## QUARTERLY JOURNAL

## AIBIOGTCAL SOCLETY OF LONDON.

## whted By

HE: ASLSTANT-SECRETARY OF THE GEOLOGLCAL SOCLETY.

- Ind si cui mortalium cordi ct cure sit non tantum inventis harere, atque is uti, sed ad ulteriora .....ar: ; atque non disputandoadverstirium, sed opere nuturam vineere; denique non belle ct prolmbiliter 1 $1 . .1$..... certo et ostensive

VOLUME THE SIX'TY-NINTH.
1913.

LONDON :
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19. Certain Upprr Jurasicic Strata of England. By Dr. Hans Salfeld, University of Güttingen. (Communicated by S. S. Bocknan, F.G.S. Read June 11th, 1913.)

## [Plates XLI \& XLII.]

By combining the evidence of a number of sections in England and near Boulogne-sur-M.er 1 have succeeded in establishing a normal succession of zones in the Oxfordian, Kimmeridgian, and Portlandian rooks, using these terms according to the German and French classifications. Dispensing with A. d'Orbigny's separate stage of the Corallian, I agree with Oppel in extending the 'Oxfordian' stage up to the 'Kimmeridge,' the lowest zone of which, in accordance with the view of H. Douvillé, A. de Lapparent, and E. Haug, I recognize to be that charucterized by Pictonia baylei, sp. nov. ( $=$ Pictonia cymodoce Bayle, ${ }^{1}$ 'I'ornquist, and others, non Ammonites cymodoce d'Orbigny). Further, I divide the Oxfordian into two portions: the lower chiefly yields Oardiocerata of the groups of cordatum and tenuicostatum, ending above with the zone of Perisphinctes martelli Oppel ep. and P. bipleas de Loriol ${ }^{2}$ (Ammonites martelli auctt., non $A$. biplex Sow.); the upper comprises the following zones in ascending forder:-(1) Zone with Perisphinctes warto Bukowski, Cartioceras (Amosboceras) alternans von Buch sp. and allied species; (2) Zone with Perisphinctes decipiens J. Sow. sp., P. achilles d'Orb. sp., and Oardioceras (Amueboceras) serratum J. Sow. sp.; (3) Zone with Ringsteadia [gen.nov. ${ }^{3}$ pseudocordrutus Blake sp. ( $=$ Ammonites mutahilis Damon, Proplanailites mutubilis R. Douville, non A. mutabilis J. de C. Sow.) and other species of this new genus.

The Kimmeridgian in the German and French sense would comprise the following zones, taken in ascending order:-(1) Zone with Pictonia baylei sp. nov. and other species of Pictonia; (2) Zone with Rasenia [gen. nov.] cymodnce d'Orb. sp., R. uralensis d'Orb. sp., R. themarum Oppel sp., in addition to others, and, further, Carcliocerata which have invariably been described as Cardioceras alternans von Buch sp., but belong to other species and other uroups; for example, C. kitchini sp. nov. ( $=$ Ammonites alternans 11. B. Woodward, 'Jur. Rocks of Britain' Mem. Geol. Surv. vol. v, 1995, fig. 68, p. 155); (3) Zone with Rasenia mutabilis J. de C. Sow. sp.
${ }^{1}$ E. Bayle, 'Explication de la Carte géologique de la France' vol. iv (1878) 1.1. IXvi; A. Tornquist, 'Die degenerierten Perisphinctiden des Kimmeridge "'IM Le Harre Abhandi. Schweiz. Palaont. Gesells'h. vol. xxiii (1896) pl. ii $1^{11}$ iii, ligs. 1-2, \& pl. iv. fig. 1. The genus Pictonia has hitherto been found

Il-ively in Northern France, England, and North Germany (Pomerania).
P' de Loriol, 'Oxfordien supérieur \& moyen du Jura Lédunien' Abhandl.
haveiz. Paläont. Gesellsch. vol. xxx (1903) pl. vi. Mweiz. Paläont. Gesellsch. vol. $x \times x$ ( 1903 ) pl. vi.
1).J. G.S. No. 275.
${ }^{4}$ See p. 429.
(non Ammonites mutabilis auctt.) ; (4) Zone with Aulacosteqhanus yo d'Orb. sp. and $A$ contejeani Thurmann sp. ; (5) Zone with Aulacostephanus pseudomutabilis de Loriol sp., A. eudoxus d'Orb. sp., A. urdorce Pavlov sp., A. subundora Pavlov sp., etc., and Cardiocrata which again have been deseribed as Curdioceras altemans ron Buch sp., but belong neither to this species (or group) nor to the group of $C$. hitchini sp . nor., but to a new group. ${ }^{1}$ On the Continent we conclude the Kimmeridge or Kimmeridgian with this zone (5), following A. d'Orbigny's precedent ; for no doubt can exist that the boundary with the Portlandian of that author falls above the beds containing Ammonites eudowus, A. pseudonutabilis, etc., and below those yielding A. gravesianus d'Orb, etc.

The Portland or Portlandian in the German and French sensecomprises the following zones, in upward sequence:-(1) Zonewith Gravesia [gen, nov.] ${ }^{2}$ gravesiana d'Orb. sp. and other species; (2) Zone with Gravesia irius d'Orb. sp. and other species; (3) Zone with Virgatites miatschkoviensis Michalski sp. and other species; (4) Zone with Perisphinetes pallasianus d'Orb. sp. and other species; (5) Zone with Perisphinctes pectinatus Phillips sp.; (6) a zone marked by a new, densely-ribbed Perisphinctes ( $P$, eustlecottensis sp. nov.) from the Lydite Pebble-Bed at Swindon, which was apparently confounded with $P$. pectinatus by Blake, (7) Zone with Perisphinctes gorei sp. nov. ( $=$ Ammonites biplex de Loriol \& Pellat ${ }^{4}$ and A. biplex anctt. in part); (8) Zone with. Perisphinctes pseudogigas Blake sp., a species which stands very near to $P$. giganteus J. Sow. sp. or P. bononiensie de Lor. sp., but. is much more inflated; (9) Zone in which Perisphinctes gigunteus. $J$. Sow. sp. and P. bononiensis de Loriol sp. are found.

With this zone (9) the Portland or Portlandian in A. d'Orbigny's sense concludes. At a later time the formational designation 'Portlandian' was extended to include the Upper Volga Stage, the three Craspedites Zones, which, according to the work of Prof. A. Pavlor and others, must follow normally above Zone 9.

So much for the zonal subdivisions; let us now turn to the individual sections in England.

At the classic locality of Kimmeridge, which has given its name to the Kimmeridge Clay and to the formation 'Kimmeridgian,' the lowest subdivision seen in the flat anticline near the 'Lifeboat House' consists of clays with Aulacostephanus eudoxus, A. pseudomutabilis, etc., the fauna remaining unchanged up to the 'supposed Maple Ledge.' Above this bed up to tho
${ }^{1}$ The monographic description of the genus Cardioceras will shorty appear in 'Palæontographica.'
${ }^{2}$ Gravesia, gen, nov.; genotype Ammonites gravesianus d'Orbigny, 'Palóon' franç.: Terr. jurass.' vol. i (1850) pl. cexix.
${ }_{3}$ See p. 429.
${ }^{4}$ P. de Loriol \& E. Pellat, 'Monographie paléont. \& géol. des Fhng" suphimers do la Tomation Jurassique des Environs de Bonlegnesur-Mur

'Yellow Ledge' ${ }^{\text {i }}$ the clays contain Gravesia flattened by pressure, those below belonging to the group of Gr. gravesiana d'Orb. sp., those above to the group of Gr. irius d'Orb. sp.

This is of great importance. It is not only that the Gravesia Beds are here recognized in England for the first time, ${ }^{2}$ but we are thereby enabled to fix exactly the boundary between 'Kimmeridgian' and 'Portlandian' in the Kimmeridge section; that is to say, all that follows above the 'supposed Maple Ledge; must be correlated with the Portlandian.
The clays between the 'Yellow Ledge Stone-Band' and the 'Oil-Shales' form the equivalent of the Virgatites Beds, although I have never found a true Virgatites here. To the same zone we must also assign a part of the overlying clays. Somewhat below the 'White Septarian Band,' however, we reach the beds with Perisphinetes pallasianus d'Orb. sp. This zone must be recognized at extending up to the basal limit of the 'Portland Sands.'

Blake's statementa conoerning the ammonites contained in the Portland Sands and Portland Oolite of Purbeck, and also of Portland, I ban, in the main, confirm. In the highest beds of the Portland Eand at Portland I found Periaphinctes gorei sp. nov., whioh indicates that the overlying Portland Oolite comprises the two zonen charaoterized by Perisphinotes psoudogigete Blake sp. and P. giganteus J. Sow. sp, respectively, an anamed by Blake.

We.may now consider the exposures in the neighbourhood of Weymouth. The Osmington Oolite yields Periaphinctes martelli Oppel sp., and accordingly correnponds with the uppermost zonie of the Lower Oxfordian. The Sandefoot Clay, from its position, must correspond to the zone of Perisphinctes warta and Cardioceras alternans. The Sandafoot Grits yield Perisphinotes achilles, $P$. decipiens, Cardioceras serratum, and Ilingsteadice, thus corresponding with the two upper zones of the Upper Oxfordian. Above the Sandsfoot Grits we may place the basal line of the Kimmeridge, lithologically not a very sharp division. The clays and marls which lie above the Sandsfoot Grits contain uncrushed Pictonia. Then follow thinly-laminated clays yielding Rasenia oymodoce and other species, above which are similar beds containing $R$. mutabilis, all much compressed. The beds with Aulacostephanus pseudomutabilis, A. eudoxus, etc., are exposed in the higher nodular layers. The zone of Aulacostephanus yo,
'For the position of theee stone-bands, see A. Strahan, 'The Geology of the Isle of Purbeck \& Weymouth' Mem. Geol. Surv. 1898, pl. x.

The ammonites described by Prof. Pavlov \& Mr. Lamplugh from the Nipelion Clay as Olcostephanus (Polyptychites) gravesiformis are true PolyHychifes of the Valanginian, and not identical (as assumed by the first-named writor) with species of the group of the Gravesie from the Gigas-Schichten of Hh, lowest Portlandian of North-West Germany. See A. P. Pavlov \& G. WF. lamphug, 'Argiles de Speeton \& leur Equivalents' Bull. Soc. Imp. Nat. M.w.'. II. \&. vol. 7 (1892) p. 482.
as also the Gravesia and Virgatites Beds of the Lower Portlandian, cannot be recognized here, because the section is, to a great extent, obscured by talus.
The clays below the Portland Sands bere likewise yield Perisphinctes pallasianus throughout.

The section at Red Lane, Abbotsbury, described by Blake \& Hudleston ${ }^{1}$ (given by them in inverted order of succession) shows in Bed 2 of Blake a dark-brown, richly-ferruginous, soft oolite, containing in abundance Waldheimia dorsetensis Walk., Rasenia thermarum Oppel sp., $R$. uralensis d'Orb. sp., and other species. These 'Corallian Beds' of Blake are, therefore, the exact equivalents of the Lower Kimmeridge Clay of Weymouth, the zone of Rasenia cymodoce, a fact already recognized by Prof. H. Douvillé.

The exposures near Swindon prove that the Kimmeridge Clay facies, as shown in the clay-pit at Telford Road, extends down as far as the zone of Perisphinotes decipien and Oardioceras serratum. Below this follow sandstones of the 'Corallian.' Clays with Pictonice are exposed at the buse of Buzzard's Clay-pit in Swindon. The leathery shales at the top of the Lower Olay-pit contain Aulucostephanus pseudomutabilis, A. sudosus, etc. Since the succeeding clays and marls yield Virgatice, the dividing-line between Kimmeridgian and Portlandian must here be placed immediately above the leathery shales. The Gravesia Beds are here either entirely wanting, or are condensed to a minimum.
It is known that Perisphinctes pectinatus ocours in the Portlend Nands below the Swindon Clay. The Swindon Clay iteelf has yielded no ammonite. On the other hand, the 'Lydite PebbleBed,' immediately overlying the Swindon Clay, containg a new ammonite of contemporaneous age-a Perisphinctes related to $P$. ulmensis Oppel sp., P. denseplicatus Waagen, and . P. postulmensiz Blaschke-in addition to very numerous, rolled, phogphoritized and silicified fossils derived from lower horizons, particularly from the zone of Perisphinctes pallasianus. Immediately above, in the base of the calcareous sandstone, Perisphinctes gorei sp. nov. is abundant. The main mass of the calcareous sandstone yields Perisphinctes pseudogiyas Blake sp. as the characteristic species. The overlying Swindon Sands may be regarded as equivalent to the zone of Perisphinctes giganteus, although it has not been possible to prove the occurrence of ammonites in them.

It is important to note that, in the Swindon neighbourhood, the sandy facies persists longer than at Portland and in Purbeck. The boundary which is there drawn between the Portland Sands and the Portland Oolite would fall at Swindon in the calcareous sandstone, above the zone yielding Perisphinctes gorei. $>$

At Westbury the top of the Ironstone yields Ringsteadic ; above
${ }^{1}$ J. F. Blake \& W. H. Hudleston, 'On the Corallian Rocks of England' Q. J. G. S. vol. xxxiii (1877) p. 273.
this comes Kimmeridge Clay, which thus probably begins here with the zone containing Pictonice.

It can, therefore, be recognized that over the whole region described the change of facies between the Kimmeridge Clay and the Portland Sands occurs at one and the same time. The facies-division between Kimmeridge Clay and Corallian is, however, not ohronologically constant, but changes to the extent of several zones even within short distances: thus, for instance, between Weymouth and Abbotsbury, or between Westbury and Swindon.

As regards other localities, I will merely emphasize the fact that the Kimmeridge Clay, exposed at Market Rasen (Lincolnshire), which has furnished the splendidly-preserved ammonites that constitute a particular embellishment in many collections, has only yielded the fauna of the zone of Rasenia cymodoce and $R$. uralensis.

The foregoing account forms the flrst pullication of a part of my comprehensive studies on the zonal subdivision and correlation of the Upper Juransic formation (in the German sense) of Middle and North-Western Europe. The investigation of the faunas will be dealt with in separate monographs of the genera, to be publisher in ' Palæontographioa.'

Finally, I winh here to express my warmest thanks to all those gentjemen who, by valuable advice and information and by giving access to collections, as well as by the loan of fossile, have supported and furthered my studies: particularly to Dr. A. Smith Woodward, Prof. W. J. Sollas, Mr. G. C. Crick, Dr. F. L. Kitchin, ${ }^{2}$ Mr. S. S. Buckman, ${ }^{1}$ Mr. Gore, and Mr. Barnes, in addition to others.

## Appendix: Ammonite Names.

## Ringsteadia, gen, nof.

Genotype, Ammonites pseudocordatue Blake, emend. Salfeld.
Blake's illustration, in Q. J. G. S. vol. xxxiii (1877) pl. xiii, fig. 1, scarcely reproduces the characters of the genus. Since the origina specimen cannot be found, I take as type of the genus that ammonite from the same locality which agrees most closely with Blake's description. The following must rank as synonyms of A. pseudocordatus Blake, emend. Salfeld :-
1888. Ammonites mutabilis R. Damon, 'Supplement to the Geology of Weymouth \& the Isle of Portland ' pl. xvi, fig. 1.
1809. Proplanulites mutabilis R. Douvillé, Bull. Soc. Géol. France, ser. 4, vol. ix, pl. vii, fig. 1 \& pl. viii, fig. 1.
The name is derived from Ringstead Bay, near Weymouth (Dorset).
${ }^{1}$ I am also indebted to Dr. Kitchin for translating this paper, and to Mr . Buckman for bringing together my results in the form of the table which follows (p. 428).
Tabular Summary of Results.


## Rasenia, gen. nov.

Genotype, Ammonites cymodoce d’Orbigny, 'Pal. Française: 'Terr. Jurass.' vol. i (1850) pl, ecii, fign. $1 \& 2$ (non tigs. $3 \& 4$ ), \& pl. ceciii, tig. 1.

Another characteristic species is Ammonites aralensis d'Orligny, in Murehison, de Vemenil, \& Keyserling, 'Géologie de la Rassie d'Europo' vol. ii (1845) pl, xxxii, figs. 6 \& 7 (non figs. 8 \& 9).

Rasenia comprises many of the so-called Olcostephani of the Kinmeridgian. The above-mentiened species belong to two distinct groups of Rasenicy, of which the first becomes smooth with age, while the second acquires strong, undivided ribs. Rasenia is a genus rich in species, which have their chief development in the Kinmeridge of Northern France, lingland, and the interior of Russia, but occur also as fremuent accessory faunal constituents in Southern Germany, Switzerland, the middle and south of Frunce, -and the Alpine Jura.

The name is derived from Market Rasen (Lincolnshire).
Pribphinctes fastlecotinnile, ap. nov. (Plg. XLI \& XLIL.)
Ammonites poctinatue of Englidh nuthors (iu part).

| Measuremonta.' |  |  |  |
| :---: | :---: | :---: | :---: |
| $\begin{gathered} \text { Diametor } \\ \text { millimatros. } \end{gathered}$ | Breadih of whorl. <br> (Peroentuge of diam.) | Thichness of whorl. <br> (l'ercentuge of dinu.) | Width of tumbilicus. (1'ercentage ol' diam.) |
| 170 | 87 |  | 37 |

Description.-This form possesses an oval whorl-section, even in youth ; the greatest thickness is close to the umbilicus. The 'umbilical edge is rounded, the umbilical alope (inner margin) steep. The inner whorls overlap one another by about a half; in later whorls the overlap is rather less.
The ribbing is very fine and relatively weak, while the number of primary ribs is very great; at a diameter of 110 millimetres there are about 130 in a single whorl. At a diameter of 145 mm the main ribs become gradually more widely spaced and stronger while the number of external ribs, on the other hand, remains approximately the same. The ribs rise obliquely backwards from the umbilicus, and soon take a forward bend, running almost radially across the lateral area. The ribs divide in an irregularly fasciculate (virgatite) manner, and at all stages of growth pass over the periphery without any break. The first furcation of ribs occurs about the middle of the lateral area.

The inner whorls show, up to a diameter of about $8 \overline{\mathrm{~mm}}$., flattened, narrow constrictions almost parallel with the ribs.
The lobes and saddles are very finely divided. The deep external and first lateral lobes lie on the same radius; both are relatively broad. The second lateral lobe extends to somewhat more than

[^0]half the length of the first ; it is directed a little obliquely, and is. likewise relatively broad. A 'suspeusive' lobe, which extends down to a radius drawn from the external lobe, possesses three obliquely-directed auxiliary lobes. The saddles are more or lesssymmetrically divided by the primary indentations. The first lateral saddle extends somewhat beyond the external saddle.
The length of the body-chamber and the form of the aperture are not known.
Locality.-Swindon, above the so-called 'Swindon Clay,' at the base of the so-called ' Portland Oolite,' in the Lydite Pebble-Bed at Eastlecott railway-cutting.
Number of specimens studied.-Four.
Collections.-Geological Institute of the University of Güttingen ; British Museum (Nat. Hist.), No. 88657.
Remarks.- Perisphinctes eastlecottensis stands near to $P$. ul. mensis Oppel sp., from the Gravesia Beds (lowest Portlandian), to $P$. clenseplicatus Waagen, and to $P$. postulmensis Blaschke. It is distinguished from these species, however, by its different proportions and its finer ribbing. In specimens having the same width of umbilicus, $P$. eastlecottensis possesses a considerably: greater height and thickness of whorl.
$P$. ulmensis Oppel sp., at given dimensions, has a wider umbilicus, and possesses ribs which are stronger and broader and have a marked backward slope; in this species, also, the wider spacing of the primary ribs comes on at a much earlier age.
$P$. denseplicatus Waagen, from the Tithonian, and the very imperfectly-known P. postulmensis Blaschke, stand nearer to the English species thau does $P$. ulmensis Oppel sp. $P$. denseplicatus has a wider umbilicus, and is considerably thiuner and narrower in the whorl; also important differences in the lobe-line appear to be present, at least so far as the material that has been figured is concerned.
P. postulmensis appoars likewise to have a wider umbilicus, and to show narrower and thinner whorls.
Virgatites quenstedti Rouillier is a form which has similar ribbing; but its whorl-section and proportions are quite different.

Explanation of plates XLI \& XLII.
Plate XLI.
Portlandian, eastlecottensis zqne.
Perisphinctes eastlecottensis, sp. nov. Holotype. Lydite I'ebble-Bed, Eastle-cott, Swindon (Wiltshire). Coll. British Museum (Nat. Hist.), No. 88657. Side view, $\times 0.7$.

## Plate XLII.

Portlandian, eastlecottensis zone.
Perisphinctes eastlecottensis, sp. nov. Fig. 1, peripheral view ; Fig. 2, apertural view of the example shown in PI. XLI, both $\times 0 \%$.

## Discussion.

Dr. A. Morlay Davies said that all who were working at the Upper Jurassic rocks would welcome this contribution to the difficult subject of their zonal correlation. His first comment on the zonal table exhibited was that it proved more clearly than before that the term 'Oxfordian' would have to bo abolished. While several of the zones on the Author's list could at once be recognized, others had unfamiliar names, and among these he failed to identify such well-marked famal horizons as those of Amceboceras (alternans zone) and Physodoceras (orthocera zone). The paper would, however, doubtless remove theso difficulties, and oxplain why other index-fossils had been chosen.
Dr. F. L. Kirchin expressed satisfaction that be had given encouragement to the Author to lay before the Society the first fruits of his work in England. He considered that the paper made a great advance in our knowledge of the strata with which it deals: provious accounts of these rocks became thereby desirably supplemented by a detailed investigation, conduoted from the purely zonal standpoint. The spenker regarded the Author as uspecially qualified to undertake this work, equipped as he wus with sound palmontologioal knowledge and wide experience of typical Continental sections. He believed that the Author had conducted his fleldobservations with exemplary care, and that his results might, therefore, be accepted as nubstantially accurate, providing a sound busis for future work. It gave him plensure to report that the Author hoped to return to this country next year, in order to continue thene researches. Thanks were due to Mr. Buckman for bringing bofore the meeting this first valuable contribution.

Mr. G. W. Lamplugh said that the sequence of ammonito-\%onos demonstrated by the Author could not fail to prove of service to students of the British Upper Jurassic rocks. The sucoossion and correlation seemed to be firmly based, and, so long as this was the cuse, the method adopted for grouping the zones into formations was of secondary consequence. The Author had followed the usual Continental grouping, which was not convenient for stratigraphical purposes in this country, where the use of Kimmeridgo Clay us a descriptive lithological term could hardly be displaced.

The Author's disoovery of the true horizon of the inflated gravesianus forms in the Kimmeridge section was of peculiar interest, because of the difficulties which had arisen through the origiual confusion of these forms with the Polyptychites of the Speeton Clay. The speaker desired to know by what features the species of this group are distinguishable when they are crushed flat. He mentioned that he had recently found specimens of Aulucostephanus in the Kimmeridge Clay of Filey Bay, at about the horizon indicated in the Author's scheme.

Mr. W. F. Gwinnell referred to the occurrence of ammonites in some of the Upper Jurassic zones under consideration, in the Northern Highlands of Scotland, on both the eastern and the
western shores. While in Inverness some seven years ago he obtained from Eathy Shore on the coast of Cromarty, in an in durated shale, a number of small specimens which were referred by Mr. G. C. Crick to the Hoplites-eudowus group. All are small, some very small, and more or less crushed, but the shell is still pearly.

The President (Dr. A. Straifan) pointed out that this was a purely palæontolagical research on a region in which the strata were strougly differentiated by their lithological characters, and in which they formed conspicuous and characteristic features. In such a region the stratigraphical method of classification was forced upon the observer. But it was to be remembered that, while the stratigraphy was locally paramount, the paleontological method became essential in dealing with areas of a continental order of magnitude.

The part of Dorset with which the Author dealt was classic ground, inasmuch as it had given to the world anch names a Purbeckian, Portiandian, Kimmeridgian. If Kimmerid gian meant anything, it should have meant the Kimmeridge Clay of Kimmeridge and the neighbourhood. Yet, on palwontologioal grounds, a not inconsiderable part of that formation had been transferred to the Portlandian, in order to harmonize with other parts of Europe.

Similar difficulties in reconciling the results of the stratigraphioal and palxontological methods had arisen in the correlation of other formations, and would continue to arise so long us the stratigraphical and palwontological methods of nomenclature wore confused. In the Table before him he saw a zonal olassification founded solely on the palicontology, but into it had been introduced a nomenclature for the grouping of the zones which had been misappropriated from the stratigraphical column. The term Kimmeridgian was, in his opinion, a misuse in such an association. These remarks wero not to be taken as an adverse criticism of the palwontological results which the Author had obtained. On the contrary, it appeared that a notable advance had been made in our knowledge of the sequence and correlation of the palæontological zones.

Mr. Buckian, in reply, heartily thanked the Fellows on behalf of the Author for their kind reception of the paper: he would like to add his personal appreciation of its value. The President's suggestion that he (the speaker) should invent a dual nomenclature -one for the stratigraphical and another for the zoological se-quence-appealed strongly to him, as he had done this in a paper published by the Society so long ago as 1898 : that it was not carried on was due to intimation from 'the powers that be' that it was unnecessary. So he certainly commended the President's opinion. Various points raised in the discussion were dealt with in the paper itself, especially the questions of stratigraphy. The fault lay with the speaker and not with the Author, if the exposition had not dealt quite fully with these matters.
20. On the Halesowen Sandstone Series of the Sotth Stafyordshire Coalfield, and the l'etrified Wood found therein at the Witley Colliery, Hallsowen (Worcestinsime). Iyy Henry Kay, F.G.s. With an Appendix on Dhboxvton kay, sp. nov., by E. A. Newhle Arber, M.A., Nc.D., F.G.S. (Read April $23 \mathrm{rd}, 1413$.)
[1'lathe XLIII \& XLIV.]
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## I. Introndotion.

Iny present paper deals with part of the higher beds of the Coal Measures, as doveloped in the South Staffordshire Coalfleld. The generally necepted subdivision of the Upper Carboniferous rocks in this coalfield is:-
(4) Keele Series $=$ Lower Permian.
(3) Halesowen Sandstone Series.
(2) Red Coul-Mensure Clays or Old-IIill Marls.
(1) Productive Measures.

The object of the present communication is to describe in greater detail than has yet been attompted the Halesowen Sandstone Series, and more especially its relationship to the Keele Neries above, and the Red Coal-Measure Clays below. Special attention to the Halesowen rooks has been stimulated by the fine natural exposures north of the Clont Hills, by the discovery of unrecorded exposures elsewhere (as shown in the sequel), and by the further discovery of the remarkable petrified wood found at Witley.
The paper is not an exhaustive account of the strata described, but merely an attempt to throw light upon a hitherto neglected subject.
l am indebted to Prof. Charles Lapworth for much encouragement in my work, and to Dr. Walcot Gibson for valuable suggestions. I am particularly indebted to Dr. E. A. Newell Arber for his scientific description of the petrified wood, and for the assistance that he has given in regard to the arrangement of the



[^0]:    ${ }^{1}$ For the method of giving proportions, see S. S. Buckman, 'Yorkshire 'Type Ammonites' pt. 9 (1913) p. viii.

