Walker collection at Cambridge, with notes on certain of these, and for the loan of specimens; to Mr. T. H. Withers for his report on the Upper Greensand cirripedes; to Dr. B. Pope Bartlett for reporting on rock-specimens and fossils of Upper Greensand and Cenomanian age submitted for his opinion; and to our colleagues Mr. C. B. Wedd, for many helpful criticisms, and Mr. W. Manson, for the skill and care with which he has prepared the drawings for our illustrations.

Carboniferous Fossils from Siam.

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

(PLATE II.)¹

Introduction.

IN 1899 the Cambridge Exploring Expedition to the Malay Provinces of Lower Siam collected a few fossils and many rock-specimens at a place named Kuan Lin Soh, in the Patalung district. A small broken image of Buddha from the temple of Bah Nah containing some similar fossils was considered to have been quarried from the same beds, and it was believed that these specimens represented strata of Cretaceous age.²

In the following year a brief report on the same material was made by the late Professor T. McK. Hughes,³ and he was led to regard the fauna as indicating the highest beds of the Carboniferous or the Permo-Carboniferous, basing his conclusions on the following rough determination of the fossils: "*Proetus* sp., encrinite stems and arms, several species of lamellibranchs and brachiopods, including at least one species of *Chonetes*, *Pleurotomaria* sp., and a cephalopod with horse-shoe lobes." Special attention was paid to the lithological characters of the rocks in which the fossils occurred, and two types were recognized by Professor Hughes: (1) a grit of varying coarseness without determinable fossils, and (2) a very fine rock composed almost entirely of silica, with practically no lime, but some alumina.

It is the latter rock which has yielded the organic remains here described, the coarser rock not having any recognizable fossils in it.

The fossiliferous rock is of a curious and uncommon character, having an argillaceous or even chalky appearance, though thin sections and chemical analyses prove that it is almost entirely composed of minute grains of silica. When fresh it is tough and hard, with rarely a shaly and usually a subconchoidal fracture. It is whitish in colour, but occasionally is stained yellow or pink. It becomes soft and pulverulent when weathered and more or less decomposed, with a chalky feel and aspect.

¹ This Plate will appear in the March issue.

² Report Brit. Assoc., Bradford, 1900, pp. 393-8.

³ Report Brit. Assoc., Glasgow, 1901, p. 414.

The fossils, which are scarce and mostly fragmentary, are in a poor state of preservation, consisting either of crushed internal casts or external impressions, with the shell sometimes retained as a thin film.

It was felt that a more detailed examination of the material than was given in 1900-1 might yield fuller and more definite results, and Professor Hughes accordingly entrusted me in 1915 with the task, as the specimens had been deposited in the Sedgwick Museum. A large number of fragments have been carefully broken open or split, and by this means it has been possible to augment to a considerable extent the list which Professor Hughes gave in 1901, and to fix with more certainty the stratigraphical position of the beds. The fauna proves to be of peculiar interest, and in the almost total ignorance of the geology of this district of Siam the following notes may be of value to future investigators in these parts.

Pronorites aff. *cyclolobus* (Phillips). (Pl. II, Fig. 1.)

The late Mr. G. C. Crick kindly examined for me the single specimen of a cephalopod in the collection which shows a suture-line distinctly, and he considered that the shell was referable to the genus *Pronorites* and allied to the Carboniferous species *Pr. cyclolobus* (Phillips).¹ Our specimen shows about the last quarter of the outer whorl and a portion of the body-chamber; four suture-lines are preserved. The more strongly marked horseshoe-shaped saddles and the blunter or even rounded second lateral and accessory lobes, and the fact that the first and second lateral saddles nearly touch respectively those of the preceding suture-line and overlap the bases of the preceding adjoining lobes, are features which distinguish it from the typical *Pr. cyclolobus*. The whole shell when perfect must have measured about 20-25 mm. in diameter.

Prolecanites (?) sp.

Some poor impressions of the exterior and some flattened imperfect internal casts of a goniatite may perhaps be referable to a species of the genus *Prolecanites* rather than to *Pronorites*, but the reference is uncertain. The shell was apparently discoid and laterally compressed with all the whorls (6-7) exposed in the wide, shallow, open umbilicus. The overlapping of the whorls appears to have been slight, but the outer whorl increases more rapidly in size than the inner ones, and there are some traces of a more complicated suture-line than in *Pronorites*. Perhaps *P. compressus* (Sow.)² and *P. mixolobus* (Phill.)³ may be compared with it; the latter is

¹ Phillips, *Geol. Yorkshire*, 1836, pt. ii, p. 237, pl. xx, figs. 40-2. Foord and Crick, *Cat. Foss. Ceph. Brit. Mus.*, pt. iii, 1897, p. 264, text-fig. 125, p. 261.

² Sowerby, *Min. Conch.*, vol. i, 1813, p. 84, pl. xxxviii. Foord & Crick, *Cat. Foss. Ceph. Brit. Mus.*, pt. iii, 1897, p. 252, fig. 121.

³ Phillips, *Geol. Yorks*, pt. ii, 1836, p. 236, pl. xx, fig. 43; Foord & Crick, *op. cit.*, p. 254.

recorded by Crick¹ from the Coddon Hill Beds of Devonshire, which are closely similar lithologically as well as faunistically with the Siamese deposit, and the same species is a characteristic one of the "Posidonienschiefer" of the Harz and of Geigen, near Hof. There is apparently another species of *Prolecanites* or more probably *Nomismoceras* represented in the collection, but it is too poorly preserved for determination.

Glyphioceras (?) sp.

One slab of rock contains many much-crushed casts and impressions of a subglobose cephalopod with a broad rounded back and large convex outer whorl, slowly increasing in size, but almost completely overlapping the inner whorls, which are exposed in a small, deep, umbilicus with rectangular (?) edges. A few widely distant concentric constrictions cross the outer whorl. This shell may belong to the genus *Glyphioceras* (cf. *Gl. mutabile* Phill.),² or to *Gastrioceras* (cf. *G* (?) *Kayseri* Loczy,³ of the Carboniferous of China), but there is not sufficient of it known to determine its relations. Mansuy⁴ has doubtfully recorded the genus *Glyphioceras* from the Carboniferous of Eastern Yunnan, but it is a well-represented genus in the "Posidonienschiefer" of the Harz.

Pleurotomaria (*Mourlonia*) aff. *conica* Phillips. (Pl. II, Fig. 2.)

There is one portion of a shell of a *Pleurotomaria* half imbedded in matrix and somewhat crushed, but it can be seen to have been a low trochiform shell of 4-6 whorls, rapidly increasing in size and with an apical angle of 70-80 degrees. Each whorl is rather sharply angulated at the band, which in the basal whorl is peripheral, but on the upper whorls is situated a little distance above the suture-line. The apical surface of the whorls is slightly excavated just above the band, but becomes gently convex near the suture-line. Below the band the umbilical surface of the basal whorl seems to have been strongly convex, but it is rather crushed and has a concentric fracture simulating a revolving ridge. The margins of the band are sharp and prominent. The surface of the whorls is crossed by strong, regular, transverse, curved striæ, which are of almost equal size and nearly equidistant, and they meet the band on the apical surface at about 30 degrees or less, but apparently are nearly at right angles to it below. Dimensions: height (estimated) about 17 mm., basal diameter about 19 mm. With regard to its

¹ Crick, Quart. Journ. Geol. Soc., vol. lv, 1895, p. 652.

² Phillips, *Geol. Yorks*, pt. ii, 1836, p. 236, pl. xx, fig. 26. Crick, *Cat. Foss. Ceph. Brit. Mus.*, pt. iii, 1897, p. 181 (and references). Holzapfel, *Palæont. Abhandl.*, vol. v, pt. i, 1889, p. 29, t. ii, figs. 2-6.

³ Loczy, *Wiss. Ergebn. Reise Szechenyi in Ostasien*, Bd. iii, 1898, p. 44, t. i, figs. 7, 7a. Schellwien in Futterer's *Durch Asien*, Bd. iii, Lief. i, 1903, p. 139, t. i, figs. 1, 2.

⁴ Mansuy, *Mem. Surv. Geol. Indochine*, vol. i, fasc. ii, 1912, p. 87, pl. xvi, fig. 5.

affinities, this shell seems to resemble *Pl. conica* Phillips,¹ of the Carboniferous Limestone, which Mrs. Longstaff² thinks may belong to the subgenus *Trechmannia* rather than to *Mourlonia* sens. str. The figure of a shell named *Pl. vittata* Phill. by Holzapfel³ also bears a considerable resemblance to our specimen, and we may also compare the species *Pl. (Mourl.) Cayeuxi* Mansuy,⁴ described from the Dinantian of Eastern Yunnan.

Euomphalus cf. *subcircularis* Mansuy. (Pl. II, Fig. 3.)

Several specimens of small planorbiform shells, with an average diameter of about 8 mm., may perhaps be compared with Mansuy's *E. subcircularis*⁵ from the Carboniferous of Eastern Yunnan, though there are many European species which may be allied. The shell is coiled in a flat spiral of 5-6 rounded whorls, nearly subcircular in section and increasing very slowly in size, with a submarginal carination on the upper surface dying out towards the mouth. The spire is rather sunken, being slightly depressed below the level of the outer whorl, and the open umbilicus is also concave. Rather strong concentric striae cross the whorls.

Helminthochiton cf. *priscus* (Münster). (Pl. II, Fig. 4.)

There is one symmetrical sub-semicircular and subconical plate of a species of *Helminthochiton* measuring 6 mm. in diameter, which agrees in general characters with the anterior plate of *H. priscus* (Münst.) as described and figured by De Koninck.⁶ The slightly raised small median apex projects a little behind the angulated posterior end, and from the apex there radiate on each side a pair of submarginal fine straight grooves separating low rounded ridges. A rather large crescentic shelly process or shelf projects at a lower level behind the posterior end of the plate, and is crossed by a narrow triangular fissure which is doubtfully an original feature.

Parallelodon aff. *corrugatus* De Koninck. (Pl. II, Fig. 5.)

There is one right valve of a shell which is referable to the genus *Parallelodon*, but like the other fossils it is badly preserved. In shape it is transversely rhomboidal; the inferior margin is gently sinuated; the posterior end is rounded-subtruncate; the beak is broad, low, obtuse, and situated at about one-third (or less) the length of the shell; and the surface is ornamented with very fine radial lines and concentric growth-lines, the latter becoming stronger near the margin. In length the valve is about 15.5 mm., and in height about 9.5 mm. It appears to be allied to *P. corrugatus* De Koninck, as described

¹ Phillips, *Geol. Yorks*, vol. ii, 1836, pl. xv, fig. 22.

² Longstaff, *Quart. Journ. Geol. Soc.*, vol. lxviii, 1912, p. 303.

³ Holzapfel, *Palæont. Abhandl.*, vol. v, pt. i, 1889, p. 50, t. vi, fig. 14.

⁴ Mansuy, *op. cit.*, vol. i, fasc. ii, pt. ii, 1912, p. 89, pl. xvi, fig. 7.

⁵ Mansuy, *op. cit.*, vol. i, fasc. ii, pt. ii, 1912, p. 105, pl. ix, figs. 3a-3d.

⁶ De Koninck, *Fauna Calc. Carb. Belg.*, vol. iv, 1883, p. 199, pl. l, figs. 37-48; pl. li, fig. 36; pl. liii, figs. 21-9.

by Wheelton Hind,¹ but the ornamentation is finer. We may also compare, as regards general shape, the Culm shell from Hagen, figured by Nebe² as *Macrodon* cf. *normalis* De Koninck.

Edmondia sp. (Pl. II, Fig. 6.)

One internal cast and external impression of a small oval shell measuring 10·5 mm. in length and 8·5 mm. in height has the anterior and posterior ends subequally rounded; the inferior margin is strongly arched, and the beak is obtuse, broad, and less than one-third the length of the shell from the anterior end. The surface is covered with strong subangular, rather unequal rugæ. It seems comparable to *Edmondia MacCoyi* Wh. Hind,³ but has not such blunt extremities. Mansuy⁴ has described a species of *Edmondia* from the Carboniferous of French Indo-China, but it does not seem to be identical with our form.

Allorisma (?) sp.

One imperfect right valve of an elongated shell which has a somewhat swollen and incurved beak and strong concentric rounded undulations of subequal size, directed slightly obliquely to the length of the shell, seems probably comparable with *A. sulcata* (Fleming).⁵ The anterior end seems rather abruptly truncate, and the posterior end rather sharply rounded; there is a strong rounded umbonal ridge running down to the latter end, with a very weak, wide depression in front of it, crossing the shell to the inferior margin, which is faintly sinuated. The length of the shell is about 24 mm., and the height at the anterior end about 10 mm. Species of *Allorisma* have been recorded from the Upper Carboniferous of Sumatra.⁶

Protoschizodus (?) sp.

The occurrence of a species of this genus is suggested by some very imperfect casts too poor for precise identification.

Posidonomya Becheri Bronn, var. nov. *siamensis*. (Pl. II, Fig. 7.)

Shell obliquely suboval to subrhomboidal, posteriorly expanded and flattened, with a long, gently curved or nearly straight hinge-line, rather less than the length of the shell; posterior margin gently and continuously arched, meeting hinge-line at very obtuse angle; inferior margin more or less sharply rounded; anterior margin nearly straight, with weak, wide, shallow sinuation at base of long narrow triangular ear; hinge-line meeting anterior margin at about 75

¹ Wheelton Hind, *Mon. Brit. Carb. Lamell.*, vol. i, p. 140, pl. x, figs. 16-19.

² Nebe, *Neues Jahrb. f. Miner. Geol.*, Beil. Bd. xxxi, 1911, p. 458, t. xiv, fig. 7.

³ Wheelton Hind, *Brit. Carb. Lamellibr.*, vol. i, p. 329, pl. xxxvi, figs. 23-30.

⁴ Mansuy, op. cit., vol. ii, fasc. v, 1913, p. 25, pl. iv, fig. 6.

⁵ Wheelton Hind, op. cit., p. 422, pl. xlviii, figs. 3-11.

⁶ Fliegel, *Palæontographica*, Bd. xlviii, 1901, pp. 108-9.

degrees. Body of shell very gently convex, sharply marked off from anterior ear; umbo acute, directed forwards, situated at about one-third length of hinge-line or subterminal. Surface of shell covered with strong regular, concentric undulations, triangular in section, of equal or subequal strength and size, becoming less regular on anterior ear and smaller and weaker on posterior portion of shell, with fine, straight, radiating lines crossing them in middle part of valves. Some fine concentric lines are also occasionally present on the undulations. Dimensions: (I) height (oblique), 30 mm.; length (parallel to hinge-line), 23 mm. (II) height (oblique), 80 mm.; length (parallel to hinge-line), 55 mm.

FIG. 1.—*Posidonomya Becheri* Bronn, var. nov. *siamensis*.

Remarks.—This is the species which occurs on the small broken image of a Buddha from the temple of Bah Nah. There are several more or less perfect examples of various sizes on it, and one shows both valves in juxtaposition and well preserved. The largest specimen is imperfect. The ornamentation is like that of *Posidonomya Becheri* Bronn;¹ but with regard to the characters of this genus there is considerable diversity of opinion. Zittel says it has no ears, whereas

¹ Wheelton Hind, op. cit., vol. ii, p. 27, pl. vi, figs. 11–15.

Wheelton Hind says it has a rounded anterior ear and a compressed expanded posterior ear. The anterior ear is well seen in our complete specimen, which has both valves preserved, and in this example the ear seems relatively wider and larger than in the other specimens. In the largest shell the umbo seems subterminal, and the whole shell more elongated and less rhomboidal. Distortion often affects the shape of specimens of *Posidonomya*, and some of the difficulties and differences of opinion with regard to its characters result from this cause. There is a shell figured by De Koninck as *P. plicata*¹ which bears much resemblance to our specimens, and the Culm shells from North Devon, which Phillips² figured and described as *P. Becheri* and *P. lateralis* Sow. may also be compared. Diener³ has referred some indistinct casts in the Anthracolithic beds of Spiti to this genus, but otherwise it does not seem to have been recorded from the Carboniferous of Asia.

The discovery of specimens of this shell at Kuan Lin Soh in a rock precisely similar to that of the image from Bah Nah, and their occurrence in the same rock as the rest of the fauna, fixes the age of the specimens in the image.

Posidonomya (?) cf. *radiata* Wh. Hind.

There is an imperfect impression of the greater part of the left valve of an obliquely ovate shell about 11 mm. high, with a gently convex surface marked by fine concentric lines and straight, radiating, broad ribs which are of rather unequal strength and width, being sharp, narrow, and strong near the posterior margin, but low and weak in the middle. So far as its characters can be determined, there is a resemblance of this shell to *Posidonomya radiata* Wh. Hind,⁴ but the generic reference of this species seems open to doubt.

Pseudamusium cf. *pratenuis* Von Koenen. (Pl. II, Fig. 8.)

There is one right valve of a species of a pectinoid shell represented in the collection by an internal cast and external impression, which resembles *Pecten pratenuis* Von Koenen⁵ from the Culm of Germany. It measures 13 mm. in length and 10 mm. in height. In shape it is obliquely oval and very inequilateral; the beak is small, acutely pointed, directed forwards, and subanterior in position. The body is nearly flat and well marked off from the narrow elongated depressed posterior ear, which reaches about half-way down the posterior margin. The anterior edge of the shell is strongly arched forwards below the very small projecting anterior ear, which seems

¹ De Koninck, op. cit., p. 182, pl. xxxix, fig. 8.

² Phillips, *Palæoz. Foss. Cornw. Dev.*, 1841, pp. 44-5, pl. xx, figs. 73-4.

³ Diener, *Perm. Foss. Centr. Himal. : Palæont. Ind.*, ser. xv, *Himal. Foss.*, vol. i, pt. v, 1903, p. 138.

⁴ Wheelton Hind, op. cit., p. 31, pl. vi, figs. 6-9.

⁵ Von Koenen, *Neues Jahrb. f. Min. Geol.*, 1879, p. 329, t. vi, figs. 3, 4.

to have a deep byssal notch below it. The posterior margin of the posterior ear meets the hinge-line at a very obtuse angle. The surface of the body has a few strong, but low, concentric undulations and finer concentric lines. Wheelton Hind¹ considers Von Koenen's species to be identical with Salter's *Aviculopecten fibrillosus*, which he puts in the genus *Pseudamusium*. *Ps. auriculatum* (McCoy)² may also be compared.

Aviculopecten cf. *densistria* (Sandberger). (Pl. II, Fig. 9.)

The right valve of a small pectiniform shell, of which the impression and external cast are preserved, is practically indistinguishable from the Culm species described and figured by Von Koenen³ as *Pecten densistria* Sandberger.⁴ Our specimen has a height of about 6 mm. and a width of about 5 mm.

Actinopteria sp.

The impression of the left valve of a small shell, about 9·5 mm. in length, appears to belong to the genus *Actinopteria* or *Pteronites*. In general shape, position of beak, size of pre-umbonal portion, hinge-line, and convexity of body, it resembles the Scotch species, *Pteronites fluctuosus* Etheridge,⁵ which Hind⁶ refers to the genus *Actinopteria*, but the ornamentation is rather different, consisting in our specimen of numerous very fine, equidistant, regular radiating lines, more closely placed on the flattened posterior half of the shell behind the body, on which concentric growth-lines are also present.

(To be continued.)

Escarpments and Transverse Rivers.

By HENRY BURY, M.A., F.G.S.

AT the end of a valuable paper on the superficial deposits to the north and north-west of London, Mr. Barrow⁷ puts forward certain views as to the origin of escarpments and transverse rivers in the Chiltern Hills and the Weald which can hardly be allowed to pass unchallenged by those interested in the progress of geomorphology, for *unless there is more evidence in their favour than has yet been produced* these views are not progressive, but distinctly reactionary. To sum up the position in his own words (op. cit., p. 47): "Long after the cessation of all the bending movements

¹ Wheelton Hind, op. cit., vol. ii, 1903, p. 106, pl. xvi, figs. 16–22.

² Ibid., p. 108, pl. xvi, figs. 23–7.

³ Von Koenen, op. cit., p. 327, t. vi, fig. 2.

⁴ Sandberger, *Rhein. Schichtsys. Nassau*, p. 296, t. xxx, fig. 12.

⁵ Etheridge, *Geol. Mag.*, Vol. X, 1873, p. 345, Pl. XII, Fig. 1.

⁶ Wheelton Hind, op. cit., p. 25, pl. v, figs. 8–12.

⁷ Proc. Geol. Assoc., vol. xxx, 1919, pp. 1–48.