eyes and facial sutures suggest that it may be a larval form. On the other hand, these features are also shown by such minute trilobites as *Agnostus*, *Microdiscus*, and *Shumardia*; and the lack of resemblance to any of the larger trilobites of the Tremadoc fauna, together with the circumstances that both specimens are minute, and that the larger of the two shows no advance in organization, tells in favour of the view that we are dealing with an adult form. For this form I would suggest the name of *Acanthopleurella Grindrodi*. The conformation of the head suggests Trinucleoid affinities, but there is no marginal rim, and the rest of the body appears to show Olenid characters. *Shumardia* is possibly an ally, but from this form *Acanthopleurella* differs in the extension of the glabella to the front margin of the head, in the absence of all glabella-furrows with the exception of the neck-furrow, and in the spinous prolongations of the thoracic pleuræ, and in other respects.

NOTICES OF MEMOIRS.

I.—On a Primitive Type of Structure in Calamites. By D. H. Scott, M.A., Ph.D., F.R.S.[1]

PALÆONTOLOGICAL research has afforded evidence that the Horsetails and Lycopods, groups now so distinct, had a common origin. The class Sphenophyllales, restricted, so far as we know, to the Palæozoic epoch, combines in an unmistakable manner the characters of Equisetales and Lycopodiales, while at the same time presenting peculiar features of its own. Broadly speaking, it is in the external morphology and in the reproductive structures that the Equisetales are approached, while the anatomy has an evidently Lycopodiaceous character.

The synthetic nature of the Sphenophyllales, indicated clearly enough in the type-genus *Sphenophyllum* itself, comes out still more obviously in the new genus *Cheirostrobus*. Here the general morphology of the strobilus, the form and structure of the sporangiophores and of the sporangia themselves, are all of a Calamarian type, while the anatomy of the axis is as clearly Lycopodiaceous in character.

So far nothing has been found to bridge the gulf which separates the anatomy of the Calamarieæ (Palæozoic Equisetales) from that of the Sphenophyllales or the Lycopods. The most ancient known genus of Calamarieæ—*Archæocalamites*—approaches the Sphenophyllales in the superposition of the foliar whorls and in the dichotomous subdivision of the leaves, points on which Professor Potonié, especially, has laid stress. Anatomically, however, according to the researches of Dr. Renault and Count Solms-Laubach, it was an ordinary Calamite, differing in no essential respect from those of the Coal-measures. The stem of *Archæocalamites*, like that of its later allies, had a large pith, surrounded by a ring of collateral vascular bundles, the wood of which, primary as well as secondary,

[1] Read before the British Association, Section C (Geology), Glasgow, Sept., 1901.

was wholly *centrifugal* in development, the first-formed tracheides lying on the border of the pith, at the points marked by the carinal canals. In *Sphenophyllum*, on the one hand, the whole of the primary wood was *centripetally* developed, and there was no pith. In *Cheirostrobus* the same holds good, except that an insignificant portion of the primary wood may possibly have been added in a centrifugal direction. In Lycopods there may or may not be a pith, but the whole (*Lycopodium, Psilotum, Lepidodendron*) or the greater part (*Tmesipteris*) of the primary wood is centripetal.

The Calamite which forms the subject of the present communication occurs in the well-known Burntisland beds of the Calciferous Sandstone Series, at the base of the Carboniferous formation. The material is calcified, and the structure excellently preserved, though the specimens so far discovered are small and fragmentary. Their interest depends on the fact that each vascular bundle possesses a distinct arc of centripetal wood on the side towards the pith. The carinal canals are present, as in an ordinary Calamite, and contain, as usual, the remains of the disorganized protoxylem. They do not, however, as in other Equisetales, form the inner limit of the wood, but xylem of a considerable thickness, and consisting of typical tracheides, extends into the pith on the inner side of the canal, which is thus completely enclosed by the wood. Hence, starting from the spiral tracheides of the protoxylem, there was here a considerable development of xylem in a centripetal as well as in a centrifugal direction. That the organ was a stem, and not a root, is proved, not only by the presence of the carinal canals, but by the occurrence of nodes, at which the outgoing leaf-traces are clearly seen.

This appears to be the first case of centripetal wood observed in a Calamarian stem, and thus serves to furnish a new link between the Palæozoic Equisetales and the Spenophyllales, and through them with the Lycopods.

The specimens have not as yet supplied any evidence as to the superposition or alternation of the verticils, so we are not at present in a position to determine the genus to which they belonged. Provisionally, until further investigation has cleared up this question, the new stem may bear the name of *Calamites pettycurensis*, from the locality where it occurs.

II.—The Scottish Ores of Copper in their Geological Relations.

By J. G. Goodchild, F.G.S.[1]

THE ores of copper occurring in Scotland appear, so far as their origin is concerned, to be referable to two primary categories. The first of these includes those minerals whose origin is evidently connected with the uprise of thermal waters; and the second includes those which are due almost entirely to deposition of materials carried down in solution from some rocks at a higher level to others below. The two methods of origin may be likened to the ebb and the flow of the tides.

[1] Read before the British Association, Section C (Geology), Glasgow, Sept., 1901.

To the first category belongs most of the Chalcopyrites occurring in Scotland, and with that mineral is to be included also Chalcocite and Bornite. These mostly occur in connection with mineral veins. A small percentage of other compounds of Copper with Sulphur appears to have originated in connection with certain eruptive rock of sub-basic composition. When these latter have been affected by dynamic metamorphism the process seems to have favoured the local concentration of the mineral which was formerly diffused. Hence several Epidiorites contain Chalcopyrites, apparently as an original constituent (if we regard their schistosity as original to that type of rock).

To the second category, that of the ebb-products, or minerals of secondary origin, belong all the remainder.

Taking these in the order, and with the numbers, adopted by Dana, we have, first, (15) Native Copper. There cannot be much doubt that all the Scottish specimens of this are of secondary origin. The earlier stage seems to have been that of solution, along with those of the constituents of a sub-basic eruptive rock, through which, probably, the copper ore was originally diffused in very minute quantities. The decomposition of the rock by surface agencies has again converted this into solution—probably in the form of carbonate—from which solution any one of various reagents, in most cases probably decomposing organic matter, has reduced the dissolved substance to the metallic state. In this form it has been deposited as thin sheets along the divisional planes of the rocks situated at a lower level than its point of origin. In the form of films of this kind it occurs at Boyleston, in Renfrewshire, where it is found in lavas of Lower Carboniferous age; and at Ballochmyle, in the joints traversing the marls of the New Red Rocks there. I may remark, in passing, that these rocks so closely resemble the Bunter Sandstone that I should never have hesitated to refer them to that horizon had not a different opinion regarding their age been expressed by the distinguished author of "The Scenery of Scotland."

Native Copper also occurs in the form of minute particles—possibly crystals—in some of the Prehnites of Boyleston and Glen Farg. Doubtless these varieties of Prehnite owe their colouring matter to the presence of this mineral, just as the ordinary green variety of Prehnite owes its colour to diffused compounds of copper of other kinds—possibly to Chrysocolla. The same metal also occurs at Boyleston, disseminated throughout some of the beautiful crystals of Calcite which line some of the drusy cavities of the lavas there. When Native Copper is enclosed in these crystals the external form is much more complex than where the metal is absent.

Some Chalcopyrites must undoubtedly be classed amongst ebb-products also, seeing that a second generation of crystals often occurs upon minerals whose secondary origin cannot be doubted. Atacamite has been claimed as a Scottish mineral, but, it seems to me, on insufficient grounds.

(224) Cuprite, as might be expected, occurs in connection with the other decomposition products of common ores. Usually it occurs

as one of the constituents in the compound known as Tile Ore; but occasionally, as at Glen Farg, it shows traces of crystalline exterior; or as at Boyleston, where Mr. Craig-Christie has got it in the capillary or velvet-like form. Some of the silicate of copper from Lauchentyre appears to me to be coloured red by Cuprite, which may also occur there in the free state.

(230) Tenorite has not yet been proved to occur as a separate Scottish mineral; but the black Chrysocolla from Lauchentyre and other mines in the neighbourhood may possibly owe its coloration to this mineral.

(288) Malachite calls for no special remark here beyond the statement that it does not appear to show crystalline termination at any locality in Scotland except at Sandlodge, in Shetland, where it seems to have been taken for Brochantite.

(289) Azurite is singularly rare in Scotland, and has not yet been found with visible crystalline faces. (290) Aurichalcite, (741) Linarite, and (739) Caledonite, well known as secondary products of the decomposition of veins containing Copper, do not call for any special remark in this abstract.

REVIEWS.

I.—Roads: their Construction and Maintenance; with Special Reference to Road Materials. By Allan Greenwell, Assoc. M. Inst. C. E., F.G.S., and J. V. Elsden, B.Sc., F.G.S. 8vo; pp. 280. (London: *The Builder* Student's Series. Price *5s.*)

GEOLOGISTS may well claim to have an interest in road-metal. The heaps of stone by the roadside arrested the attention of the 'naturalists' in old days, and ofttimes attracted them to the quarries. Thus the Kellaways Rock of Wiltshire came into notice and attained a distinction which nowadays would not have been accorded to it. Then each parish, whenever possible, provided material for its roads, and in different parts of the country there were numberless pits and quarries, many of which have long since been closed and hidden beneath soil and vegetation. Even now many by-roads are mended with local stone of no great durability, and in parts of Somerset these ways are repaired with the basement limestones and fossils of the Upper Lias. Along the principal roads the freestones and rag-beds of the Oolites, however, are less frequently used; the Carboniferous Limestone, the Hartshill stone, and the dark basalts of Clee Hill and Rowley Regis have usurped their place. Far better roads have resulted, although carriers have complained that they cannot see their way at night so readily as of yore on the present dark metal. To the introduction of railways we may trace the dispersal of the better kinds of road material, while, as the authors remark in the work before us, the powers acquired by County and District Councils "have completely revolutionised the system of road management in this country."