were noted in the cases, particularly those of the big tree trunks that give an indication of the size and character of the specimens.

3. "*Coal-balls*" were described and demonstrated, in particular the magnificent piece of the unique mass recently acquired by the museum. The formation of the dolomitic concretions within the coal was outlined, and their immense importance to botanists indicated. They contain perfectly preserved fragments of plants of many kinds which composed the coal, as was seen in sections in the cases which were transparent enough for microscopic examination.

4. *Other petrified plant structures* were examined, and examples of silicification were noted in the case containing fine trunks of the Bennettitales and some of the large shafts of woody gymnosperms. The sheer beauty these sometimes possess was illustrated by a large specimen from Arizona.

5. More recent fossils were represented by masses of partly encrusted *Chara* from the Tertiary, which led up to the concluding reference to the process of petrification now going on in limy waters.

Throughout, one of the objects of the demonstrator was to indicate the general aspect of the fossils, and to encourage collectors to recognise specimens such as coal-balls, which give little outward indication of their truly interesting nature.

REPORT OF A VISIT TO THE EXHIBITS OF POLYZOA AND CORALS IN THE GEOLOGICAL DEPARTMENT OF THE BRITISH MUSEUM (NATURAL HISTORY).

SATURDAY, FEBRUARY 15TH, 1913.

By W. D. LANG, M.A., F.Z.S.

IN spite of the foggy weather, thirty-eight members assembled in the Central Hall, and were admitted to the Geological Department (which, owing to the darkness, was closed to the general public) by permission of the keeper, Dr. A. S. Woodward. Preceded by two attendants bearing lanterns, the party groped its way to the exhibited series of Polyzoa. Here, by the help of the lanterns, enough light was thrown upon the cases to make possible an inspection of their contents.

Attention was first directed to the general appearance of the skeletons of recent Polyzoa so commonly thrown up by the waves on the sea-shore;* and comparison was made with similar fossil skeletons occurring, generally in a fragmentary condition, in the stratified rocks. Next the fossil Polyzoa were considered

* *Electra* and *Flustra*.

from the point of view of their occurrence in the field. As a group they are capricious in their appearance in any one set of beds, tending to occur in pockets and irregularly, if at all, in a given thickness of rock. For instance, Polyzoa abound in the Bradford Clay, but are extremely rare in England in the Oxford Clay. It was later suggested by the President that the explanation of this sporadic appearance ultimately would be found by a study of the conditions determining a favourable Polyzoan environment.* An example of a nest of Polyzoa in a piece of Chalk is exhibited† [B.M. specimen D. 14,248]; also a slab of Carboniferous Limestone [B.M. specimen D. 2,457] full of such forms as *Fenestella*.‡ In spite of their irregularity in occurrence, here and there are horizons that are characterised over considerable areas by an abundance of Polyzoa, often mainly of one species; e.g., the "Bryozoa Bed" of the Lower Carboniferous in the neighbourhood of Bristol, full of *Rhabdomeson* [B.M. specimen D. 7,230];§ and the "Millepore Bed," made of *Haploecia*, in the Inferior Oolite of Yorkshire [B.M. specimens D. 750, D. 14,250].|| Other horizons, of considerable thickness, are, in places at least, composed largely of Polyzoa, and form Polyzoan Limestones and Sands. Of the former, the Rochester Shale from near New York [B.M. specimens D. 9,825, D. 9,827-8],¶ abounding in Polyzoa, is of the same age as our English Wenlock Limestone [B.M. specimens 38,492, D. 10,078], which itself is often similarly composed; and Polyzoan Limestones of corresponding age are exhibited from the I. of Gotland [B.M. specimen D. 14,249]. A similar case is presented by the Limestone of Faxø, Denmark** [B.M. specimens D. 9,111, D. 9,115], and that of Needs Camp, Buffalo River, Cape Colony†† [B.M. specimen D. 14,251], both of Danian age, and in places made almost entirely of Polyzoa. The Bathonian Calcaire à Polypiers of Normandy‡‡ [B.M. specimens D. 3,058, 60,224] is another Polyzoan Limestone; while the East Anglian Crag§§ [B.M.

* See, on this point, Gregory, 1896, "The Jurassic Bryozoa," British Museum Catalogue of Fossil Bryozoa, pp. 19 and 20. With his conclusions, however, I do not agree.

† The Chalk is that described by Rowe, 1908, *Proc. Geol. Assoc.*, vol. xx, part 4, pp. 231-2.

‡ The beds are described by A. Strahan, 1890, *Mem. Geol. Surv.*, expl. to sheet 79 S.E., pp. 25-6, and some of the contained Polyzoa by Shrubsole, 1881, *Quart. Journ. Geol. Soc.*, vol. xxxvii, pp. 178-189.

§ For horizon, see Vaughan, 1905, *Quart. Journ. Geol. Soc.*, vol. lxi, p. 229, and for general account see Stoddart, 1861, *Ann. Mag. Nat. Hist.*, series lii, vol. viii, p. 486.

|| For description with references to former accounts, see Fox-Strangways, 1892, *Mem. Geol. Surv.*, "Jurassic Rocks of Britain," vol. i, pp. 206-216.

¶ See Bassler, 1906, "The Bryozoan Fauna of the Rochester Shale," *Bull. U.S. Geol. Surv.*, No. 292.

** For the Polyzoa of this Limestone, see Pergens and Meunier, 1887, *Ann. de la Soc. Roy. Malac. Belg.*, vol. xxi, (1886) *Memoirs*, p. 187.

†† For horizon and extent, see Schwarz, 1909, *Trans. Geol. Soc. S. Africa*, vol. xi, pp. 107-115; also Newton, 1913, *Records of the Albany Museum*, vol. ii, No. 5, p. 332; and for the contained Polyzoa, Lang, 1908, *Ann. S. African Museum*, vol. vii, pp. 1-11.

‡‡ For horizon, see Lapparent, 1906, "Traité de Géologie," 5th edition, p. 117.

§§ For general account, see Reid, 1890, *Mem. Geol. Surv. United Kingdom*, "The Pliocene Deposits of Britain," pp. 19-41; and for the Polyzoa, Busk, 1859, *Mon. Pal. Soc.*, "The Fossil Polyzoa of the Crag."

specimen D. 3,960] and the Farrington Sponge Gravel* [B.M. specimen D. 14,433] are familiar Polyzoan Sands.

Another interesting point in connexion with the occurrence in the field of Polyzoa is the manner in which some incrusting forms prefer one particular kind of attachment. Harmer,† in the "Cambridge Natural History," gives examples among recent Polyzoa; and among fossils, *Stomatopora antiqua*, Haime, from the Lower Lias, incrusts *Gryphæa arcuata* (Lamarck) in preference to any other basis [B.M. specimens D. 7,622-3].‡

Having considered how they are generally found, the Field Geologist naturally turns to the use of Polyzoa for determining horizons. Their usual manner of occurrence, irregularly and in pockets, prepares him for their general uselessness. To be of value for determining horizons, a group of fossils should be distributed as evenly as possible throughout a considerable thickness of beds and over a wide area; and it is just these conditions that Polyzoa do not, as a rule, fulfil. Again, to be useful to the field-worker, a fossil should be obvious and easily determined. Polyzoa are small, and, until cleaned, stained, and subjected to a searching microscopic examination, generally cannot be determined with any accuracy. Their use in the field, then, is necessarily small; and on that account, probably, they are a much-neglected fossil-group. The number of fossil species is, moreover, so vast, and so little work has been directed towards unravelling their relationships, that it is not possible at present even to exhibit them so that the collector can identify his specimens.

Nevertheless, it will almost certainly be possible, when the detailed work has been done, to determine with considerable accuracy the horizon of any Polyzoan-bearing bed by means of its contained Polyzoa. Three examples, though capable of determining only within fairly wide limits the horizon of the beds whence they came, are shown as earnest of an increasingly closer correlation of horizons by means of Polyzoa. *Coscinopleura*§ [B.M. specimens D. 23,391, D. 23,393] has been found at Rügen, Trimmingham, Maastricht, and New Jersey, U.S.A.; that is, it has never been found below the mucronata-zone, and it ranges into the Danian. *Cribrilina gregoryi*, Brydone|| [B.M. specimen D. 23,963], is a species characteristic of the quadratus-zone, though it has been found as low as cor-anguinum. Its presence, however, is suggestive of quadratus, and its abundance almost conclusive.¶ Finally, two related and unnamed

* See Treacher, 1907, *Proc. Geol. Assoc.*, vol. xx, p. 115, for general account and references to previous notices.

† Harmer, 1901, "Cambridge Natural History," vol. ii, p. 478.

‡ See Lang, 1905, *Geol. Mag.*, dec. v, vol. ii, p. 258.

§ Marsson, 1887, "Palæontologische Abhandlungen," vol. iv, part 1, p. 71.

|| Brydone, 1906, *Geol. Mag.*, dec. v, vol. iii, p. 330.

¶ A glance at the list of pits in Brydone's "Stratigraphy of the Chalk of Hants," 1912, is convincing. Of 398 pits in the cor-anguinum zone, *C. gregoryi* is recorded from three (pp. 53, 62, 70); of 285 pits in quadratus, *C. gregoryi* is recorded from 22 (pp. 89-95). The specimen exhibited, D. 23,963, has helped to determine the horizon of a Sussex pit (Dankton Lane, N.E. of Sompting Church) as quadratus.

species of uniserial Cheilostomes [B.M. specimens D. 491, 40,246] divide the English Chalk between them at the junction of the quadratus-and Marsupites-zones.*

Polyzoa are next considered in their zoological relationships. As with other fixed animals, their affinities must primarily be sought in their free-swimming larvæ. Unfortunately, most Polyzoa (Ectoprocta) rear their young in brood-pouches, and thus the evidence afforded by their earliest stages is masked. A few Ectoprocta, however, lay their eggs in the sea, and the larvæ on hatching resemble those of the Entoprocta, a small and peculiar group of Polyzoa, whose larvæ, in turn, closely resemble the Trochosphere larvæ of Chætopod worms. Polyzoa are consequently to be regarded as descended from the ancestors of Chætopod worms and more closely allied to them than to any other phylum.†

The larva, on settling, secretes a spherical shell, called by Cumings the protoecium.‡ It undergoes metamorphosis, and the first zoecium, the ancestrula§ of Jullien, appears and secretes a shell (which I propose to term the ancestrœcium) which carries the protoecium like a bulb at its proximal end. Specimens of Cyclostomata from the Jurassic rocks show these stages very clearly [B.M. specimens D. 21,450, D. 21,469, D. 21,297, D. 21,307]. In the Trepustomata, chiefly Palæozoic, Cumings has demonstrated by sections, and an exhibited restoration shows how the ancestrœcium is not so clearly differentiated from the protoecium;|| and this is still further marked in the Cryptostomata, of which *Fenestella* is a familiar example. In the Cheilostomata, protoecium and ancestrœcium cannot be differentiated.

Hitherto the Polyzoan, followed from the egg to the metamorphosed larva, has consisted of a single individual, and it has been seen how, even in this early stage, the main Polyzoan orders can be distinguished. Henceforth, the Polyzoan is a colony; for the ancestrula buds from one to three individuals, and these by budding form colonies which ultimately may contain many hundreds of individuals. Just as the individual in its growth exhibits characters that indicate its ancestry, so the colony as a whole is found to have a life history, exhibiting in orderly succession characters that indicate the past history of the race. Such a phenomenon has been termed by Cumings and Ruedemann "astogeny" (from *το ἄστρον*, "the city"),¶ comparable

* These both have been recorded as *Hippothoa dispersa* (von Hagenow). They are not this species, nor do they belong to the genus *Hippothoa*.

† This view is not universally accepted; it is that, however, held by Dr. Harmer, one of the highest authorities on the group. See Harmer, 1901, "Cambridge Nat. Hist.," vol. ii, p. 510.

‡ Cumings, 1904, *American Journ. Sci.*, series iv, vol. xvii, p. 50. See, too, Cumings, 1905, *op. cit.*, series iv, vol. xx, p. 170.

§ Jullien, 1888, *Mission Sci. du Cap Horn*, Zoologie, tome vi, Bryozoaires, p. 29.

|| Cumings, 1912, *Bull. Geol. Soc. America*, vol. xxiii, pp. 357-366. See also Cumings, 1905, *loc. cit.*

¶ Cumings, 1904, *loc. cit.* and 1905, *op. cit.*, p. 169, and Ruedemann, 1904, *Mem. New York State Museum*, No. 7, p. 526.

with the "ontogeny" of the individual. Examples of this are seen in the arrangement of the individuals in Jurassic Cyclostomata [B.M. specimens D. 21,440, D. 21,475, D. 21,329],* in the general shape of the aperture in Cheilostomata [B.M. specimen D. 14,963];† and a further modification of the principle is shown, where, in a branching uniserial Cheilostome, recapitulation of earlier stages is seen to occur at each branch [B.M. specimen D. 8,353].‡

The method and order of budding is seen to be important in Cheilostomes [B.M. specimen D. 14,963], and it is by modifications of this character that the change from uniserial to multiserial colonies is brought about, not, as in the Cyclostomata, mainly by the angle taken on by the new buds.§ In forms that pass from a multiserial to a katagenetic uniserial stage, the budding does not necessarily revert at once to the type characteristic of the uniserial condition.

Finally, heteromorphism in Polyzoa is shortly considered. Even in comparatively simple Cyclostomes dimorphism of the individuals composing the colony creeps in, in the form of minute individuals whose skeletons are known as tubules;|| and in all the orders it is common. As a rule, it is merely surmise that attributes definite functions to the abnormal individuals. The most startling among recent forms are the avicularia and vibracula of Cheilostomes. In these, the operculum is modified to form, in the one case a snapping beak, and in the other case a sweeping lash; and it is at least probable that the function in both cases is defensive, the avicularia to nip and so to render uncomfortable any organic body, and the vibracula to sweep away anything inorganic that otherwise would settle on the colony. And that is all that can be said of the function of heteromorphic individuals of a Polyzoan colony, except certain ones, common among Cyclostomes, which are modified to form brood-pouches. Such modified individuals are called gonœcia,¶ and must not be confounded with gonocysts,** brood-pouches in the formation of which more than one individual takes part. The nature of the familiar ovicells of Cheilostomata is still doubtful, but it is probable that they do not represent modified individuals.**

Time did not permit more than a cursory visit to the Corals; and the case containing an exhibit of Vaughan's Carboniferous Zones as illustrated by Corals was examined.††

* See Lang, 1904, *Geol. Mag.*, dec. v, vol. i, pp. 316-317.

† See Lang, 1906, *Geol. Mag.*, dec. v, vol. iii, p. 67.

‡ See Lang, 1905, *Geol. Mag.*, dec. v, vol. ii, pp. 259-260, and Bather, 1911, *Museums Journal*, vol. x, p. 312. Also Jackson, 1899, *Mem. Boston Soc. Nat. Hist.*, vol. v, p. 141.

§ See Lang, 1904, *op. cit.*, pp. 319, 320.

|| For example, in *Diastopora obelia* (Johnston), as described and figured by Hincks, 1880, "A History of the British Marine Polyzoa," p. 462, plate lxvi, fig. 10.

¶ Gregory, 1896, *Brit. Mus. Cat.*, "Jurassic Bryozoa," p. 12.

** See Hartner, 1903, *Quart. Journ. Micro. Sci.*, vol. xlv, p. 284.

†† An account of this exhibit was given in the *Geol. Mag.*, 1912, dec. v, vol. ix, pp. 435-7.