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nend si cui mortalium cordi et curæ sit non tautum inventis hærere, atque iis uti, sed ad ulteriora and are ; atque non disputando adversarium, sed opere naturan vincere; denique non belle et probabiliter pueri sed certo et ostensive seire; tales, tanquam veri scientiarum filii, nobis (si videbitur) se adjun ant, b sear Organum, **Pref**atio.

VOLUME THE SIXTY-NINTH.

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LONDON :

LONGMANS, GREEN, AND CO. PARIS: CHARLES KLINCKSIECK, 11 RUE DE LILLE. SOLD ALSO AT THE APARTMENTS OF THE SOCIETY. 19. Certain UPPER JURASSIC STRATA of ENGLAND. By Dr. HANS SALFELD, University of Göttingen. (Communicated by S. S. BUCKMAN, F.G.S. Read June 11th, 1913.)

[PLATES XLI & XLII.]

Br combining the evidence of a number of sections in England and near Boulogne-sur-Mer I have succeeded in establishing a normal succession of zones in the Oxfordian, Kimmeridgian, and Portlandian rocks, 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 characterized by Pictonia baylei. sp. nov. (= Pictonia cymodoce Bayle,' Tornquist, and others, non Ammonites cymodoce d'Orbigny). Further, I divide the Oxfordian into two portions: the lower chiefly yields Cardiocerata of the groups of cordatum and tenuicostatum, ending above with the zone of Perisphinctes martelli Oppel sp. and P. biplex de Loriol² (Ammonites martelli auctt., non A. biplex Sow.); the upper comprises the following zones in ascending order: -(1) Zone with Perisphinetes warte Bukowski, Cardioceras (Amæboceras) alternans von Buch sp. and allied species; (2) Zone with Perisphinctes decipiens J. Sow. sp., P. achilles d'Orb. sp., and Cardioceras (Amueboceras) serratum J. Sow. sp.; (3) Zone with Ringsteadia [gen. nov.]^{*} pseudocordatus Blake sp. (= Ammonites mutabilis Damon. Proplanulites mutabilis R. Douvillé, 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.]⁴ cymodoce d'Orb. sp., R. uralensis d'Orb. sp., R. thermarum Oppel sp., in addition to others, and, further, Cardiocerata which have invariably been described as Cardioceras alternans von Buch sp., but belong to other species and other groups; for example, C. kitchini sp. nov. (=Anmonites alternans H. B. Woodward, 'Jur. Rocks of Britain 'Mem. Geol. Surv. vol. v, 1895, 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) pl. lxvi; A. Tornquist, 'Die degenerierten Perisphinctiden des Kimmeridge von Le Havre' Abhandl. Schweiz. Paläont. Gesellsch. vol. xxiii (1896) pl. ii, pl. iii, figs. 1-2, & pl. iv, fig. 1. The genus *Pictonia* has hitherto been found cochusively in Northern France, England, and North Germany (Pomerania).

P. de Loriol, 'Oxfordien supérieur & moyen du Jura Lédonien' Abhandl.
Schweiz, Paläont, Gesellsch, vol. xxx (1903) pl. vi.
* See p. 427.
* See p. 429.

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(non Ammonites mutabilis auctt.); (4) Zone with Aulacostephanus yo d'Orb. sp. and A. contejeani Thurmann sp.; (5) Zone with Aulacostephanus pseudomutabilis de Loriol sp., A. eudoxus d'Orb. sp., A. undoræ Pavlov sp., A. subundoræ Pavlov sp., etc., and Cardiocerata which again have been described as Cardioceras alternans von Buch sp., but belong neither to this species (or group) nor to the group of C. kitchini sp. nov., 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 eudoxus, A. pseudomutabilis, 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 Perisphinctes 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. eastlecottensis sp. nov.)³ 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 ' and A. biplex auctt. in part); (8) Zone with Perisphinctes pseudogigas Blake sp., a species which stands very. near to P. giganteus J. Sow. sp. or P. bononiensis de Lor. sp., but is much more inflated; (9) Zone in which Perisphinctes giganteus. 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. Pavlov 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 the 'Yellow Ledge' the clays contain *Gravesiae* 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 Porisphinotes pallasianus d'Orb. sp. This zone must be recognized as extending up to the basal limit of the 'Portland Sands.'

Blake's statements concerning the ammonites contained in the Portland Sands and Portland Oolite of Purbeck, and also of Portland, I can, in the main, confirm. In the highest beds of the Portland Sand at Portland I found *Perisphinotes gorei* sp. nov., which indicates that the overlying Portland Oolite comprises the two zones characterized by *Perisphinotes pseudogigus* Blake sp. and *P. giguinteus* J. Sow. sp. respectively, as assumed by Blake.

We may now consider the exposures in the neighbourhood of Weymouth. The Osmington Oolite yields Perisphinctes martelli Oppel sp., and accordingly corresponds with the uppermost zone of the Lower Oxfordian. The Sandsfoot Clay, from its position, must correspond to the zone of Perisphinotes warter and Cardioceras alternans. The Sandsfoot Grits yield Perisphinctes achilles. P. decipiens, Cardioceras serratum, and Ringsteadice. 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 cymodoce 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.

¹ The monographic description of the genus *Cardioceras* will shortly appear in 'Palæontographica.'

² Gravesia, gen. nov.; genotype Ammonites gravesianus d'Orbigny, 'Paléont franç.: Terr. jurass.' vol. i (1850) pl. cexix.

³ Śee p. 429.

⁴ P. de Loriol & E. Pellat, 'Monographie paléont. & géol. des Étages sopérieurs de la Formation Jurassique des Environs de Boulogne-sur-Mer-Mém. Soc. Phys. Hist. Nat. Genève, vol. xxiii (1874) pl. ii, fig. 1.

¹ For the position of these 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 Specton Clay as Olcostephanus (Polyptychites) gravesiformis are true Polyptychites of the Valanginian, and not identical (as assumed by the first-named writer) with species of the group of the Gravesiæ from the Gigas-Schichten of the lowest Portlandian of North-West Germany. See A. P. Pavlov & G. W. Lamplugh, 'Argiles de Specton & leur Équivalents' Bull. Soc. Imp. Nat. Mone. n. s. vol. v (1892) p. 482. 2 F 2

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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.

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The clays below the Portland Sands here likewise yield Perisphinctes pallasianus throughout.

The section at Red Lane, Abbotsbury, described by Blake & Hudleston¹ (given by them in inverted order of succession) shows in Bed 2 of Blake a dark-brown, richly-ferruginous, soft colite, 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 decipiens and Cardioceras serratum. Below this follow sandstones of the 'Corallian.' Clays with Pictonia are exposed at the base of Buzzard's Clay-pit in Swindon. The leathery shales at the top of the Lower Clay-pit contain Aulacostephanus pseudomutabilis, A. eudoxus, etc. Since the succeeding clays and marls yield Virgatites, 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 Perisphinetes pectinatus occurs in the Portland Sands below the Swindon Clay. The Swindon Clay itself has yielded no ammonite. On the other hand, the 'Lydite Pebble-Bed,' immediately overlying the Swindon Clay, contains a new ammonite of contemporaneous age-a Perisphinctes related to P. ulmensis Oppel sp., P. denseplicatus Waagen, and P. postulmensis Blaschke-in addition to very numerous, rolled, phosphoritized and silicified fossils derived from lower horizons, particularly from the zone of *Perisphincies 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 Ringsteadia; 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 Pictonia.

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 chronologically 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 first publication of a part of my comprehensive studies on the zonal subdivision and correlation of the Upper Jurassic 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 published in • Palmontographica.'

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

Appendix : Ammonite Names.

RINGSTEADIA, gen, nov.

Genotype, Ammonites pseudocordatus 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 original 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.
1909. 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).

RESULTS.
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SUMMARY
TABULAR

STRATA.	 Swindon, Swindon Sands. Swindon, Calcareous sandstone. Swindon, Base of calcareous sand-stone. Swindon, Lydite Pebble-Bed. Swindon, Sands above Swindon Clay. Swindon, Clays and marls. 	Swindon. Leathery Shales, Lower Clay-pit. Abbotsbury. Iron ore. Swindon. Base of Buzzard's Clay- pit.	Westbury. Top of iron-ore. Swindon. Telford Road Clay-pit.
	Osmington. Clays below Portland Sands.	Osmington. Higher nodular layers. Cosmington. Laminated clays. Cosmington. Casr and marls.	Osmington. Sandsfoot Grits. Sandsfoot Gay. Osmington Oolite.
	 Portland. The Portland Oolite. Portland. Upper beds of Portland Sands. Kimmeridge. Kimmeridge. Clays between Yellow Ledge and Oil-Shales. Kimmeridge. Kimmeridge. Clays below Yellow Ledge. 	{ Kimmeridge. { Clays below Maple Ledge. Market Rasen. Clays.	the
ZONES.	 Perisphincles giganteus Perisphincles gorei	 Anlacostephanus pseudo- mutabilis Aulacostephanus yo Rasenia mutabilis Rasenia cymodoce . Pictonia baylei 	 Ringsteadia pseudocordatus Perisphinctes decipiens Perisphinctes wartæ Perisphinctes martelli
1	Ροκτιλχριλχ.	Киммверенки.	Гоwев Uррев Охродріан.

RASENIA, gen. nov.

(denotype, Ammonites cymodoce d'Orbigny, 'Pal. Française : Terr. Jurass.' vol. i (1850) pl. ccii, figs. 1 & 2 (non figs. 3 & 4), & pl. cciii, fig. 1.

Another characteristic species is *Ammoniles uralensis* d'Orbigny, in Murchison, de Verneuil, & Keyserling, 'Géologie de la Russie d'Europe' 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-mentioned species belong to two distinct groups of Rasenia, 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, England, and the interior of Russia, but occur also as frequent accessory faunal constituents in Southern Germany, Switzerland, the middle and south of France, and the Alpine Jura.

The name is derived from Market Rasen (Lincolnshire).

PERISPHINCTES EASTLECOTTENSIS, sp. nov. (Pls. XLI & XLII.)

Ammonites pectinatue of English authors (in part).

Measurements.1

Diametor in millimetres.	Breadth of whorl. (Percentage	Thickness of whorl, (Percentage	Width of umbilicus. (Percentage
	of diam.)	of diam.)	of diam.)
170	37	36	37
145	36	37	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 slope (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 85 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

¹ For the method of giving proportions, see S. S. Buckman, 'Yorkshire 'Type Ammonites' pt. 9 (1913) p. viii. 430

half the length of the first; it is directed a little obliquely, and islikewise relatively broad. A 'suspensive' lobe, which extendsdown to a radius drawn from the external lobe, possesses threeobliquely-directed auxiliary lobes. The saddles are more or lesssymmetrically divided by the primary indentations. The firstlateral 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 Göttingen; British Museum (Nat. Hist.), No. 88657.

Remarks.—Perisphinctes eastlecottensis stands near to P. ulmensis Oppel sp., from the Gravesia Beds (lowest Portlandian), to P. denseplicatus 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 samewidth 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 than does *P. ulmensis* Oppel sp. *P. denseplicatus* has a wider umbilicus, and is considerably thinner 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 appears 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 zone.

Perisphinctes eastlecottensis, sp. nov. Holotype. Lydite Pebble-Bed, Eastlecott, Swindon (Wiltshire). Coll. British Museum (Nat. Hist.), No. 88657. Side view, ×0.7.

PLATE XLII.

Portlandian, castlecottensis zone.

Perisphinctes eastlecottensis, sp. nov. Fig. 1, peripheral view; Fig. 2, apertural view of the example shown in Pl. XLI, both $\times 0.7$.

Discussion.

Dr. A. MORLEY 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 be 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 faunal horizons as those of Amceboceras (alternans zone) and Physodoceras (orthocera zone). The paper would, however, doubtless remove these difficulties, and explain why other index-fossils had been chosen.

Dr. F. L. KITCHIN expressed satisfaction that he 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, conducted from the purely zonal. standpoint. The speaker regarded the Author as especially qualified to undertake this work, equipped as he was with sound palcontological knowledge and wide experience of typical Continental sections. He believed that the Author had conducted his fieldobservations with exemplary care, and that his results might, therefore, be accepted as substantially accurate, providing a sound basis for future work. It gave him pleasure to report that the Author hoped to return to this country next year, in order to continue these researches. Thanks were due to Mr. Buckman for bringing before the meeting this first valuable contribution.

Mr. G. W. LAMPLUGH said that the sequence of ammonite-zonos demonstrated by the Author could not fail to prove of service to students of the British Upper Jurassic rocks. The succession and correlation seemed to be firmly based, and, so long as this was the case, 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 Kimmeridge Clay as a descriptive lithological term could hardly be displaced.

The Author's discovery 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 original confusion of these forms with the *Polyptychites* of the Specton 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 *Aulacostephanus* 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 indurated shale, a number of small specimens which were referred by Mr. G. C. Crick to the *Haplites-euclocus* group. All are small, some very small, and more or less crushed, but the shell is still pearly.

The PRESIDENT (Dr. A. STRAHAN) pointed out that this was a purely palæontological research on a region in which the strata were strongly 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 palæontological 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 such names as Purbeckian, Portlandian, Kimmeridgian. If Kimmeridgian meant anything, it should have meant the Kimmeridge Clay of Kimmeridge and the neighbourhood. Yet, on paleontological 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 stratigraphical and palaeontological methods had arisen in the correlation of other formations, and would continue to arise so long as the stratigraphical and palaeontological methods of nomenclature were confused. In the Table before him he saw a zonal classification founded solely on the palaeontology, 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 were not to be taken as an adverse criticism of the palaeontological 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 palaeontological zones.

Mr. BUCKMAN, 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 sequence—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 South STAFFORD-SHIRE COALFIELD, and the PETRIFIED WOOD found therein at the WITLEY COLLIERY, HALESOWEN (WORCESTERSHIRE). By HENRY KAY, F.G.S. With an Appendix on *D.ADONYLON KAYI*, sp. nov., by E. A. NEWELL ARBER, M.A., Sc.D., F.G.S. (Read April 23rd, 1913.)

[PLATES XLIII & XLIV.]

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I. INTRODUCTION.

THE present paper deals with part of the higher beds of the Coal Measures, as developed in the South Staffordshire Coalfield. The generally accepted subdivision of the Upper Carboniferous rocks in this coalfield is :---

- (4) Keele Series = Lower Permian.
- (3) Halesowen Sandstone Series.
- (2) Red Coal-Mensure Clays or Old-Hill Marls.
- (1) Productive Measures.

The object of the present communication is to describe in greater detail than has yet been attempted the Halesowen Sandstone Series, and more especially its relationship to the Keele Series above, and the Red Coal-Measure Clays below. Special attention to the Halesowen rocks has been stimulated by the fine natural exposures north of the Clent 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.

I 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



J. W. Tutcher, Photo.

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Bemrose, Collo, Derby

J. W. Tutcher, Photo

Bernrose, Collo, Derby

PERISPHINCTES EASTLECOTTENSIS, sp. nov.

PERISPHINCTES EASTLECOTTENSIS, sp. nov.