intervening between the two sections, proves that there is a very small gap between them.

Further to the west, between Sand and Wedmore, the *Avicula contorta* series, which is nearly horizontal, forms a spread; and the hard crystalline Wedmore Limestone is dug in the fields for road-material and building-purposes. Near Sand, and close to the windmill, the limestone, 3 feet in thickness, passes below into a greenish calcareous shale, full of *Avicula contorta*. It contains vertebræ of an undetermined Fish, and remains of *Acrodus minimus*, *A. acutus*, *Sargodon Tomicus*, *Saurichthys apicalis*, *Cardium Rhæticum*, and *Avicula contorta*, and rests upon a dark clay, as in Snake Lane. At the base of the southern scarp, also, near Mudgely, the beds are seen with the usual fossils.

To the east, near Wells, the summit of the small outlier of Pen Knowle is composed of White Lias. In exploring, in 1862, some of those equivocal remains of doubtful origin, use, and antiquity, which are usually termed "hut-circles," I exposed a section of the

White Lias some 8 feet in depth. It yielded the usual fossils, namely, *Modiola minima*, *Cardium Rhæticum*, and *Montlivaltia*. Among the débris thrown out from one "hut-circle" were fragments of the "bone-bed"—a quartz-conglomerate containing *Gyrolepis Alberti* and *Acrodus minimus*, which proved that the unknown quarrymen had passed some 16 or 20 feet into the *Avicula contorta* beds below. There can be no doubt in this case, as in the previous section at Snake Lane, that the White Lias rests immediately upon the Rhætic beds, without any trace of the *Ammonites-planorbis*-bearing rocks, or Saurian beds.

5. *Poulden Hills, Turn Hill, Langport, Hatch.*—Throughout the whole southern scarp of the Poulden Hills, from Dunball on the west, where there is a good section in the railway-cutting, past Moorlinch and Greinton, the White Lias is seen resting immediately on the *Avicula contorta* beds, the grey and variegated marls forming the lower two-thirds of the ancient Post-pliocene sea-cliff. Thence, after passing up the river Carey as far as Charlton Mackarel, and being brought up by a fault among the *Ammonites planorbis* shales near King Weston, it caps the promontory of Turn Hill, and forms a considerable portion of the Liassic spread from High Ham to Langport.

The ascent of Turn Hill presents a section which may be considered representative of the beds in the Vale of Bridgewater.

Section at Turn Hill.

	Feet.
A. Red marl	
B. Red and grey marls, red predominating	62
C. Alternations of red and grey marls, the grey predominating	20
D. Alternations of grey and black marls, with a few faint bands of red	20 ?

The section is here obscured by the detritus of the soft Lower *Avicula-contorta* shales.

	Thickness, feet.	inches.
1. Hard shelly limestone, like Wedmore stone, with *A. contorta*		
2. Grey marly shale	0	6
3. Hard grey lias	0	6
4. Grey marly shale	0	3
5. Grey lias	0	5
6. Grey marly shale	0	4
7. Grey lias	0	3
8. Grey marly shale	0	8
9. Four layers of grey lias	1	9
10. Grey shale	1	8
11. Grey lias	0	6
12. Grey shale	2	0
13. Bluish lias	0	8
14. Grey shale	2	0
15. Blue lias	0	8
16. Shale	0	?

The beds from 3 to 12 inclusive yielded the usual fossils of the White Lias, namely, *Modiola Hillana* (juv.), *M. minima*, *Cardium Rhæticum*, *Montlivaltia*, and *Ostrea interstriata*, together with an

Avicula and a *Pecten*. The three upper beds I consider to belong to the base of the zone of *Ammonites planorbis*, which, in a quarry at a short distance from the top of the scarp, yields *Ostrea liassica* and a small species of *Avicula*, and contrasts with the White Lias in the dark colour of its beds. The grey marls and black shales of C, non-gypsiferous in this section, are highly charged with both the varieties of gypsum a little distance to the north; and a gentleman of greater enterprise than prudence, imagining that it occurred in a vertical vein, spent £800 in discovering that it runs parallel with the bedding underneath his neighbour's land.

From Langport the *Avicula contorta* zone sweeps southward past Red Hill, as far as Hatch Park. Mr. Charles Moore, in his valuable paper on the Rhætic beds of Somerset, has taken away the need of my speaking of its occurrence at Beer Crowcombe and North Curry. To the extreme accuracy of his sections of the White Lias of Stoke, St. May, and Long Sutton, I can bear testimony. No. 3 of his section* at the latter place yielded the only *Pleurophorus* obtained from these beds.

6. *Summary of Sections.*—A comparison of the Rhætic sections, given above, with those of Dr. Wright† and Mr. Charles Moore, shows that, lithologically, hardly any two agree. Sometimes the calcareous element is wanting, as at North Curry; at others it is greatly developed, as at Watchet, where the thin beds of limestone split up the thick bed of marly shale which generally intervenes between the "Pecten-beds" and the "bone-bed." Sometimes the sandstones are absent (Bath Easton) or, as is more usually the case, are very well represented. This irregularity seems to me to indicate a deposit off-shore in comparatively shallow water, affected considerably by currents. The White Lias, on the contrary, appears to have been deposited in a sea of considerable though, as proved by its varying thickness, of variable depth, and out of the reach of litoral influences. In common with the Lower Lias series it contains no arenaceous beds; as compared with the beds below it, it is remarkable for the development of its white, pinkish, and grey limestones.

The sections taken to the east of Watchet, and at Turn Hill, that at Saltford given by Dr. Wright, and those of Mr. Charles Moore, prove beyond all doubt the true position of the White Lias—below the Saurian zone of the *Ammonites planorbis* group, and immediately above the *Avicula contorta* series.

§ III. *Palæontology.*

In the preceding sections I have paid particular attention to each Rhætic bed, to see whether, as on the Continent, well-defined zones of life are traceable. The following table, showing the range of each species, as far as the *A. planorbis* zone, is the result of the endeavour. It is by no means an exhaustive list, and represents merely the fossils that I have found myself.

* Quart. Journ. Geol. Soc. vol. xvii. p. 491.
† *Ibid.* vol. xvi. pp. 378 *et seq.*

1. *Range of Fossils of Rhætic Beds and White Lias.*

Name.	Grey marls beneath Bone-bed fig. 1.	*Avicula contorta* zone, W. Watchet.	*Avicula contorta* zone, E. Watchet.	White Lias.	*Ammonites planorbis* zone.
Hypsiprymnopsis Rhæticus, *Dawkins* ...	F				
Pterodactylus ...	F	17	16		
Acrodus minimus, *Ag.* ...	F H	1–17	1–16		
Acrodus acutus, *Ag.* ...	...	1–17	1–16		
Acrodus striatus ...	...	...	16		
Hybodus plicatilis, *Ag.* ...	...	...	20		
Hybodus pyramidalis, *Ag.* ...	...	...	20		
Gyrolepis Alberti, *Ag.* ...	F H	1–17	1–16		
Gyrolepis tenuistriatus, *Ag.* ...	F H	1–17	1–16		
Sargodon Tomicus, *Plien.* ...	F	1	16		
Saurichthys acuminatus, *Ag.* ...	...	...	16		
Saurichthys apicalis, *Ag.* ...	F	1	16		
Squaloraia, *Ag.* ...	...	...	16		
Desmacanthus cloacinus, *Quenst.* .	...	1			
Belo- (Geo- ?) teuthis, sp. ...	F				
Chemnitzia nitida, *Moore* ...	...	...	18		
Chemnitzia Henrici, *Moore* ...	...	5	28		
Cylindrites elongatus, *Martin* ...	...	11	28		
Axinus cloacinus, *Op. & S.* ...	...	5–15	16–28		
Axinus elongatus, *Moore*... ...	...	5–9	14		
Axinus depressus, *Moore*...	...	...	14		
Anatina Suessi, *Op.* ...	...	...	20		
Anatina præcursor, *Quenst.* ...	...	5			
Pleurophorus, sp. ...	...	...	...	Long Sutton.	
Pleurophorus elongatus, *Moore*...	...	5–9	3–28		
Pleurophorus angulatus, *Moore*...	...	...	18–28		
Myophoria postera, *Quenst.* ...	...	...	16–20		
Pteromya Crowcombeia, *Moore* ...	...	...	18		
Avicula contorta, *Portl.* ...	...	1–17	1–24		
Avicula solitaria (?), *Moore* ...	...	...	20		
Lima præcursor, *Quenst.* ...	...	...	23		
Lima pectinoides, *Sow.* ...	...	...	...	Watchet.	Sharpham.
Modiola minima, *Sow.* ...	F	...	11–23	Turn Hill, &c.	Street.
Modiola Hillana, *Sow.* ...	...	...	...	Turn Hill.	Butleigh.
Placunopsis alpina, *Winkl.* ...	...	...	24		
Ostrea liassica, *Strickl.* ...	...	...	...	Snake Lane.	Street.
Ostrea interstriata, *Emmerich* ...	...	...	...	Turn Hill.	
Gervillia præcursor, *Quenst.* ...	F				
Pecten Valoniensis, *Defr.* ...	F				
Pecten Rhæticus, *Quenst.* ...	...	...	24–26		
Trigonia curvirostris, *Quenst.*...	..	...	20		
Cypricardia suevica, *Oppel*...	...	...	20		
Cardium Rhæticum, *Merian* ...	F	...	18–26	Turn Hill, &c.	
Pullastra arenicola, *Strickl.* ...	F H	15	13–16		
Myacites striatogranulata, *Moore*.	F				
Annelidan tracks ...	F H				
Serpulæ ...	...	...	...	Snake Lane.	
Astræa ...	...	...	...	Snake Lane.	
Montlivaltia ...	...	...	...	Turn Hill, &c.	

2. *Palæontological Relations of the White Lias to the Beds above and below.*—If I have failed to make out distinct zones of Rhætic life, yet the preceding table throws great light upon the mutual relations of the beds, and especially with regard to the White Lias. Of the Fishes so abundant below, not one passes upwards; of the Saurians of the *Ammonites planorbis* group above, not one passes downwards. It has yielded, so far as I know, neither Vertebrates nor Ammonites*. Of its Mollusca, *Cardium Rhæticum* and *Modiola minima*, of the marlstones below the bone-bed, run side by side into its upper beds, where the former becomes extinct, while the latter ranges upwards into the zone of *Ammonites raricostatus*. Mr. Etheridge has identified one shell from Long Sutton as *Pleurophorus* (sp.), a genus peculiarly Rhætic. *Monotis* and *Ostrea interstriata*, on Mr. C. Moore's authority, are common to it and the beds below; *Ostrea liassica*† to the beds below and above. *Lima pectinoides* and *Pecten textorius* (Saltford), which are unknown below, range into the zone of *Ammonites Turneri*; *Modiola Hillana*, *Pholadomya glabra*, and *Unicardium cardioides*—the two latter found by Mr. Sanders with *Pinna Hartmanni* at Saltford—into that of *Ammonites Bucklandi*. Passing over, therefore, the fossils common alike to the *Ammonites planorbis* group above and the Rhætic beds below, we have *Monotis* (Moore), *Cardium Rhæticum*, *Pleurophorus* (sp.), and *Ostrea interstriata* linking it to the former; *Modiola Hillana*, *Pecten textorius*, *Pholadomya glabra*, and *Unicardium cardioides* to the latter,—a mixture of forms which appears to me to indicate a border-land between two formations, belonging neither to the one nor the other. The sudden break in the succession of life between it and the zone of *Avicula contorta* indicates a lacuna, of greater or less magnitude, in the succession of the beds. In the absence of arenaceous deposits it contrasts with the beds below; in the great development of the calcareous element it resembles the beds above. And, until there be further evidence upon the subject, it will be far safer to consider it the passage-beds of the Lower Lias than, with Mr. Charles Moore, to assign it to the Rhætic formation, or, with Dr. Wright, putting the Saurian zone and the "firestone" beds beneath, to incorporate it with the *Ammonites planorbis* group above.

3. *Range of Fossils in Rhætic Beds.*—There are a few points worthy of note in the range of the Rhætic fossils. Of the Fishes found below the bone-bed, *Acrodus minimus*, *Sargodon Tomicus*,

* Dr. Wright, in his valuable section of the Street quarries (Quart. Journ. Geol. Soc. vol. xvi. pp. 389–391), considers that the "firestone" and bottom Saurian-bearing beds lie at the base of the group into which he has incorporated the White Lias. That he is mistaken in this view I have proved by actual survey. The lower Street Saurian beds extend westwards past Woolavington, as far as the Dunball Cement Works, where they occupy a position *above* the White Lias. Here, as at King Weston and West Hatch, they contain numerous Saurians, associated with *Myacites unionoides*, the latter of which characterizes the cement-shales of the lower zone of the *Ammonites planorbis* group. On the evidence, therefore, of the Street section, and still less of that at Saltford, I cannot admit that the fossils of the Saurian zone, or of the beds above it, have been proved to belong to the fauna of the White Lias.

† Quart. Journ. Geol. Soc. vol. xvii. p. 496.

Gyrolepis Alberti, *G. tenuistriatus*, and *Saurichthys apicalis*, the four latter extend downwards into the Muschelkalk; and, of the Mollusca, *Pecten Valoniensis* and *Pullastra arenicola* range high up into the Rhætic beds. *Gervillia præcursor*, *Myacites striatogranulata* (both found by Mr. Moore in the "flinty bed" at Beer), and *Beloteuthis* (*Geoteuthis*), sp., are peculiar, in the Watchet section, to the strata below the bone-bed, together with the Hypsiprymnoid tooth and the Annelidan tracks.

Of the species found above the bone-bed, *Pteromya Crowcombeia* occurs in the upper part, along with *Hybodus plicatilis*, *Anatina Suessi*, *Myophoria postera*, *Lima præcursor*, *Trigonia curvirostris*, and *Placunopsis alpina*. The "Pecten-beds" to the east of Watchet and the *Pleurophorus* limestone (No. 18) appear to be the best defined. Dr. Wright recognizes the former at Uphill.

§ IV. *Lower Boundary of the Rhætic Formation.*

The discovery of organic remains of Rhætic age in the grey sandy marlstones below the bone-bed thrusts downwards the lower boundary of the Rhætic formation into the grey marls usually considered to belong to the Keuper, the sole difference between the fossiliferous beds at Watchet and the non-fossiliferous beds elsewhere being the accidental preservation of the fossils in the former place. Lithologically, in colour and texture they are the same, and they were deposited under the same arenaceous conditions. Relying, therefore, on this evidence, I should include the grey marls and marlstones, and black shales, whether fossiliferous or not, in the Rhætic formation (see fig. 1, A to H; fig. 2, E), the lower boundary of which I should place in the red marls below, considering the alternations of red and grey marls the passage-beds between it and the Keuper. The conglomeratic bone-bed—the old boundary—deposited on a water-worn surface, and containing pebbles of the subjacent rock, indicates a break in the succession of the beds.

§ V. *Thickness of the Rhætic Beds and White Lias.*

The following table shows the thickness of the White Lias and the Rhætic formation, both above and below the bone-bed, in Somersetshire.

Locality.	Thickness of Beds.		
	Rhætic.		White Lias.
	Grey marls below bone-bed.	*A. contorta* zone above bone-bed.	
	feet.	feet.	feet.
Watchet	84	20–25	11+
Snake Lane	...	20+	...
Long Sutton	...	.....	17
Beer Crowcombe (Moore)	...	10¾	9
High Ham	...	.....	12+
Saltford (Wright)	30	25	23

Conybeare and Phillips give the thickness of the White Lias at Bath Easton as 10 feet, at Paulton as 12 feet.

§ VI. *Summary.*

The four points that I have striven to make out in this part of the paper are, first, the true position of the White Lias immediately upon the *Avicula contorta* series, without the intercalation of any Saurian zone, or any other member of the *Ammonites planorbis* group; secondly, its isolation from the Rhætic formation, both lithologically and palæontologically; thirdly, its palæontological distinctness from the *Ammonites planorbis* zone; and lastly, the downward extension of the Rhætic formation below the bone-bed. I have confined myself strictly to Somerset, to which alone my observations apply. Their application to other districts I leave to the greater leisure of some fellow-worker in the field of science.

Part II. *On the* Discovery *of a new* Fossil Mammal *in the* Grey Marls *beneath the* Bone-bed.

§ I. *Introduction.*

So far back as 1847 the existence of a Rhætic Mammal, having closer affinities with the Marsupials than with any other order, was proved by the discovery of *Microlestes* in the bone-bed of Diegerloch*, which yielded also coprolites and Saurians. Eleven years later, in 1858, Mr. Charles Moore, F.G.S., submitted to Professor Owen several small teeth from a Rhætic breccia that filled a fissure in the Mountain Limestone, near Frome, in Somersetshire. These were determined to belong to the genus *Microlestes* of Professor Plieninger, and to be most closely allied to the *Plagiaulax* found, by the energy of Mr. Beckles, F.G.S., at Purbeck, and described by Dr. Falconer, F.R.S., in the Journal of the Society. In the year 1861 I had the good fortune to discover the traces of a Rhætic Mammal on the sea-shore to the west of Watchet, in the rocks that underlie the bone-bed.

§ II. *Position of the Fossil.*

The hard arenaceous marlstones (F of fig. 1 of the preceding Part), which yielded the first traces of life in the passage from the red marls upwards, yielded also the tooth in question. I chiselled it out of the ripple-marked surface of a reef which the sea had freed from the deposits above, and out of which also were obtained teeth of *Acrodus minimus* and *Sargodon Tomicus*, scales of *Gyrolepis Alberti* and *G. tenuistriatus*, a hollow compact Pterodactylian bone, a portion of the pen of *Belotеuthis* or *Geoteuthis*, a small undetermined amphicœlian vertebra, and a few fragments of wood and of *Pecten Valoniensis*. The fissile many-laminated stone did not admit of my separating the layer in which the fossil tooth occurred from the rest of the laminæ that make up the mass of G. Its exact position was 2 feet 6 inches below the lower boundary of H (fig. 1), and 10 feet 6 inches below the bone-bed. Having been found at a lower horizon,

* Jahreshefte Würtemberg, 1847–48, p. 164.

therefore, than the Microlestian teeth of Frome and Diegerloch, it is the earliest-known trace of a fossil Mammal in the Secondary rocks.

§ III. *Description.*

The crown (see fig. 3), oblong in shape, is very long in proportion to its width, being 1·5 inch long to 0·4 wide. The higher side of its obliquely worn summit, imbedded in, or rather adherent to, the stone, exhibits two isolated involutions of enamel on that portion of the tooth that is supported by the posterior fang. Anterior to these are two wider and less prominent folds. The anterior corner, unfortunately broken by the waves, may perhaps have borne an additional fold. The cervix is very well defined. Of the two divergent fangs, the anterior had been broken short off before it was imbedded in the matrix; the posterior or smaller of the two (in length 0·11 inch) is perfect, and has its tip slightly reflected. There is no evidence as to its position in the jaw.

§ IV. *Determination.*

The former discovery of Marsupials in the Secondary rocks naturally inclined me to seek the existing analogue of this bone and mutilated stump in that great order, now, with the exception of the Opossum, confined to the southern hemisphere; and this inference has been verified by a rigid comparison. The small well-marked folds on the higher side of the tooth, coupled with its oblique grinding surface and its great length and narrowness, point, and point only, towards the *Macropoda* of Van der Hoeven (the Kangaroos) and the *Hypsiprymnidæ*, or Kangaroo-rats. Of the former genus, the first trenchant bifanged milk-molar approximates closely to the fossil in the waved outline which it would present if the inner and posterior extension of the trenchant edge were removed by wear; but the section, in that case, would be trihedral, instead of being oblong as in the fossil. The absence of plication on the permanent premolar of *Macropus*, apart from its great transverse extent, puts that genus out of the comparison. The trenchant plicated premolar, on the other hand, of *Hypsiprymnus* is impressed with all the main characteristics of the fossil. The oblique wear of the crown, the great length as compared with the breadth, the plicæ, and the implantation by two fangs are seen alike in both (see figs. 3–5). But, while the general correspondence in form is so marked, the minor differences are by no means unimportant. One section of the *Hypsiprymnidæ* [*H. Gaimardi*, *H. Hunteri*, *Bettongia Grayi*, *B. penicillata*, &c.] presents seven narrow plicæ, a second [*H. minor* (=*H. murinus*, Owen), *Bettongia rufescens*, &c.] four wide plicæ respectively on their premolars. In the small number of folds (four, or perhaps five), and in their width, the fossil points away from the former towards the latter of these; it differs from the latter in the fact that two of the plicæ are supported by the posterior fang, while in the recent four-plicated premolars all the plicæ are supported by the stout anterior fang. Figs. 4 *a* and 4 *b** represent the unworn

* Nos. 1783–84 of Hunterian Catalogue.

and worn lower premolar of *Hypsiprymnus Hunteri*, magnified four times, the latter being a little more advanced in wear than the fossil. The outer and lower side of its crown presents but the faintest traces of the plicæ, while on the inside they are easily recognized. It proves that the absence of plication in the corresponding side (the lower) of the fossil cannot be admitted as evidence against its Hypsiprymnoid character. In a word, the nearest living representative of the fossil appears to me to be *Hypsiprymnus Hunteri*, *Bettongia rufescens*, or some other of the Kangaroo-rats with four-plicated premolars. All the premolars of *Hypsiprymnus* which I have examined are at least twice the size of the fossil.

Figs. 3–5.—*Illustrating the affinities of* Hypsiprymnopsis Rhæticus.

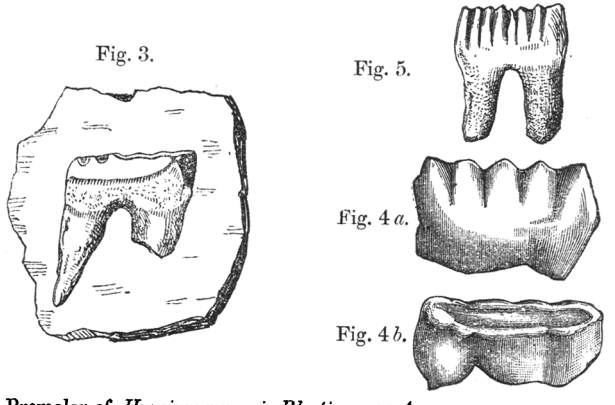


Fig. 3. Premolar of *Hypsiprymnopsis Rhæticus*; × 4.
4 *b*. Right lower premolar of *Hypsiprymnus minor*, very much worn; × 4; = *H. murinus* of Hunt. Cat. 1784.
4 *a*. Unworn left lower premolar of *H. minor*; × 4.
5. Unworn left lower premolar of *H. Hunteri* (Ow.); × 2.

Whether or not the tooth belongs to the Rhætic *Microlestes* cannot be decided, because the tubercular true molars of the latter have alone been found. Nor can its relation to *Plagiaulax* be affirmed, as the worn crown reveals nothing of the verticality or the obliquity of the folds. But, nevertheless, there is a sufficiently characteristic portion of it left to indicate a premolar most closely allied to that of the Kangaroo-rats. Until, therefore, additional remains be found, I have provisionally named it *Hypsiprymnopsis Rhæticus*—a name that represents its position in the geological scale and its zoological affinities.

§ V. *Range of Marsupials in Time.*

It is a very significant fact, that all the Secondary Mammalia that have with any accuracy been determined represent one or other of the families of the most lowly organized Mammalian order*. Of

* The small jaw of *Stereognathus*, from Stonesfield, is *sui generis*, different

the six families into which the eminent Dutch zoologist, Van der Hoeven*, divides the Marsupials now existing, the entomophagous and sarcophagous *Dasyurina* are represented in the "dirt-bed" of Purbeck by the *Spalacotherium*† and *Triconodon* ‡, and in the Stonesfield slate by the *Amphitherium* and *Phascolotherium*, the former the analogue of the insectivorous *Myrmecobius* § of Western Australia, the latter that of the *Thylacinus* ‖ of Van Diemen's Land. The *Pedimana* (Wagn.) can hardly be said to be represented, though both the above fossils from Stonesfield present some of their characteristics, and the latter to such a degree that the scale of evidence inclines but a little in favour of *Thylacinus*. The presence of the *Macropoda* (Van der H.) (= *Poëphaga*, Owen) is proved by the discovery of the Kangaroo-rat allies:—namely, in the Purbeck beds, of the *Plagiaulax*, the true affinities of which have been so amply demonstrated by Dr. Falconer¶; in the Rhætic bone-bed, of the *Microlestes* of Frome and Diegerloch, closely allied, according to Professor Owen, to *Plagiaulax* (Palæont. p. 303); and, lastly, in the strata below the bone-bed, by the discovery of the *Hypsiprymnopsis Rhæticus* of the Watchet shore. Thus, out of Van der Hoeven's six families, two are amply represented, and have an extended range—the entomophagous and sarcophagous *Dasyurina* from the Purbeck to the Inferior Oolite, and the phytophagous *Macropoda* also from the Purbeck downwards into the Lower Rhætic Marls. At the present day, of the Marsupials but a few species of the Opossums linger in the northern hemisphere, in Mexico, California, and the Southern States; and but one genus (*Didelphys*) is found out of Australasia and the islands to the south-east of the Straits of Macassar. But, on reviewing the past, we see their range rapidly extending. Cuvier's memorable discovery in the Paris Basin extends the area of *Didelphys*, or the most cosmopolitan of the existing Marsupials, to Europe in the Eocene period. And still further back, amid the relics of a fauna and flora similar to those which still inhabit the area now occupied by the Marsupials—amid *Zamiæ* and *Cycadeæ*, Cestracionts, and *Trigoniæ*—the few Mammalian scraps that have escaped the waves indicate the presence in England of members of one-third at least of the existing Marsupial families.

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from that of any animal living or extinct. On the faith of *Pliolophus vulpiceps* of the London Clay being less unlike it than any other, I am unwilling to admit its classification among the Placental herbivores. (See Quart. Journ. Geol. Soc. vol. xiii. p. 4; Owen, Palæont. p. 308.)

* Handbook of Zoology, vol. ii. pp. 612–622, 8vo, 1858. Transl. by Dr. Clarke.

† Owen, Palæont. p. 315.

‡ *Ibid.* p. 313.

§ Owen, Brit. Foss. Mam. pp. 29–60; Palæont. p. 303.

‖ Owen, Brit. Foss. Mam. p. 67; Palæont. p. 306.

¶ Quart. Journ. Geol. Soc. vol. xiii. p. 261; vol. xviii. p. 348.