THE STILE END BEDS AND DRYGILL SHALES (ORDOVICIAN) IN THE EAST AND NORTH OF THE ENGLISH LAKE DISTRICT

BY

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By W. T. DEAN

CONTENTS

SYNOPSIS

Previous opinions regarding the stratigraphical position of the Stile End Beds and Drygill Shales are reviewed and revised in the light of recent field-work. Geological maps showing the principal fossil localities are included, and all the significant shelly fossils are discussed and illustrated. One new trilobite species, *Encrinurus kingi*, is described from the Stile End Beds.

I. INTRODUCTION AND ACKNOWLEDGMENTS

The group of Ordovician strata immediately overlying the Borrowdale Volcanic Series in the main portion of the Lake District forms a narrow, strip-like outcrop running from the Lancashire coast near Millom, north-eastwards to a point near Shap, Westmorland, by way of Coniston, a distance of about thirty-two miles. The name Coniston Limestone Group or Series has generally been applied to these rocks, the nomenclature of which has been reviewed by Mitchell (1956 : 431). Earlier the same author (Mitchell 1925) had established the following detailed succession of Ordovician rocks in the north-eastern part of the outcrop :—

Ashgill Shales / Applethwaite Beds	up to 400 feet
UNCONFORMITY	
Stockdale Rhyolite	0 to 450 feet
Stile End Beds, with conglomeratic base	up to 250 feet
UNCONFORMITY	
Borrowdale Volcanic Series	

There seems to have been a tendency for many geologists to regard the whole of this succession as being of Ashgill age, probably in deference to Marr's assertion (1916 : 38) that the fauna of the Stile End Beds was apparently identical with that of the Applethwaite Beds. In fact, apart from the trilobites *Phacops* (now *Chasmops*) *marri* (Reed 1894) and *Acidaspis magnospina* (Stubblefield 1928), no shelly faunas have been figured or described from the whole of the succession, and previous faunal lists are so out of date as to be virtually valueless to stratigraphers at the present day. The present detailed investigation of the Stile End Beds has been restricted to the type-area, east of Kentmere, and it shows that these strata belong to the Caradoc Series, though representing only a small part of the classical type-succession as found in south Shropshire and, to a lesser extent, the Cross Fell Inlier, about twelve miles north-east of Shap Fell. In addition to my personal collecting, the late Prof. W. B. R. King generously placed at my disposal his collection, now in the Sedgwick Museum, from the same area.

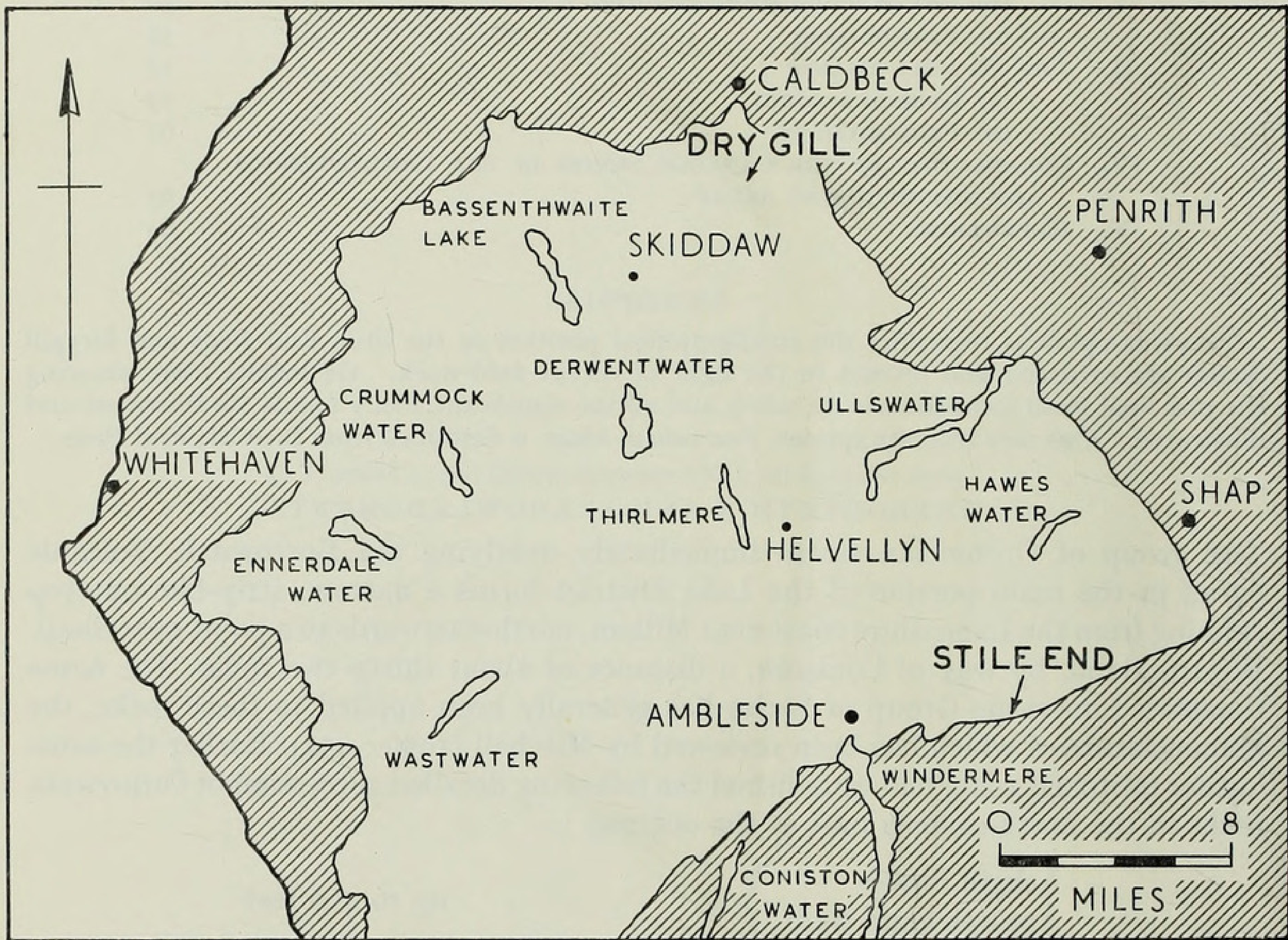


Fig. 1. Sketch-map showing the position of Stile End and Dry Gill in relation to the rest of the Lake District.

The Drygill Shales, known only from their small, isolated outcrop just to the north of Carrock Fell, Cumberland, in the extreme north of the Lake District, have been generally neglected by palaeontologists and stratigraphers. Stubblefield (1939 : 56), noting their Caradoc age, commented on the presence of what he called the *Broeggerolithus* – "*Acaste*" – *Brongniartella* fauna, and remarked on its affinities with those of the Lleyn Peninsula, North Wales. However, no fossils have yet been figured from this interesting, but tectonically disturbed, outcrop. During the present mapping, numerous trilobites and brachiopods have been obtained, and I am much indebted to my wife for her help in collecting, both here and at Stile End. Dr. C. L. Forbes has loaned the specimens, now in the Sedgwick Museum, which were collected by Elles & Wood and listed by them in their paper of 1895. Prof. W. F. Whittard has kindly read and criticised the manuscript and made suggestions for its improvement.

II. THE STILE END BEDS EAST OF KENTMERE

(*a*) *General account*

The Stile End Beds form a strip-like outcrop varying in breadth from approximately 70 to 150 yards and extending east-north-eastwards from Kentmere towards Shap by way of Long Sleddale (see Text-fig. 2). The strata comprise a conglomeratic horizon of variable thickness passing upwards into dark-grey mudstones, the latter being sometimes strongly cleaved so as to form poor quality slates which were once quarried on a small scale near Stile End farm itself, as was noted by Harkness & Nicholson (1866). They are overlain by the Stockdale or Yarlside Rhyolite, and this is followed in turn by the Applethwaite Beds, of Ashgill age, which overstep the foregoing strata. The Stockdale Rhyolite crops out only in the eastern part of the Lake District, but the Stile End Beds and Applethwaite Beds traverse the Lake District in a roughly south-westerly direction. In the present paper only the Stile End Beds east of Troutbeck are considered ; this is not only the type-area for the strata, but is apparently the most fossiliferous part of the outcrop.

The first reference to what are now the Stile End Beds was made by Harkness & Nicholson (1866) when they recorded fossils " near the summit " of the Borrowdale Volcanic Series. Later, Aveline (*in* Aveline & Hughes 1888 : 7) subdivided the Coniston Limestone Series into :

Ashgill Shales
Limestone
Felsite
Calcareous ash with fossils.

Of these, the two lowest are now the Stile End Beds and Stockdale Rhyolite, in ascending order.

Harkness & Nicholson (1877 : 461–2) described a " band of brownish or bluish grey shales . . . separated from the Coniston Limestone by a bed of trap " at what they called " Style-End Grassing ". The latter name is not shown on the present-day Ordnance Survey Maps or the Old Series Geological Survey map, and presumably refers to the grass covered area to the east of Stile End Farm. The age and position of the beds were not discussed, but the fauna was said to be of Bala type and the fossils listed included *Calymene blumenbachi* Brongniart, *Orthis vespertilio* Sowerby and *Petraia aequisulcata* M'Coy.

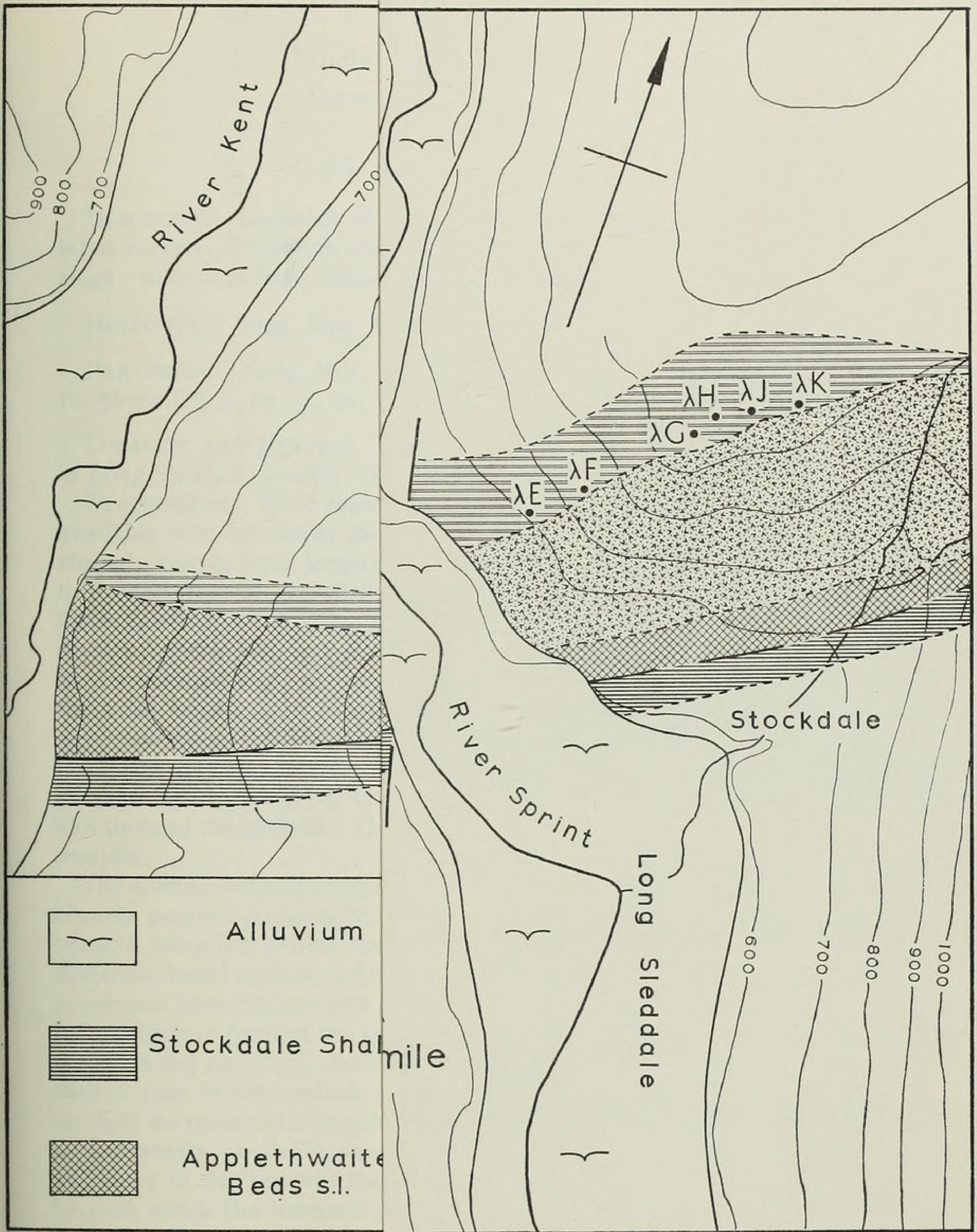
Marr (1892 : 97, 99) used the term Stile End Beds for the basal subdivision of the Coniston Limestone Series near Kentmere, and later (Marr 1916 : 38) he stated that the fauna of these strata seemed identical with that of the Applethwaite Beds—a conclusion now known to be incorrect, as the latter subdivision is of Ashgill age. The outcrop of the Stile End Beds was depicted by Mitchell (1925) and, together with additional field-mapping by the writer, forms the basis of the locality-map in the present paper. Mitchell also showed the relationship of the overlying Stockdale Rhyolite and the overstep at the base of what he called the Upper Coniston Limestone, now the Applethwaite Beds. The last-named strata and their basal conglomerate, with the Stile End Beds and Yarlside Rhyolite, had earlier been placed by Marr (1892 : 97 *et seq.*) in the Sleddale Group, but in view of the stratigraphical gaps now known to exist in the higher Ordovician rocks of northern England it seems preferable to allow this term to lapse.

Shelly fossils have now been collected from several localities at various levels through the succession and at points situated along the outcrop east of Kentmere. Trilobites and brachiopods have been obtained from most of the localities and they enable a reasonable correlation to be made with part of the Caradoc succession in south Shropshire. Although no definite limestone bands are developed in the Stile End Beds east of Kentmere, and there is no suggestion of reef-formation, nevertheless both solitary rugose and compound tabulate corals are not uncommon, the latter generally occurring as isolated " sops " within the grey mudstones.

(*b*) *List of fossiliferous localities*

The following list does not claim to be comprehensive, as unidentifiable and fragmentary shelly fossils have been found at other points along the outcrop, but it comprises all localities which yielded identifiable material during the present field-work. Further collecting is always likely to establish additional localities.

λA. 1,800 feet at 82° from main building of Stile End Farm.
λB. Although shown on the map as one locality, in practice three closely-grouped localities were used, as follows :
λB1. 2,650 feet at 76° }
λB2. 2,580 feet at 77° } from main building
λB3. 2,540 feet at 78½° } of Stile End Farm.
λC. 3,510 feet at 76° from main building of Stile End Farm.
λD. 3,490 feet at 77° ,, ,, ,, ,, ,, ,,
λE. 2,000 feet at 325° from Stockdale Bridge, Long Sleddale.
λF. 2,040 feet at 335° ,, ,, ,, ,, ,,
λG. 2,300 feet at 348° ,, ,, ,, ,, ,,
λH. 2,380 feet at 350° ,, ,, ,, ,, ,,
λJ. 2,400 feet at 354° ,, ,, ,, ,, ,,
λK. 2,480 feet at 0° ,, ,, ,, ,, ,,



Mitchell (1925)

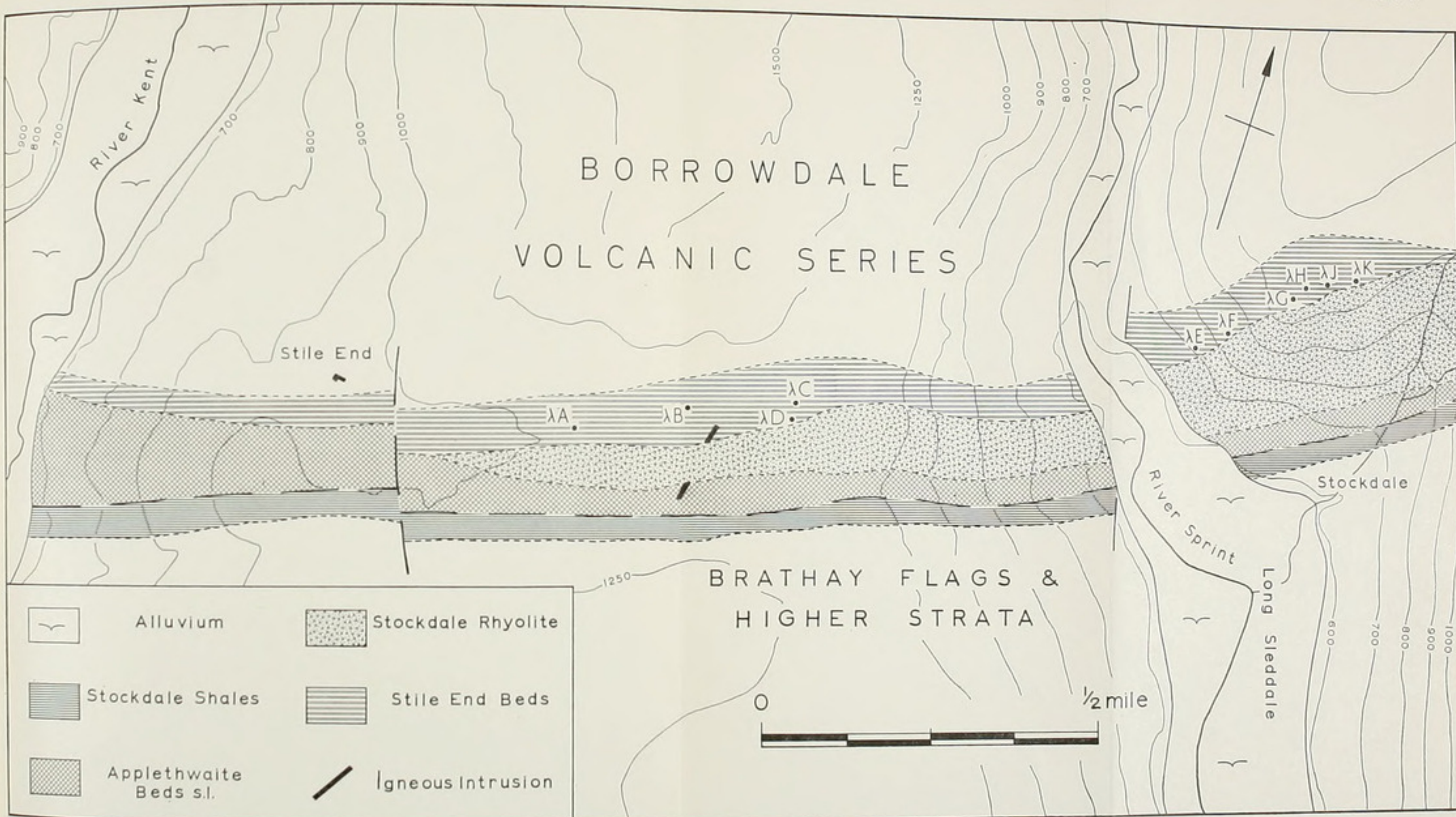


Fig. 2. Map showing fossil localities in the Stile End Beds which are mentioned in the text. Geological boundaries from maps of Mitchell (1925) and the writer.

(*c*) *Palaeontology*

Class **TRILOBITA**

Family **ENCRINURIDAE** Angelin 1854

Genus ***ENCRINURUS*** Emmrich 1844

Encrinurus kingi sp. nov.

(Pl. 1, figs. 6, 7, 12 ; Pl. 2, figs. 1, 2, 7)

DIAGNOSIS. Cephalon of characteristic *Encrinurus* form, with coarsely tuberculated surface. Pygidium subtriangular in plan. Axis with at least 25 entire axial rings ; side-lobes with eleven pairs of pleural ribs ending in small free points.

HOLOTYPE. Sedg. Mus. A.51706 (Pl. 2, fig. 1).

PARATYPES. Sedg. Mus. A.51705 (Pl. 1, figs. 6, 7); British Museum (Nat. Hist.), In. 56791 (Pl. 2, fig. 7); In. 56979 (Pl. 1, fig. 12) ; In. 56993 (Pl. 2, fig. 2).

LOCALITY AND HORIZON. All the known specimens are from the Stile End Beds in Long Sleddale, locality λF.

DESCRIPTION. No complete cranidium has yet been found, and of the fragments available only one shows the glabella. The latter is roughly twice as long as broad, strongly convex both longitudinally and transversely, and expands forwards gently to a short frontal glabellar lobe which overhangs the anterior border. There are three pairs of small glabellar lobes of equal size, separated from one another by smooth, notch-like indentations denoting the glabellar furrows. The occipital furrow is broad (*sag.*) and of moderate, uniform depth. The occipital ring is of about the same length (*sag.*) as each of the glabellar lobes, and is ornamented with five large tubercles. Similar coarse tuberculation covers the surface of the glabella, but is insufficiently well preserved to detect any regular pattern. A fragment of the right fixigena (Pl. 1, fig. 12) is typical of the genus, its surface carrying large tubercles like those of the glabella. The eyes are too poorly preserved to ascertain their exact position.

The species is better known from the pygidium. This is roughly triangular in plan, bluntly pointed posteriorly, almost twice as long as broad, the line of maximum breadth being just behind the anterior margin. The straight-sided axis, with slightly flattened dorsal surface, is fairly narrow, occupies frontally about one quarter of the maximum breadth, whence it narrows backwards uniformly and ends in a blunt point a little in front of the pygidial tip, to which it is connected by a low, post-axial ridge. Axial rings are small and numerous, separated from each other by deeply incised ring furrows which become shallower medially. Each ring is transversely straight for most of its length (*tr.*) but turns backwards slightly at either end. There is apparently no development of axial tubercles, and the axial rings diminish markedly in size towards the axial tip. The holotype pygidium has 25 axial rings, beyond which the terminal piece is apparently smooth. The adaxial half of each side-lobe is approximately horizontal, but the abaxial half is steeply declined beyond a well-defined fulcrum. In addition to the anterior pair of half-pleurae there are eleven pairs of conspicuous pleural ribs separated by equally broad (*exsag.*) pleural furrows ; both ribs and furrows become progressively less well defined towards the tip of the pygidium. The ribs of the first pair are transversely straight as far as the fulcrum but then flex backwards sharply to the lateral margin where they end in small free points. Subsequent pairs of ribs become progressively straighter but are directed more strongly backwards, so that the final pair runs almost parallel to the axial line. The free points of the posterior ribs are relatively small, as far as can be seen.

DISCUSSION. The species of *Encrinurus* with which the pygidium of the new form may be compared include *E. praecursor* Tripp, *E. multisegmentatus* (Portlock) and *E. trispinosus* Reed. The first of these (Tripp 1954 : 681, pl. 4, figs. 13–25), from the Caradoc Series near Girvan, has a similar number of ribs but more axial rings, up to 32, and many of the ring furrows are obsolete medially. *E. multisegmentatus* (Portlock) from the Killey Bridge Beds of Ireland (perhaps high Caradoc in age) has been redescribed by Tripp (1957 : 61, pl. 12, figs. 1–6), and possesses a greater number of both axial rings (up to 32) and pleural ribs (12 or 13). In addition, some of the ring furrows become obsolete medially, a feature found also in *Encrinurus trispinosus* from the Upper Drummuck Group (Ashgill Series) of Girvan (Reed 1906 : 122–124 ; 1914 : 39).

OTHER TRILOBITES

Several specimens of *Chasmops* (Pl. 1, figs. 1, 2, 5, 10) have been collected from the Stile End Beds at localities λA, λB1–3, λC, λD and λG. Most are sheared and distorted, but some show enough diagnostic features to compare them with *Chasmops extensa* (Boeck), a Norwegian species refigured by Størmer (1940 : 138) and recently redescribed and illustrated from south Shropshire (Dean 1961 : 336). In Shropshire the species appears about the middle of the Upper Longvillian Substage and ranges upwards into the lowest zone of the Onnian Stage, but attains its maximum size and abundance in the Actonian. The Stile End specimens are often large, though they never reach the proportions of the largest Shropshire individuals. It is interesting that only three specimens of *Chasmops* cf. *extensa* have been found in what are probably Actonian strata in the Cross Fell Inlier (Dean 1962 : 104), though the general absence of the species there is probably due less to ecological factors than to elimination of the appropriate strata by faulting.

Only one damaged specimen (Pl. 1, figs. 3, 4) of *Calyptaulax* cf. *actonensis* Dean (1961 : 328), a laterally compressed pygidium with abraded axis, has been found. The pleural lobes carry six pairs of pleural furrows, extending from the axial furrows to the inner margin of the doublure, and five or perhaps six pairs of rib furrows, developed across the distal half of each pleural lobe. These figures correspond with those found in the better-preserved type-material from south Shropshire. The tip of the Stile End pygidium is apparently narrower and sharper than that found in Shropshire specimens, but is probably the consequence of mechanical deformation. The new record of *Calyptaulax* is interesting because the genus, although abundant and widespread in the Ashgill Series of both the Anglo-Welsh area and Scotland, is known only in Shropshire from the Actonian and basal Onnian, and at Cross Fell from the Onnian and Pusgillian—that is to say, in these localities it is presumably confined to the uppermost Caradoc Series.

A few specimens probably referable to *Gravicalymene* have been found in the Stile End district. Only one, a cranidium (Pl. 1, fig. 11), is sufficiently well preserved for comparison, and is figured here as *Gravicalymene* cf. *praecox* (Bancroft). This specimen, although slightly compressed laterally, nevertheless shows a glabellar outline and unconstricted axial furrows, as well as part of a thickened anterior border, such as are found in *Gravicalymene praecox*. The latter species was first described by Bancroft (1949 : 308) as *Diacalymene praecox* from the Harnagian Stage of south Shropshire. Since then the species has been placed in *Gravicalymene*, and it has been shown that closely similar trilobites reappeared in the Onnian and, more especially, Actonian Stages of Shropshire (Dean 1963 : 225). The latter form may therefore be contemporaneous with the Stile End specimen.

A single large cranidium of *Atractopyge* (Pl. 2, figs. 3, 5), collected by Professor King from locality λG, is the only example of the genus so far known with certainty from the Stile End district. The material is insufficient for precise identification, but there is a general resemblance to *Atractopyge scabra* (Dean 1962 : 91) from the Onnian and Pusgillian Stages of the Cross Fell Inlier, though the frontal glabellar lobe of the latter species is apparently shorter. Further comparison is not possible. The genus had a long, though sporadic, history in the Ordovician of England and Wales, being known from rocks as early as the Llandeilo Series and as late as the Ashgill Series. In south Shropshire, however, only a single specimen, a pygidium, is recorded from the Actonian Stage (Dean 1961 : 318), and may be regarded as approximately contemporaneous with the present cranidium.

Two specimens of *Proetidella*?, a right librigena and an incomplete cranidium (Pl. 1, figs. 8, 9) from λE and λG, are the sole representatives of the Proetidae so far known from the Stile End Beds. The glabella is broadly parabolic in plan with a distinct preglabellar furrow. The preglabellar field and anterior border furrow are well defined, whilst the anterior border forms a low, upturned brim. In some respects the specimen resembles the type-species of *Proetidella*, *P. fearnsidesi* Bancroft (1949 : 304), but the latter form has, in most cases, a less well-defined anterior border furrow, though there is some variation within the species (Dean 1963 : 243). The anterior border of the Stile End specimen somewhat resembles, but is set lower than, that of the uncommon species *Proetidella*? *marri* (Dean 1962 : 124) from the Lower Longvillian of the Cross Fell Inlier. In south Shropshire, where *Proetidella* probably ranges from the Costonian to the Actonian, fragments of generally similar type have been recorded from the Marshbrookian and Actonian Stages (Dean 1963 : 246) but are insufficiently known for comparison.

Other Fossil Groups

A few indifferently preserved dalmanellids which may be compared with *Cryptothyris paracyclica* (Bancroft) have been found near Stile End at localities λC, λG, and λK. The best preserved specimen, the internal mould of a brachial valve (Pl. 2, fig. 6), is apparently shorter and more convex than the type material, due to mechanical deformation. However, it shows the peripheral zone of sharply defined ribbing noted by Bancroft in his original description (1928 : 56, pl. 1, figs. 6–9). Even more conspicuous is the area occupied by the adductor muscle impressions, which extends more than half-way from the crurae to the anterior commissure and is divided into two by a longitudinal ridge, with a transverse ridge separating the anterior and posterior adductor impressions, of which the latter are conspicuously the smaller. In south Shropshire *Cryptothyris paracyclica* has been found to be a reliable Actonian index fossil (Dean 1958 : 211, pl. 25, fig. 7), but the genus is uncommon and has not previously been recorded elsewhere. *Nicolella* cf. *actoniae* (J. de C. Sowerby) (Pl. 3, figs. 5, 9) also refers to a common Actonian species in Shropshire.

Sowerbyella is represented by a few specimens (for example Pl. 2, figs. 10, 11) at localities λB1 and λB2. The type-species, *Sowerbyella sericea* (J. de C. Sowerby) from the Upper Longvillian of south Shropshire, has recently been redescribed by Williams (1963 : 446) and bears a general resemblance to the Stile End individuals. However, there is a variety of forms of *Sowerbyella* distributed throughout most of the Caradoc Series of the Anglo-Welsh area, and no detailed comparison is possible with the present distorted material.

The Stile End brachiopods include at least four strophomenid genera. Several fragments of *Leptaena* have been found (see Pl. 3, fig. 8) at localities λB1 and λD and may, perhaps, be compared to *L. salopiensis* Williams (1963 : 477) from the Actonian of south Shropshire. The genus *Hedstroemina* appears in south Shropshire in the Marshbrookian, where it is represented by *H. parva* Bancroft and, more especially, *H. fragilis* Bancroft. In the succeeding Actonian it comprises only *H. robusta* Bancroft, a fairly common species described from the Acton Scott district (Bancroft 1929 : 59, pl. 2, figs. 6, 7). In the vicinity of Stile End a few large specimens have been collected which are close to the last-named species, although, once again, distortion makes specific determination difficult (see Pl. 3, figs. 1–3). *Hedstroemina robusta* has not yet been reported from elsewhere in Britain, but has been recorded from what is probably a slightly earlier horizon in Norway (Spjeldnaes 1957 : 133, pl. 8, fig. 5). The internal mould of a damaged strophomenid ventral valve (Pl. 2, fig. 8) is broadly similar in the form of the crural plates and ornamentation to that of *Strophomena grandis* (J. de C. Sowerby), though the proportions have been altered by deformation. In Shropshire the species ranges from the Upper Longvillian into the Actonian. Another ventral valve (Pl. 2, fig. 9) resembles that of *Rafinesquina*, but lacks evidence of internal structures.

Platystrophia is represented by two internal moulds of pedicle valves (Pl. 3, figs. 4, 7) from locality λG. *Platystrophia* has a long vertical range in the Anglo-Welsh area, and the Stile End specimens cannot satisfactorily be assigned to any known species. The genus is rare in south Shropshire, but has been recorded from the Actonian (Dean 1958 : 223).

The triplesiid *Bicuspina* was erected by Havlíček (1950 : 18) on the basis of the Bohemian *Orthisina cava* Barrande 1848 and said to include also the Anglo-Welsh Caradoc species generally listed as *Triplesia* or *Cliftonia spiriferoides* (M'Coy) (for illustrations see Davidson 1871 : 275, pl. 37, figs. 3–7). One specimen of a brachial valve (Pl. 3, fig. 10) from locality λG near Stile End shows a pattern of adductor muscle impressions closely similar to those of *B. spiriferoides* but is otherwise too poorly preserved for comparison. The same form occurs also at λB1 and λD. In Shropshire and Wales all the recorded occurrences of *Bicuspina* are from earlier subdivisions of the Caradoc, particularly the Lower Longvillian.

None of the other brachiopods has proved stratigraphically useful, and a few indeterminate valves possibly referable to *Dolerorthis* (for example Pl. 3, fig. 6) belong to a long-ranging and inadequately-known group.

Occasional remains of gastropods in the Stile End Beds have proved inconclusive with regard to the age of the rocks. The best preserved (Pl. 2, fig. 4) is a distorted internal mould of *Cyrtolites* cf. *nodosus* (Salter), a species which has a long vertical range in south Shropshire, from the Soudleyan to the Actonian (Dean 1958 : 220–223).

Corals, both solitary and compound, are not uncommon in the Stile End Beds, particularly in the outcrops of Long Sleddale. They were mentioned briefly by Hill (1951 : 20–21) who stated that they originated from the " Coniston Limestone " *sensu lato*, and noted that it was difficult to tell which came from Marr's Caradoc or Ashgill Series, though they derived in the main from the " Sleddale Group " (see earlier). She recorded *Syringophyllum* (now *Sarcinula*) *organum* (Linné), *Streptelasma aequisulcatum* (M'Coy) and *Halysites* as being abundant, a fauna resembling that of the Robeston Wathen Limestone of South Wales, and, in addition, a " wide-tubed *Propora* " was noted.

The following coral genera have recently been found : *Streptelasma* (λA, λB_2, λB_3, J), *Halysites* (λB_3, λG), *Lichenaria?* (λJ) and *Propora* (λC, λG, λH, λK). The detailed distribution of the British Ordovician corals is poorly known at the present time, but in view of the Actonian age of the Stile End Beds, it would not be surprising to find that the affinities of the contained corals do, in fact, lie with those of the Robeston Wathen Limestone, which occupies a stratigraphical position high in the Caradoc Series of South Wales, though its exact zonal level in the shelly facies is still obscure.

III. THE DRYGILL SHALES

(*a*) *General Account*

The Drygill Shales (see Text-fig. 3) form an irregularly lenticular outcrop, about three-quarters of a mile by one-sixth of a mile in size, with long axis running east-west. To the north they are faulted against the Borrowdale Volcanic Series, and to the south against granophyres of the Carrock Fell Igneous Complex, whilst to both east and west they are interdigitated with dyke-like extensions from the Harestones Felsite, itself also a constituent of the Carrock Fell Complex.

The strata were first noted by Ward (1876 : 17, 24) who briefly referred them to the Skiddaw Slates and considered them to represent a transitional series between those beds and the Borrowdale Volcanic Series. Their true significance was first appreciated by Nicholson & Marr (1887) who gave them the name by which they are generally known. These authors showed, by means of a small sketch-map, the general distribution of the outcrop but left its outline obscure and did not attempt to show the relationships with the surrounding rocks, though they indicated a large expanse of volcanic rocks belonging to the Eycott Series of the Borrowdale Volcanic Series to the north, and a more complex group of igneous rocks in the neighbourhood of Carrock Fell to the south. They listed the following fossils : *Ampyx rostratus* Sars, *Calymene cambrensis* Salter, *Lichas laciniatus* Wahlenberg?, *Stygina murchisoniae* Murchison, *Trinucleus favus* Salter, *Beyrichia complicata* Salter, *Leptaena sericea* Sowerby, *Obolella*? and *Orthis testudinaria* Dalman. Nicholson & Marr believed that the Drygill Shales were younger than the Upper Skiddaw Slates and older than what they called the " Coniston Limestone proper ". Although they noted that the fauna agreed best with that of the Dufton Shales of Cross Fell Inlier, they concluded that the shales were lithologically and faunistically distinct from any strata above the Borrowdale Volcanic Series and so probably belonged to the Volcanic Series itself.

In another, later, paper Marr (1892) modified the above view and suggested that the Drygill Shales had probably a greater affinity with the Coniston Limestone. Subsequently, he instigated the reinvestigation of the Drygill faunas by Elles & Wood who later (1895) largely substantiated Marr's modified views and gave long faunal lists, though they pointed out the deformed nature of the specimens constituting the fauna. Their material has been re-examined and the new determinations of the more useful specimens, comprising trilobites, brachiopods and ostracods, are listed below. The numbers refer to the collections of the Sedgwick Museum, but in some cases no specimen has been found.

Specimen	Old identification	New identification
A.40124–25	*Ampyx rostratus* Sars	*Lonchodomas* sp.
—	*Ampyx tetragonus*	No specimen available
A.40146	*Ampyx tumidus*	*Lonchodomas* sp.
A.40163–65	*Stygina murchisoniae*	gen. et sp. indet.
—	*Trinucleus seticornis*	No specimens available
—	*Trinucleus concentricus*	
—	*Trinucleus* sp. (allied to *affinis*)	
—	*Phacops* (*Pterygometopus*) *alifrons* ? M'Coy	
A.40143–44	*Phacops* (*Acaste*) *appendiculatus*	*Kloucekia apiculata* (M'Coy)
A.40145	*Phacops* sp.	*Kloucekia apiculata* (M'Coy)
A.40141–42	*Dindymene ornata* Linnarsson	*Lonchodomas* sp.
A.40133–40	*Calymene blumenbachi* *Calymene senaria* *Calymene cambrensis*	*Flexicalymene* cf. *caractaci* (Salter)
—	*Lichas laciniatus*	No specimen available
A.40161–62	*Beyrichia complicata*	*Tallinnella* sp.
—	*Obolella*? sp.	No specimen available
A.40079–81	*Plectambonites sericea*	*Sowerbyella* sp.
—	*Plectambonites transversalis* *Plectambonites quinquecostata*	No specimens available
A.40082–87 A.40088–89	*Orthis testudinaria* *Orthis elegantula*	*Dalmanella* (s.l.) sp.
A.40090–91	*Lingula ovata*	*Lingulella?* sp.

Elles & Wood (1895) followed Nicholson & Marr (1887) in assuming that the rocks, which dip generally south or south-south-west, formed a uniform succession which could be followed downwards by means of a roughly south-westerly traverse along the southern fork of Dry Gill itself. The succession obtained was as follows, in descending order :

1. Drab-coloured shales, unfossiliferous
2. Blue-grey shales, weathering white
3. Dark blue-grey or black mudstones
4. Volcanic rocks
5. Dark fossiliferous mudstones with trilobites and brachiopods.

On the basis of the faunas they divided the strata into two parts, an Upper Group, characterized by an abundance of *Trinucleus*, and a Lower Group with an abundance of *Ampyx* and *Orthis testudinaria*, though they admitted that such a subdivision might be of only local application. Although Elles & Wood considered the beds to be related to the Dufton Shales and the Sleddale Beds (= Stile End Beds + Yarlside Rhyolite + Applethwaite Beds) their faunal lists included certain forms, such as *Trinucleus seticornis* and *Dindymene ornata*, which, as pointed out later by Marr (1916 : 42), suggested the existence of Ashgill strata. As noted elsewhere in this paper, such a view is not now acceptable.

Since 1916 the Drygill Shales have attracted little attention, and none of the fossils has ever been figured. Hollingworth (1938) showed the general relationships of their outcrop, and described briefly the alteration of the shales by igneous intrusions and mineralizing solutions. He also (p. 209) gave a map of the area, showing the elongated ovoid outcrop of the Drygill Shales interfingered at either end with the Harestones Felsite, and this was later elaborated slightly in the Geological Survey's Regional Handbook for Northern England (*in* Eastwood 1946, fig. 12). Stubblefield (1939 : 56), in discussing what he called the "*Broeggerolithus* – "*Acaste*" – *Brongniartella* " fauna in the Caradoc Series of England and Wales, stated that it was found in an argillacous facies in both the Pwllheli Mudstones and the Drygill Shales, and linked the latter with the Dufton Shales. Existing knowledge of the Drygill Shales has more recently been briefly reviewed by Mitchell (1956 : 434) who suggests that the beds may rest unconformably on the Borrowdale Volcanics and Skiddaw Slates, and also that the Coniston Limestone Group (used by him in a broad sense) may have extended originally over the whole of the central Lake District. This view now requires modification, and is discussed later.

Basically the rocks are dark-grey mudstones which, as noted by Marr (1916 : 42), bear a marked lithological resemblance to the Dufton Shales of the Cross Fell Inlier. However, they have been much disturbed tectonically and although there appears to be a general dip just west of south, accurate dip readings were found to be unobtainable or of little use so that estimates of thickness are unreliable.

The greater part of the outcrop comprises what appear to be whitish-grey shales, but this appearance results from a combination of cleavage and alteration by the intrusion of the adjacent Harestones Felsite. Hollingworth (1938 : 214) has noted the possible kaolinisation of the so-called " shales " by the felsite, and the latter forms a substantial outcrop both to the east and to the west of that of the Drygill

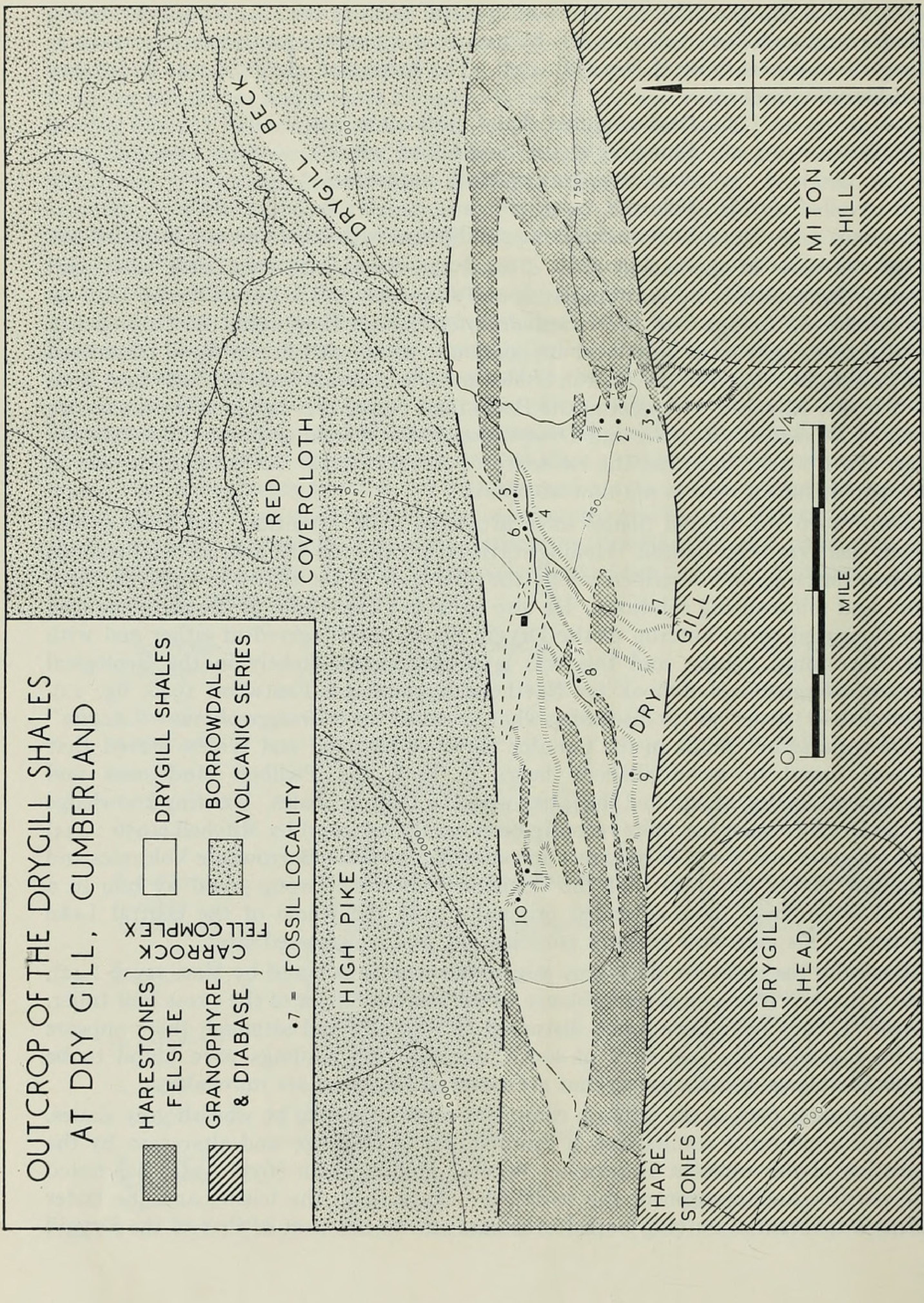

OUTCROP OF THE DRYGILL SHALES
AT DRY GILL, CUMBERLAND
HARESTONES FELSITE
GRANOPHYRE & DIABASE
CARROCK FELL COMPLEX
DRYGILL SHALES
BORROWDALE VOLCANIC SERIES
•7 = FOSSIL LOCALITY
DRYGILL BECK
RED COVERCLOTH
HIGH PIKE
MITON HILL
DRY GILL
DRYGILL HEAD
HARE STONES
0
1/4
MILE

Fig. 3

Shales. The junction of the two is, on the whole, irregularly dentate with occasional dyke-like extensions of the felsite interdigitating with the Caradoc strata and sometimes running for a considerable distance approximately along the strike. No lithological subdivision of the rocks has proved practicable.

(*b*) *Palaeontology*

Fossils have been found throughout most of the thickness of strata, but the fauna is sporadic, though sometimes apparently occurring in thin bands, as shown by the presence of several specimens on certain slabs of rock. The majority of the fossils are trinucleid trilobites which, as far as the generally poor preservation permits, appear to belong to one species, namely *Broeggerolithus nicholsoni* (Reed) (see Pl. 5, figs. 1, 2, 5, 8, 9, 11). Virtually all the specimens have undergone distortion to a greater or lesser degree and in different directions, so that at first sight there appear to be several different types of cephala. This obviously led to the misinterpretation of these trilobites by Elles & Wood (1895), and their record of *Trinucleus seticornis* Hisinger sp. (the type species of *Tretaspis*), as well as *Dindymene ornata* Linnarsson, led to an erroneous assumption that Ashgill strata existed at Dry Gill. The occurrence of *Broeggerolithus nicholsoni* through most of the succession suggests that only strata belonging to the Longvillian Stage of the Caradoc Series are present. This species was first described, as *Trinucleus nicholsoni* Reed, from the Alston Road, near Melmerby, in the Cross Fell Inlier. More recently it has been redescribed (Dean 1962 : 79) and shown to occur in what are now called the Melmerby Beds, of Upper and, probably, Lower Longvillian ages. *B. nicholsoni* occurs also in the Pwllheli and Llanbedrog district of North Wales, as well as in the Lower Longvillian of south Shropshire (Dean 1963*a* : 4, 11), but its distribution is somewhat anomalous as it is almost unknown from the main part of the Cross Fell Inlier.

The attempt made by Elles & Wood (1895 : 248) to subdivide the succession into two parts, an upper with an "abundance of *Trinucleus* ", and a lower with abundant " *Ampyx, Stygina Murchisoniae* and *Orthis testudinaria* " has not been found practicable. During the present work only a doubtful trace of an indeterminate *Lonchodomas* was seen at Locality 6, but Elles & Wood's collection at the Sedgwick Museum includes a few specimens of the genus, some of them on the same slab of rock. All are distorted, and specific identification is unsafe in view of the state of preservation (see Pl. 4, figs. 3, 10–12). In the Cross Fell Inlier, *Lonchodomas* has been found in only two parts of the Caradoc succession, namely the Upper Longvillian and, higher, in the Onnian and Pusgillian Stages. The specimens from the higher horizon belong to *Lonchodomas pennatus* (La Touche) and have been found almost always in association with such distinctive genera as *Onnia*, *Tretaspis* and *Onnicalymene*, but none of these has yet been found at Dry Gill. Consequently, it seems that the species present may more likely prove to be allied to one such as *Lonchodomas swindalensis* Dean (1962 : 72) from the Upper Longvillian of Cross Fell, though it must be emphasized that specific identification seems unwise with the available material. *Dindymene ornata* as recorded by Elles & Wood (A. 4014–2 in the Sedgwick Museum) probably belongs to the same form of *Lonchodomas*, and one specimen is figured here (Pl. 4, fig. 6).

All the calymenids examined from Dry Gill have proved to belong to *Flexicalymene* sensu stricto, allied to *F. caractaci* (Salter), though comparison is difficult using such distorted material (Pl. 4, figs. 5, 9). This species-group ranges through the Upper Longvillian and Marshbrookian Stages in south Shropshire, whilst at Cross Fell it is seen in the Lower and Upper Longvillian of the Melmerby district (Dean 1962 : 114).

One cranidium of *Primaspis* has recently been collected by Mr. D. Sealy from Locality 1, and represents the only odontopleurid yet known from the Drygill Shales. The specimen is figured here (Pl. 4, fig. 4) and compared with *P. semievoluta* (Reed), again a trilobite known only from the Longvillian (probably Lower Longvillian) of Melmerby (Dean 1962 : 122).

A few dalmanitid trilobites were found at localities 2 and 11. Although often distorted (see Pl. 5, figs. 4, 7), all appear to belong to *Kloucekia apiculata* (M'Coy), a species which, as far as is known, is a reliable indicator of the Longvillian Stage, at which horizon it is widespread throughout Wales and the Welsh Borders.

Among the generically determinable trilobites found at Dry Gill are two different forms of the homalonotid *Brongniartella*. One of these is the small species *Brongniartella minor* (Salter) (= *B. parva* Harper), recently redescribed (Dean 1961 : 351) and recorded only from the Lower Longvillian of England and Wales. The other, larger species of *Brongniartella* (Pl. 4, fig. 8) has a longer, scoop-like pre-glabellar field, a convex (as opposed to a transversely straight) anterior border, and a glabellar outline which narrows slightly in front of its mid-point. It is distinct from *B. minor* and may be compared with *Brongniartella bisulcata* (M'Coy), a species ranging from the Upper Longvillian to the Marshbrookian (Dean 1961 : 346) and found in Shropshire and at Cross Fell. The record of *B. minor* at localities 2, 4 and 6 suggests that Lower Longvillian strata occur in the north and eastern part of the Drygill Shales, whilst *B.* cf. *bisulcata* at locality 9 is suggestive of possibly Upper Longvillian beds to the south-west.

The pygidia listed by Elles & Wood (1895) as *Stygina murchisoniae* Salter are figured here (Pl. 4, figs. 2, 7). Both have undergone lateral compression and are generically undeterminable, though possibly belonging to the Illaenidae or Raphiophoridae.

Of the other fossils of the Drygill Shales, the few dalmanellid brachiopods found have proved inconclusive owing to their poor preservation. They are broadly referable to *Dalmanella* or *Onniella*, but no undistorted internal moulds have been obtained. The single inarticulate brachiopod listed by Elles & Wood as *Lingula ovata* M'Coy is too distorted for certain identification, but probably belongs to *Lingulella*, the genus to which *L. ovata* may, perhaps, be assigned. M'Coy's species (M'Coy *in* Sedgwick & M'Coy, 1851 : 254, pl. 1.L, fig. 6) was originally described as occuring in the " *Lingula* slates " of Penmorfa and Festiniog, North Wales, as well as the " Coniston Limestone " of Coniston, and, doubtfully, the " Bala schists " of Bryn Melyn, near Bala.

Other brachiopods broadly referable to *Chonetoidea* have been collected from localities 1, 3, 5 and 7, and one of the best preserved is figured (Pl. 4, fig. 1).

The remaining fauna includes a few indeterminate gastropods, some machaeridian plates belonging to *Plumulites*, and occasional ostracods which can be broadly assigned to *Tallinnella* Öpik. None of these has proved of stratal significance, and all belong to long-ranging fossil groups.

IV. CORRELATION OF THE CARADOC SERIES IN THE LAKE DISTRICT AND NEIGHBOURING AREAS

Although the faunas of the Stile End Beds have yet to be investigated along the remaining outcrop of the so-called " Coniston Limestone ", it is now possible to give at least a broad outline of Caradoc correlation in north-western England. The earliest Caradoc strata there belong to the Longvillian Stage, probably the lower portion of that subdivision. In the south of the Cross Fell Inlier they comprise the distinctive *Corona* Beds of Roman Fell, containing a fauna of mainly inarticulate brachiopods, bivalves and gastropods, with occasional articulate brachiopods and large homalonotid trilobites of the genus *Brongniartella*. At the northern end of the inlier, some fourteen miles away, the corresponding strata comprise blocky, grey-green mudstones with a fauna consisting predominantly of trinucleids belonging to a single species, *Broeggerolithus nicholsoni* (Reed), accompanied by small numbers of other trilobites (*Brongniartella, Conolichas, Primaspis*) with some brachiopods, mainly small dalmanellids and plectambonitids. These Melmerby Beds would appear to represent an ecological variation distinct from that at Roman Fell, although it seems unlikely that the two were entirely discrete as there is a suggestion of overlap in the vicinity of Dufton, where rare specimens of *B. nicholsoni* have been found with Lower Longvillian brachiopods in dark mudstones. The faunas at Dry Gill indicate that the succession may largely be correlated, first, with the Melmerby Beds, since both contain abundant *Broeggerolithus nicholsoni* and, secondly, with the mudstone succession in the Lleyn Peninsula of North Wales, for example the Llanbedrog Mudstones, where the beds contain additional faunal elements of essentially North Welsh type such as *Chasmops* and *Platylichas*, which are unknown from Shropshire and Cross Fell prior to the Upper Longvillian or even later stages. At Dry Gill, as at Cross Fell, owing to the lack of suitable exposures, there is no definite evidence that the base of the Lower Longvillian lies unconformably on the underlying Borrowdale Volcanic Series, but the existence of such an unconformity can hardly be doubted, and indicates a marine transgression in the lower part of the *Dicranograptus clingani* Zone. This may, perhaps, have been a continuation of the earlier, well-known *Nemagraptus gracilis* Transgression, which is now known to have persisted through at least part of the succeeding *Diplograptus multidens* Zone in some areas of the Welsh Borders. On the other hand it might be equated with the instability indicated in parts of south Shropshire during the deposition of the Lower Longvillian rocks, and apparently quite distinct from the *N. gracilis* Transgression.

The Actonian and Onnian Stages of south Shropshire contain faunal elements of Scandinavian type which are unknown from lower strata in the area (Dean 1958 : 229), and the Actonian marks the beginning of a period when faunal regions which hitherto were discrete now became linked. This hypothesis has been supported in the Cross Fell Inlier, and it has been concluded that these phenomena can be related to the widespread marine transgression, occurring in the late *Dicranograptus clingani* Zone and probably also the *Pleurograptus linearis* Zone, represented by black shales and muds, occasionally graptolitic, known in some areas as the Nod Glas and found over much of Wales (Dean 1959 : 222–223). The Actonian age now established for the Stile End Beds and their basal, marginal conglomerates fills a gap in the stratigraphy of northern England, and suggests a northern geographical limit for the Nod Glas Transgression in the Lake District. Prior to the transgression the Stile End area appears not to have undergone submergence, and there is no suggestion of Lower and Upper Longvillian deposits such as occur at Dry Gill and Cross Fell. Conversely, there is no reliable evidence for the Nod Glas Transgression at Dry Gill, and the margin of the sea must have been twenty miles farther south, in the Stile End area.

Now that the Stile End Beds are known to be Actonian in age, the possible age limits of the Stockdale or Yarlside Rhyolite can be narrowed down to the late Caradoc (Onnian and Pusgillian Stages) or very early Ashgill Series. In view of the fact that Whittington (1950 : 41) has recorded *Diacalymene* from the Applethwaite Beds of Applethwaite Common, two and a half miles west of Stile End, and suggested that the strata are of Lower Ashgill age, the Caradoc age of the Rhyolite seems the more likely. Over most of the Anglo-Welsh area the highest Caradoc beds are either absent or represented by mudstones and shales, and there is no known igneous rock comparable to the Yarlside Rhyolite.

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EXPLANATION OF PLATES

Most of the figured specimens are in the British Museum (Natural History) and their numbers bear the prefixes In., BB. and PG., denoting respectively the trilobites, brachiopods and gastropods. Certain other specimens are in the Sedgwick Museum, Cambridge, and their numbers are prefixed A. Specimens whitened with ammonium chloride before photographing. Photographs by the writer.

PLATE I

Chasmops cf. *extensa* (Boeck) . . . . . p. 54

FIG. 1. Internal mould of distorted cephalon. In. 56776. ×1·5. Locality λA.
FIG. 2. Internal mould of pygidium. In. 56978. ×1·5. Locality λG.
FIG. 5. Internal mould of fragmentary pygidium. In. 56803. ×1·5. Locality λB2.
FIG. 10. Internal mould of undistorted pygidium. In. 56798. ×0·75. Locality λG.

Calyptaulax cf. *actonensis* Dean . . . . . p. 54

FIGS. 3, 4. Lateral and dorsal views of internal mould of partly crushed pygidium. In. 56802. ×2. Locality λB2.

Encrinurus kingi sp. nov. . . . . . p. 53

FIGS. 6, 7. Dorsal and lateral views of internal mould of incomplete cranidium. Paratype, SM., A. 51705. ×2. Locality λF.
FIG. 12. Internal mould of fragmentary right fixigena. Paratype, In. 56979. ×2. Locality λF.

Gravicalymene cf. *praecox* (Bancroft) . . . . . p. 55

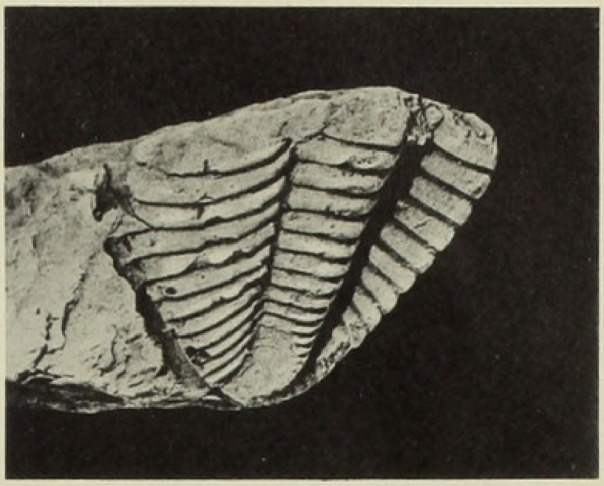
FIG. 11. Internal mould of almost complete, damaged cranidium. In. 56786. ×3·5. Locality λE.

Proetidella? sp. indet. . . . . . . p. 55

FIG. 8. External mould of right librigena. In. 56787. ×4. Locality λE.
FIG. 9. Internal mould of incomplete cranidium. In. 56799. ×3. Locality λG.

All specimens from the Stile End Beds.

1



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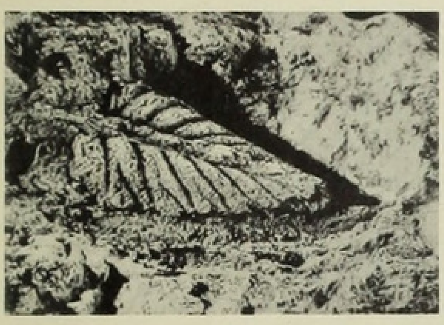

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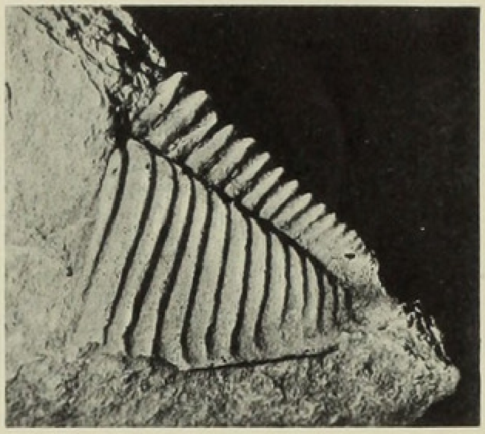

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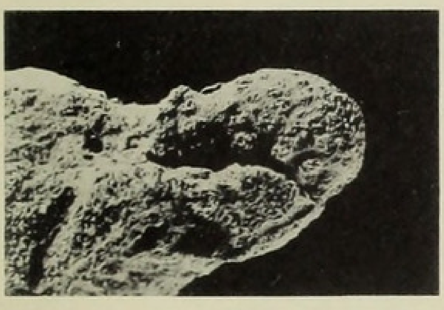

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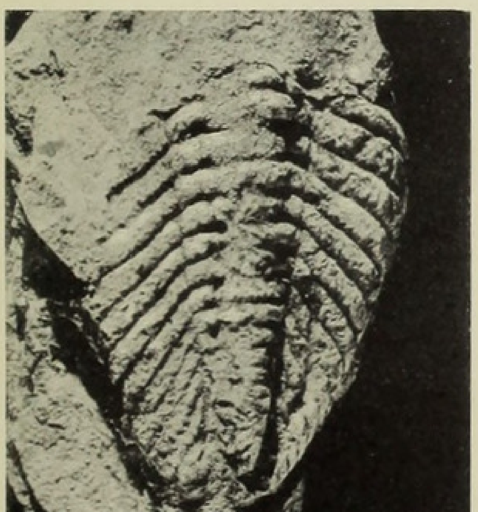

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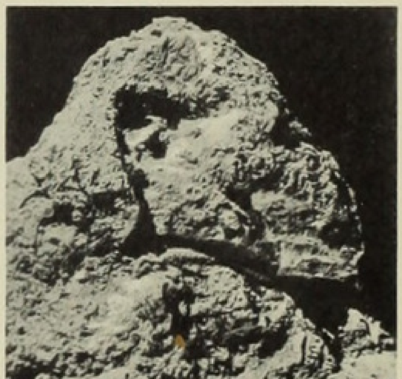


12

FOSSILS FROM THE STILE END BEDS

PLATE 2

Encrinurus kingi sp. nov. . . . . . p. 53

Fig. 1. Internal mould of holotype pygidium. SM., A. 51706. × 2. Locality λF.

Fig. 2. Internal mould of fragmentary paratype pygidium showing tip. In. 56993. × 2·5. Locality λF.

Fig. 7. Internal mould of paratype pygidium showing axial and ring furrows. In. 56791. × 2·5. Locality λF.

Atractopyge sp. . . . . p. 55

Figs. 3, 5. Dorsal and lateral views of internal mould of incomplete cranidium. Sedgwick Museum. A. 51707. × 2. Locality λG.

Cyrtolites cf. *nodosus* (Salter) . . . . . p. 57

Fig. 4. Lateral view of internal mould. PG. 3579. × 1·5. Locality λB1.

Cryptothyris cf. *paracyclica* (Bancroft) . . . . p. 55

Fig. 6. Internal mould of slightly distorted brachial valve. BB. 30070. × 2. Locality λK.

Strophomena sp. . . . . . . p. 56

Fig. 8. Internal mould of pedicle valve. SM., A. 51708. × 2. Locality λK.

Rafinesquina (s.l.) sp. . . . . . . p. 56

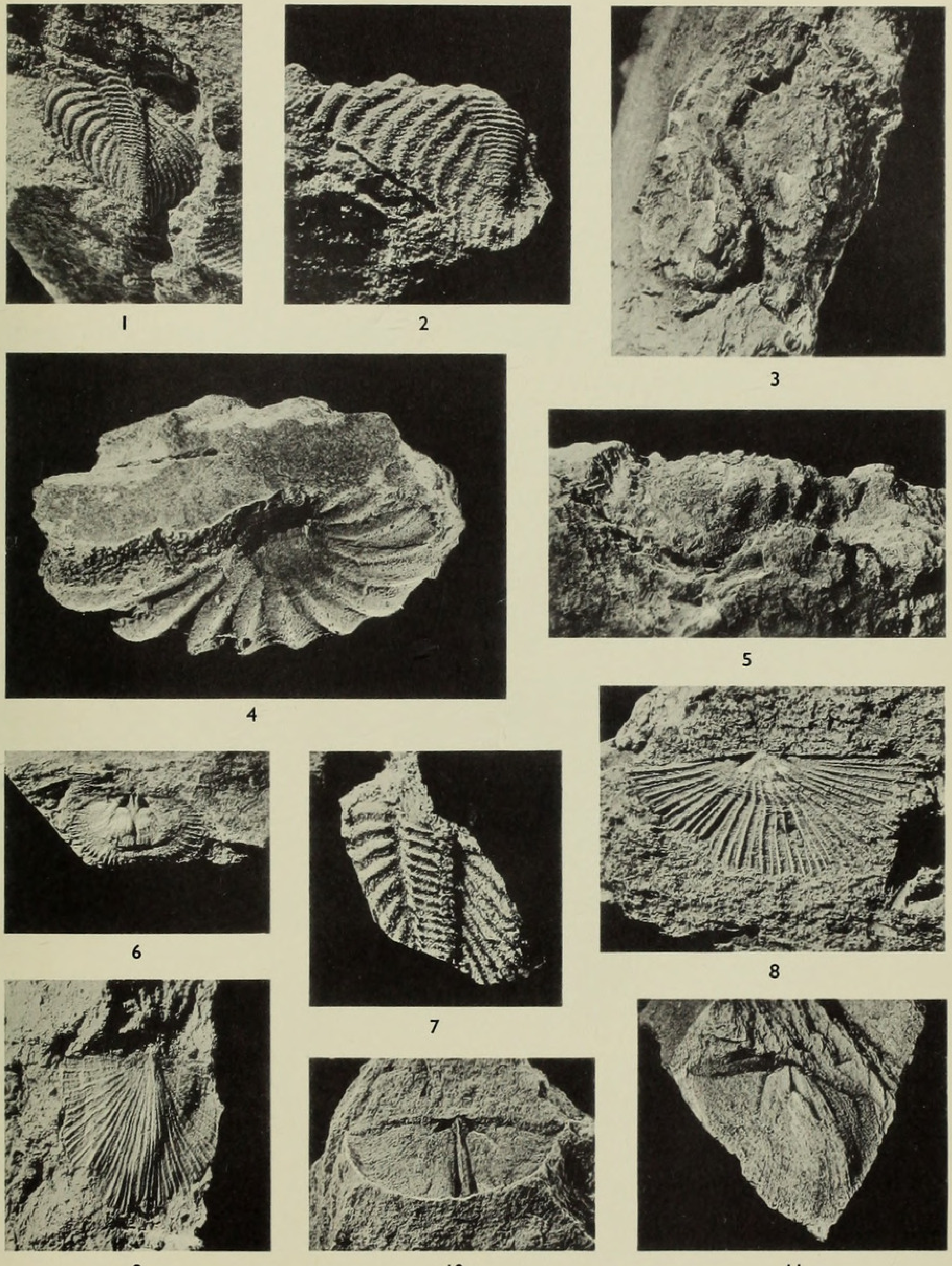
Fig. 9. Internal mould of pedicle valve. BB. 30071. × 2. Locality λG.

Sowerbyella cf. *sericea* (J. de C. Sowerby) . . . p. 56

Fig. 10. Internal mould of brachial valve. BB. 29807. × 1·5. Locality λB2.

Fig. 11. Internal mould of pedicle valve. BB. 29806. × 1·5. Locality λB2.

All specimens from the Stile End Beds.



FOSSILS FROM THE STILE END BEDS

PLATE 3

Hedstroemina cf. *robusta* (Bancroft) . . . . p. 56

FIG. 1. Internal mould of pedicle valve. SM., A. 51709. ×1·25. Locality λG.

FIG. 2. Specimen showing internal mould of pedicle valve and external mould of brachial valve. BB. 29819. ×1·25. Locality λG.

FIG. 3. External mould of brachial valve together with cardinal area. BB. 29816. ×1·25. Locality λG.

Platystrophia sp. . . . . . . p. 56

FIG. 4. Internal mould of longitudinally compressed pedicle valve. SM., A. 51710. ×2. Locality λG.

FIG. 7. Internal mould of pedicle valve. BB. 29809. ×1·5. Locality λG.

Nicolella cf. *actoniae* (J. de C. Sowerby) . . . p. 56

FIG. 5. External mould of brachial valve. BB. 29815. ×1·5. Locality λG.

FIG. 9. Internal mould of fragmentary pedicle valve. BB. 29813. ×2. Locality λC.

Orthid indet. . . . . p. 57

FIG. 6. Internal mould of pedicle valve. BB. 29825. ×2. Locality λB2.

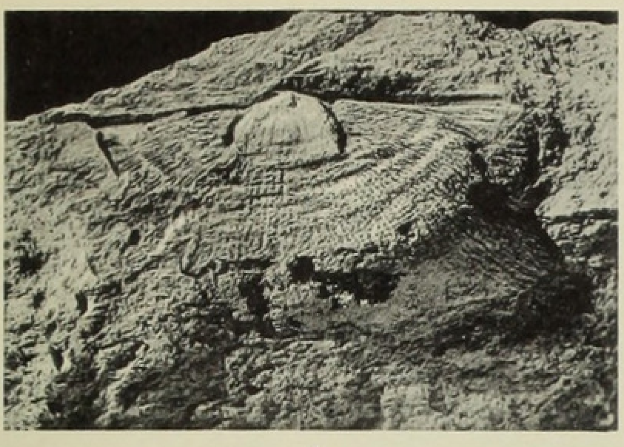
Leptaena sp. . . . . p. 56

FIG. 8. Internal mould of pedicle valve. BB. 29812. ×1·5. Locality λB1.

Biscuspina sp. . . . . p. 56

FIG. 10. Internal mould of brachial valve. BB. 29804. ×2. Locality λG.

All specimens from the Stile End Beds.



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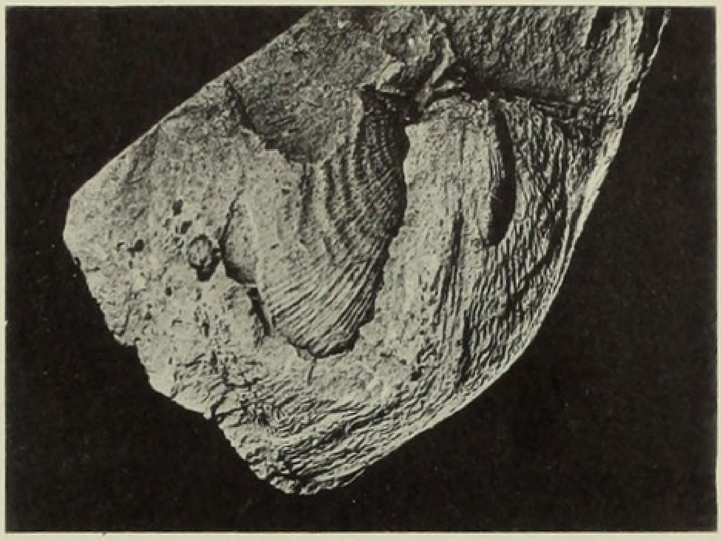

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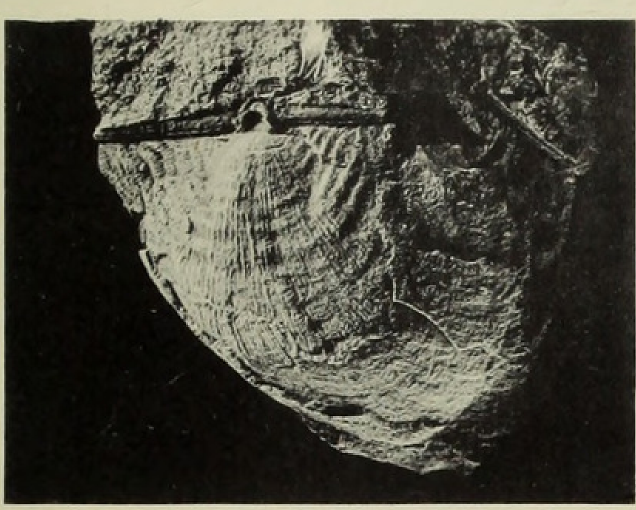

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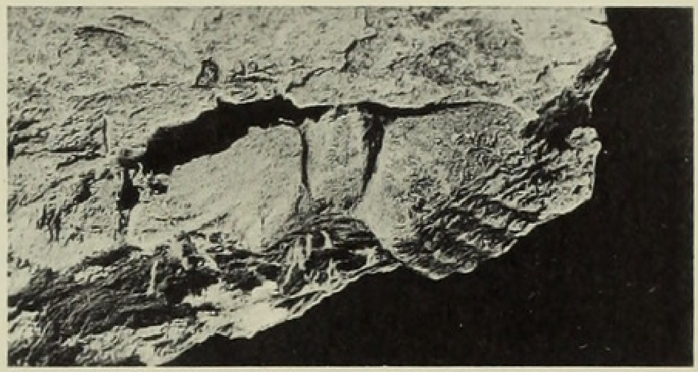

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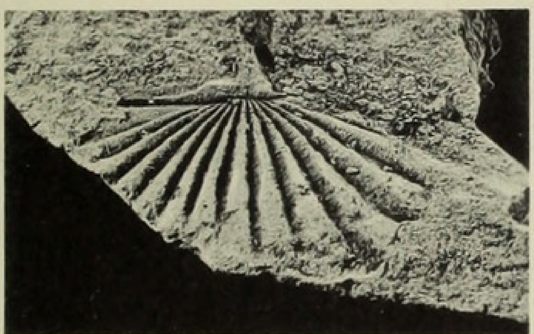

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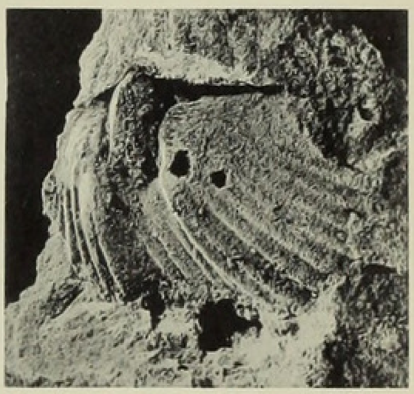

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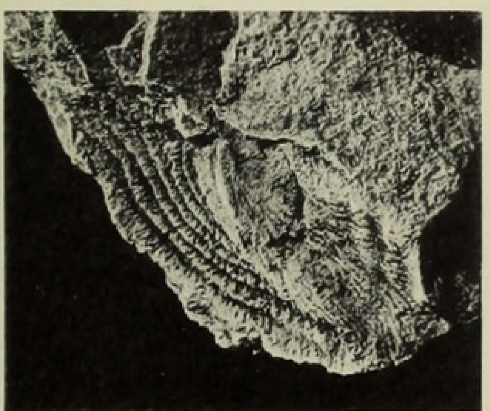

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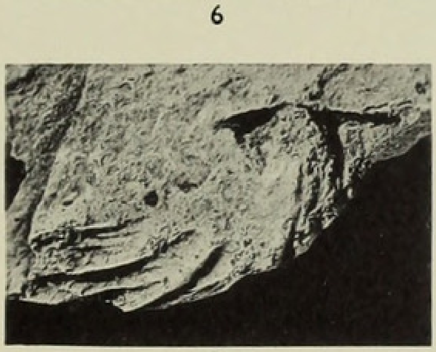

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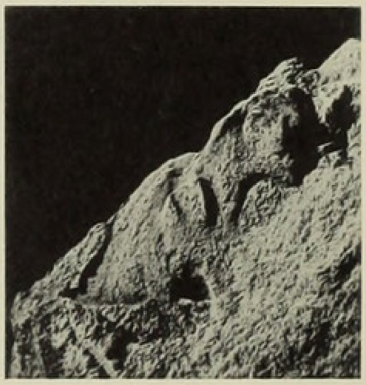

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FOSSILS FROM THE STILE END BEDS

PLATE 4

Chonetoidea sp. . . . . p. 62

FIG. 1. Latex cast of conjoined dorsal and ventral valves. BB. 30117. × 2·7. Locality 7.

Trilobite gen. et sp. indet. . . . . . p. 62

FIG. 2. Internal mould of crushed pygidium listed by Elles & Wood (1895) as *Stygina murchisoniae*. SM., A. 40164. × 2.

FIG. 7. As for Fig. 2. SM., A. 40163. × 2.

Lonchodomas sp. . . . . . . p. 61

FIG. 3. External mould of distorted cranidium. SM., A. 40125. × 2·5.

FIG. 6. Internal mould of incomplete cranidium, listed by Elles & Wood (1895) as *Dindymene ornata*. SM., A. 40142. × 7.

FIG. 10. Internal mould of cranidium, with external mould of calymenid pygidium. SM., A. 53146. × 2.

FIG. 11. Internal mould of pygidium, with external mould of dalmanellid brachiopod. SM., A. 40124. × 2.

FIG. 12. Internal mould of cranidium. SM., A. 40146. × 2.

Primaspis cf. *semievoluta* (Reed) . . . . . p. 62

FIG. 4. Internal mould of compressed cranidium. In. 56880. × 4. Locality 1.

Flexicalymene cf. *caractaci* (Salter) . . . . . p. 62

FIG. 5. Internal mould of fragmentary, distorted cranidium. SM., A. 40136. × 2·25.

FIG. 9. Internal mould of incomplete cranidium. SM., A. 40133. × 5.

Brongniartella cf. *bisulcata* (M'Coy) . . . . . p. 62

FIG. 8. Latex cast of cranidium. In. 56981. × 1·25. Locality 9.

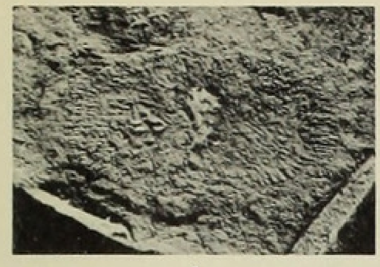
Lingulella? sp. . . . . p. 62

FIG. 13. External mould, listed by Elles & Wood, 1895 as *Lingula ovata*. SM., A. 40090. × 2·5.

Kloucekia apiculata (M'Coy) . . . . . p. 62

FIG. 14. Internal mould of distorted cephalon and thorax, listed by Elles & Wood (1895) as *Phacops* sp. SM., A. 40145a. × 1·25.

All the specimens derive from the Drygill Shales but, excluding Figs. 4 and 8, all are from old collections and unlocalised with regard to their exact position at Dry Gill.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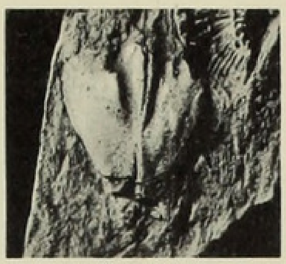
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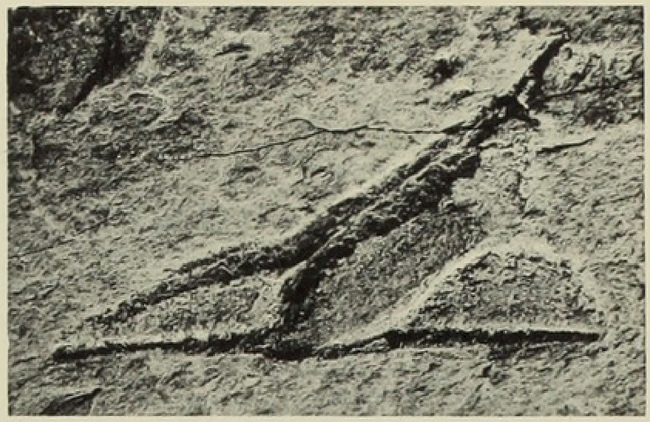
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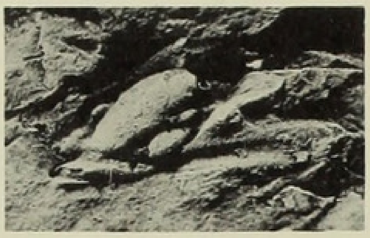
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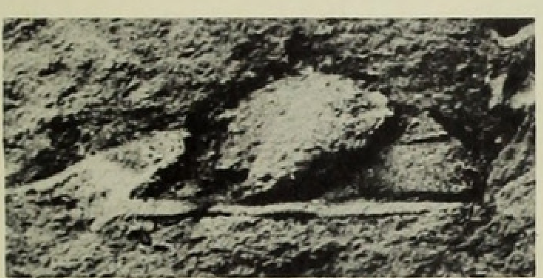
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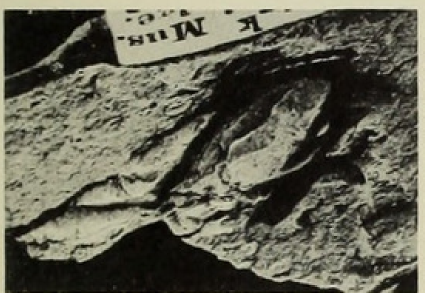
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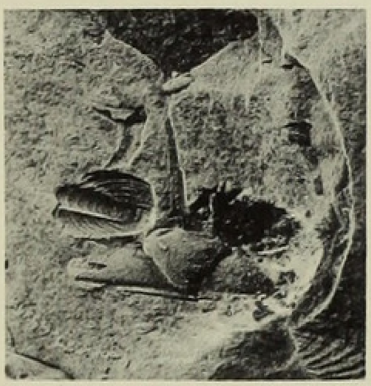
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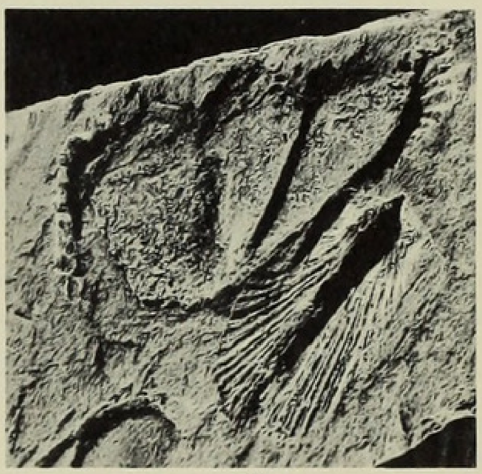
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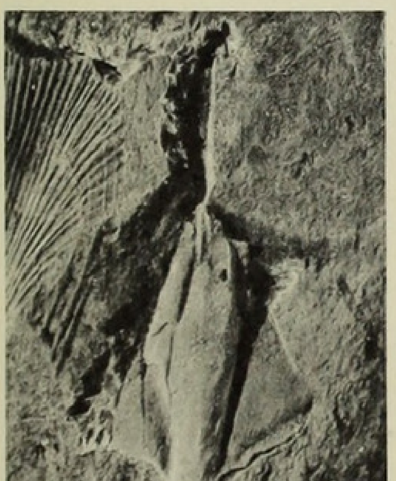
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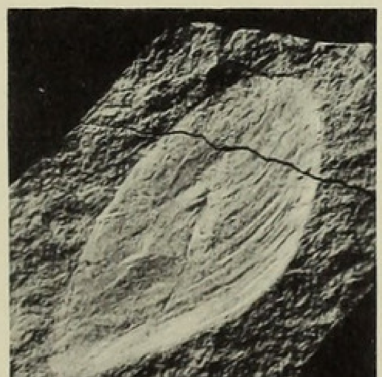
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FOSSILS FROM THE DRYGILL SHALES

PLATE 5

Broeggerolithus nicholsoni (Reed) . . . . . p. 61

FIG. 1. Internal mould of incomplete cranidium. In. 56982. × 2. Locality 6.

FIG. 2. Internal mould of pygidium. In. 56983. × 3·5. Locality 1.

FIG. 5. Internal mould of cranidium. In. 56986. × 2·5. Locality 9.

FIG. 8. Internal mould of fragmentary cranidium. In. 56989. × 2·5. Locality 6.

FIG. 9. External mould of underside of cephalic fringe and left librigenal spine. In. 56990. × 1·5. Locality 7.

FIG. 11. External mould of two incomplete dorsal exoskeletons. In. 56992. × 1·7. Locality 3.

Brongniartella minor (Salter) . . . . . p. 62

FIG. 3. Internal mould of pygidium. In. 56984. × 2·25. Locality 6.

FIG. 6. As for Fig. 3. In. 56987. × 2. Locality 4.

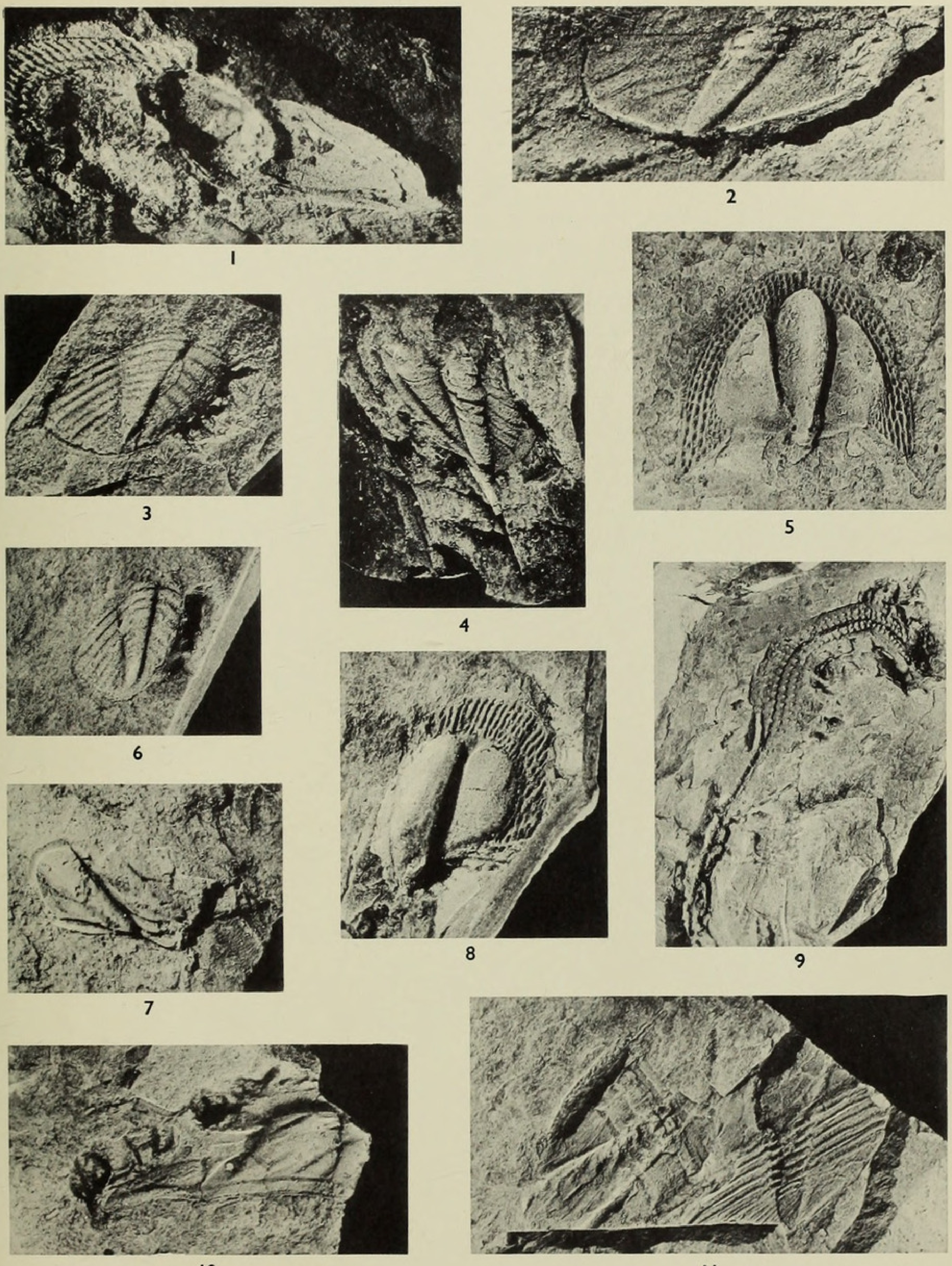
FIG. 10. Internal mould of incomplete cranidium. In. 56991. × 2·5. Locality 2.

Kloucekia apiculata (M'Coy) . . . . . p. 62

FIG. 4. Latex cast of pygidium, showing long terminal spine. In. 56985. × 2. Locality 11.

FIG. 7. Internal mould of incomplete, distorted cephalon. In. 56988. × 2·5. Locality 2.

All specimens from the Drygill Shales of Dry Gill.


1 2 3 4 5 6 7 8 9 10 11

FOSSILS FROM THE DRYGILL SHALES