organic remains; but it is remarkable that whereas in other cases radiolaria are commonly recognizable, in these slides no structure was observed that could be definitely referred to this group.

While the writer feels no hesitation now in regarding the Singapore rocks as an extension of the Pahang Tembeling Series, he nevertheless thinks a word is necessary regarding the palæontological evidence in order to meet a possible objection. Mr. R. B. Newton, to whom the writer is greatly indebted for assistance in this direction, when describing the fossils found by Mr. Bellamy near Kuala Lipis, in Pahang, as Rhætic, emphasized the fact that *Myophoria* is exclusively Triassic.¹ The same author, referring to *Estheriella radiata* (Salinas), var. *multilineata*,² found in Tembeling Series rocks in Perak, and described by Professor Rupert Jones,³ also remarks that the genus *Estheriella*, "so far as can be ascertained, is only known to have existed in Triassic times"; while, writing of the Singapore fossils, Mr. Newton says that the beds containing them "may be of Middle Jurassic age, and about the horizon of the Inferior Oolite of England or the so-called Bajocian of Continental geologists."⁴ The presence of *Goniomya* and *Podozamites* leads the author to this conclusion, but he remarks that *Goniomya* has also been found in Palæozoic rocks, although exceedingly rare;⁵ and the range of *Podozamites* in Europe is described by Nicholson & Lydekker as "from the Rhætic into the Lower Cretaceous."⁶

It is far from the writer's purpose to suggest any amendment to these remarks on the fossils he had sent to England. His object is to show that the palæontological evidence does not make it necessary either to separate the Singapore and Pahang beds, or to assume that a series of estuarine deposits of unknown thickness covers at least part of the Rhætic, the whole of the Lias, and part of the Inferior Oolite.

Mr. Newton has suggested that the Singapore rocks may be an extension of the Upper Gondwana of India, and the writer has made a similar suggestion regarding the Tembeling Series. It will be very interesting in this connection to see the result of the examination of the Shan States Rhætic fossils collected by Mr. De la Touche.

II.—SEDGWICK MUSEUM NOTES: NEW FOSSILS FROM GIRVAN.

By F. R. COWPER REED, M.A., F.G.S.

(PLATE XII.)

Ischadites Königi, Murchison.

IN the list of fossils from the Silurian rocks of the South of Scotland in the collections of the Geological Survey⁷ the two species of *Ischadites*, *I. antiquus*, Salter, and *I. Königi*, Murchison, are entered

¹ "Marine Triassic Lamellibranchs from the Malay Peninsula": Proc. Malac. Soc., vol. iv, part 3, October, 1900, p. 130.

² GEOL. MAG., 1905, p. 49.

³ Ibid., pp. 50-52.

⁴ Ibid., 1906, p. 488.

⁵ Ibid., pp. 487-8.

⁶ "A Manual of Palæontology," vol. ii (1889), p. 1526.

⁷ Mem. Geol. Surv., Silurian Rocks of Britain, vol. i, Scotland, 1899, p. 668.

as occurring in the Llandovery rocks, while a third unnamed species is recorded from the Caradoc. In the list of fossils prepared by Mrs. Gray from the collection made by her from the Silurian rocks of the Girvan district,¹ *I. Königi* is recorded from the Llandeilo beds of Balclatchie, *I. antiquus* from the Upper Llandovery of Penkill and the Middle Llandovery of Woodland Point, and *I. sp.* from the Middle Llandovery of Newlands. Nicholson & Etheridge² mentioned only two specimens of *Ischadites*, one from Balclatchie and the other from Penkill; both were referred to under the name *I. Königi*, but it was remarked that one of them appeared to possess more the characters of *I. antiquus*. The first discovery of *I. Königi* in the Girvan area was made by Mr. Robert Gray and was noticed by Professor J. Young³ in 1868, and in 1876 the same author recorded it from Penkill in his "Catalogue of Western Scottish Fossils," p. 13. Dr. Hinde⁴ gives both the localities, Balclatchie and Penkill, for the occurrence of *I. Königi*, but he regards the species *I. antiquus* as indistinguishable from it. The only other British species mentioned by this author (loc. cit.) is *I. Lindströmi*, Hinde.

The specimens submitted to me by Mrs. Gray comprise portions of four individuals with the external impression of one of them. All come from the Upper Llandovery of Penkill, and are in a poor state of preservation. The slightly concave base is seen in two of them, the smaller specimen measuring only 11 mm. in diameter and the larger one 35 mm.; the central 5-6 series of summit plates are arranged in fairly definite concentric circles. In another of the specimens the horizontal rays of the spicules number only three, the proximal ray being absent, as Hinde has explained is sometimes the case.⁵

There is only one specimen from Balclatchie which Mrs. Gray has sent me, and this closely agrees with Salter's *I. antiquus*⁶ from the Llandeilo of Garn Arenig, Wales. The four horizontal rays of the spicules are well seen on the narrow transversely rhomboid summit plates, which also seem rather more numerous than in the Penkill examples of *I. Königi*. Only the basal portion of the sponge is preserved, and the central portion seems to have been somewhat elevated into a short obtuse boss; but the whole organism has been crushed and more or less flattened out, thus increasing the apparent diameter, which measures about 38 mm.

Receptaculites Grayi, sp. nov. (Pl. XII, Figs. 1, 2.)

Amongst the material which Mrs. Gray has recently sent me for determination there are several very fragmentary specimens from the Middle Llandovery of Woodland Point which must be referred to the genus *Receptaculites*, and they probably represent a new species. They consist of portions of the upper and lower surfaces, but no

¹ Mem. Geol. Surv., Silurian Rocks of Britain, vol. i, Scotland, 1899, pp. 510, 543, 686.

² Nicholson & Etheridge: Mon. Silur. Foss. Girvan, pt. i (1873), p. 20.

³ Young: Proc. Nat. Hist. Soc. Glasgow, ser. i, vol. i (1869), p. 197.

⁴ Hinde: Quart. Journ. Geol. Soc., vol. xl (1884), p. 835.

⁵ Ibid., p. 814, pl. xxxvi, fig. 1j.

⁶ Salter: Mem. Geol. Surv., vol. iii (1866), p. 282, fig. 4.

perfect individual occurs amongst them. Some of these fossils have a slightly convex or domed surface composed of small plates, which much resemble in appearance those described and figured by Rauff¹ as belonging to the wall of *R. orbis*, Eichwald, as preserved in a limestone pebble of Ordovician age from Wartin in Pomerania. The Girvan organism must have been elliptical or subcircular in shape, and the more or less marked convexity of the upper surface, which these plates cover, seems to be an original and natural feature and not due to distortion or pressure. The plates themselves on the upper surface are small, numerous, of regular rhomboidal shape, and of equal size, about seven plates measuring 10 mm. along their greater diameters, and about nine plates measuring also 10 mm. along their shorter diameters. The plates are fitted closely together into a pavement, as usual in the genus; the boundaries of the individual plates are not very sharply marked, being partly obscured by their ornamentation and perhaps fused to a certain extent along their edges. In one specimen there is a pore at each angle between the plates, as Hinde² has shown in his figures of *R. occidentalis*. Each plate is gently convex, rising slightly towards the centre, in which is a more or less indistinct small depression, from which radiate to the sides a number of short, broken, irregular, and sinuous ridges and vermiculate grooves, interspersed with or replaced by small closely-set pits and tubercles of the same size and elevation, which by their fusion seem to produce the above-mentioned ridges and grooves (Pl. XII, Fig. 1). On many of the plates only pits and tubercles are present, and no radial arrangement is noticeable. From the examination of both the natural casts and the external impressions of the same specimens which have been carefully collected by Mrs. Gray, and from the regular occurrence of these surface-features, it becomes clear that they are not due to weathering, though Rauff was in some doubt on this point in connection with his specimen of *R. orbis*. Our Girvan species differs from the latter by the less distinct character of the radial ornamentation, by the more transversely rhomboidal shape of the plates, and by their reduced overlapping.

A fragment of the lateral (lower) surface and margin of the same species comes from the same horizon and locality. It shows a few of the outer series of upper plates, apparently similar to those above described but rather larger, situated near the edge of the upper dome, and passing over into the flattened, smooth, and larger subquadrate plates of the lower surface. These plates decidedly overlap, like tiles, from above downwards, the lower overlapping angle being generally rather prominent and thickened. A shallow median depression or pit is generally noticeable on each plate, indicating the point of attachment of the vertical ray or column of the spicule. Rauff has figured closely similar plates (op. cit., t. i, fig. 10) from the upper surface of *R. Neptuni*. Occasionally traces of tubercles seem to be visible on the surface of these plates, but this is doubtful.

¹ Rauff: Abhandl. k. bayer. Akad. Wiss. Math. Phys. Kl., Bd. xvii (1892) p. 688, t. iv, figs. 2-6.

² Hinde, op. cit., pl. xxxvii, figs. 3d, 3e.

The plates decrease in size gradually downwards towards the base or lower pole, but the specimen is very imperfect. However, the distinction between the small convex, radially pitted plates with depressed sutures on the upper surface, and these large, smooth, almost flat, tile-like, overlapping plates of the lower surface, is most marked, as Hinde has pointed out in *R. occidentalis*.

As for the actual shape of this sponge from Woodland Point, the evidence certainly suggests that the upper surface was domed; the base is imperfectly known, and whether it was concave like *Ischadites Königi* or convex or conical must remain at present an open question.

No British species of *Receptaculites* appears to have been described with the above characters, and the Scandinavian and Russian *R. orbis*, Eichwald,¹ from the Lower Silurian, appears to possess the nearest affinities.

The cast and impression of the specimen from the Middle Llandovery of Newlands which has been entered in Mrs. Gray's list as *Ischadites* sp. may probably belong to this same species. But it is in a poor state of preservation, and consists of a mere fragment of the upper surface. The plates are of regular rhomboidal shape, measuring about 2 mm. along their longer diameter, and 1 mm. along their shorter diameter; their surface appears to be channelled and pitted, and pores are found at their angles in the suture-lines, with 3-4 additional pores, usually smaller in size, along their sides. But the surface of the fossil is much weathered and imperfect, so that it is difficult to know which of these characters and structures are original.

Receptaculites girvanensis, sp. nov. (Pl. XII, Figs. 3-6.)

Shape crateriform, low, conical, with broad thick rounded lip and obtusely pointed base. Plates very numerous, rhomboidal to quadrate, all four sides being almost of the same length, very small near base, increasing very gradually in size from base to lip of cup, arranged in regular series of strongly curved intersecting rows in the usual 'engine-turned' fashion; towards the lip the series run almost horizontally owing to the strong curvature of the rows, and the plates of successive series seem to lie in vertical rows. Lower plates near base subquadrate, with surface flattened and overlapping slightly in tile-like manner; but becoming more and more convex towards lip, where no imbrication is present, and a large pore lies in the grooves at each angle between the plates. Surface of flattened lower lateral plates smooth; surface of convex lip plates ornamented with small irregular pittings.

Dimensions.—Diameter of cup, about 47 mm.; height of ditto, about 22 mm.; size of plates on lip, 8 plates to every 10 mm.

Remarks.—One large specimen, of which the dimensions are given above, affords the principal means of diagnosing the characters of this form, but there is another smaller example broken off below the lip which has a diameter of about 20-25 mm. and a height of 9-10 mm. Both come from the Starfish Bed of Thraive Glen. The larger one is fairly well preserved, though the surface of the plates is somewhat

¹ Rauff, op. cit. supra.

weathered and the concavity of the cup is hidden by matrix. It seems to be a new species, but the arrangement of the plates and general characters ally it to *R. occidentalis*, Salter,¹ of the Trenton and Galena Limestones of North America, and to *R. orbis*, Eichw.,² from the Orthoceras Limestone of the Baltic regions.

It cannot, however, be identified with either of these species, nor with any other previously described from the British Isles, and though its characters are somewhat imperfectly known a specific designation seems necessary, and that of *R. girvanensis* is suggested.

Spongarium ardmillanense, sp. nov. (Pl. XII, Figs. 7, 8.)

Corallum subcircular, discoidal, or saucer-shaped, flattened, thin, composed of small, contiguous, low, rounded, subequal ridges, radiating to margin regularly and horizontally in one plane from small smooth central area, and increasing in number by bifurcation at a little more than half their length with a considerable amount of regularity (and by less frequent intercalation) to the number of 100–110 on the margin. Ridges crossed by 3–4 strong concentric wrinkles and by numerous fine, regular, equidistant, closely-set, impressed lines. Inferior, surface of corallum not visible.

Dimensions.—Major diameter, 30 mm.; minor ditto, 25 mm.; about twelve ridges to every 10 mm. round margin.

Remarks.—The counterpart of this specimen has precisely the same appearance, the disc or flattened saucer having been split regularly in one plane. Probably the base was covered with a thin epitheca, and it seems to have had a small central knob for attachment. The substance of the corallum appears to have been of a black corneous nature.

This peculiar fossil may best be referred to the genus *Spongarium*, the true affinities and zoological position of which are unknown. The species which approaches it most closely is *Sp. æquistriatum*, McCoy,³ from the Upper Ludlow rocks; the elliptical shape and coarseness of the closely-set radiating ridges are features in common, but in the bifurcation of the ridges in our species there is an obvious difference. No British member of this genus appears to have been recorded except from the Ludlow beds. Ours comes from the Balclatchie Group of Ardmillan.

Annelidan Tube (?). (Pl. XII, Figs. 9, 10.)

Body forming a regularly cylindrical (?), straight, jointed tube, composed of a number (+ 15) of thin, calcareous, nearly flat rings of regular and equal size, successively overlapping to a slight extent those behind, and somewhat thickened towards the overlapping (posterior) edge. Each ring has a length approximately equal to one-third the diameter of the tube, and is marked by fine regular longitudinal plications, causing a weak serration of the posterior edge; a very delicate longitudinal striation is also present. Length of rings, 1.5–1.6. Diameter of tube, about 5 mm.

¹ Hinde, op. cit., p. 842, pl. xxxvii, figs. 3, 3a–m.

² Rauff, op. cit., pp. 654–691, t. iii, figs. 7–10; t. iv, figs. 1–6.

³ McCoy: Brit. Pal. Foss. Woodw. Mus., 1855, p. 42, pl. 1 B, figs. 15, 15a.

Horizon and Locality.—Drummuck Group: Thraive Glen, Girvan.

Remarks.—The three specimens in Mrs. Gray's collection are somewhat crushed and the tube is flattened, supposing it to have been once cylindrical; and it is to crushing that we may attribute two continuous longitudinal grooves running down the side of one specimen across several rings; and possibly in another specimen a narrow flattened longitudinal ridge traversing uninterruptedly six or seven consecutive segments is also due to the same cause.

This curious jointed tubular fossil is most probably of an annelidan nature, and allied to *Cornulites* and *Conchicolites*.¹ It differs from the former by its cylindrical instead of conical shape, but agrees in the overlapping of the flat rings and longitudinal striation, as well as in its solitary habit and non-attachment to foreign objects. *Conchicolites* is gregarious, attached, and curved, with thin walls and no longitudinal striæ, but is not so markedly conical as *Cornulites*. The latter is known only from the Silurian, but *Conchicolites* is an Ordovician genus. It does not seem possible to refer it to either of these genera sens. str., though its affinities with them are suggested.

EXPLANATION OF PLATE XII.

- FIG. 1.—*Receptaculites Grayi*, sp. nov. Plates of upper surface, showing ornamentation. $\times 6$.
 „ 2.—Ditto. Plates of lower surface. $\times 4$.
 „ 3.—*Receptaculites girvanensis*, sp. nov. General view of specimen. $\times 1\frac{1}{2}$.
 „ 4.—Ditto. Portion of lateral surface of same specimen, showing arrangement of plates. $\times 2$.
 „ 5.—Ditto. Plates near lip of same specimen. $\times 8$.
 „ 6.—Ditto. Plates near base of same specimen. $\times 6$.
 „ 7.—*Spongarium ardmillanense*, sp. nov. $\times 1\frac{1}{2}$.
 „ 8.—Ditto. Counterpart. $\times 1\frac{1}{2}$.
 „ 9.—Annelidan tube (?). $\times 3$.
 „ 10.—Ditto. Two segments. $\times 6$.

III.—ON SOME MINOR BRITISH EARTHQUAKES OF THE YEARS 1904–1907.

By CHARLES DAVISON, Sc.D., F.G.S.

THE four years 1904–1907 were marked by the occurrence of three considerable earthquakes, one of which (the Derby earthquake of July 3rd, 1904) disturbed an area of about 25,000 square miles, another (the Doncaster earthquake of April 23rd, 1905) an area of about 17,000 square miles, while the third (the Swansea earthquake of June 27th, 1906) was felt over an area of 66,700 square miles, and, with the exception of the Hereford earthquake of 1896, was the strongest felt in this country during the last twenty years. Besides these, there were 56 others of less intensity, 9 of which originated in England, 44 in Scotland, and 3 in Wales. The total number for the nineteen years 1889–1907 is thus 214, or 50 in England, 137 in Scotland, and 27 in Wales.

¹ Nicholson: Amer. Journ. Sci., vol. iii, ser. III (1872), p. 202.