SOME BRITISH LOWER PALAEOZOIC CONODONT FAUNAS

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CONTENTS

Conodonts have been studied intensively for the last twenty years in the United States, but little attention has been paid to them in Britain. Digestion in acetic acid of some of the Lower Palaeozoic limestones of England and Wales has revealed the presence of at least four faunas. Conodonts from the Llandeilo Limestone of South Wales, the Gelli-grin and Pen-y-garnedd Limestones of North Wales and the Aymestry Limestone of Staffordshire and Shropshire are described. Four new genera, *Balognathus*, *Holodontus*, *Icriodella* and *Sagittodontus*, and a number of new species are described, and the conodont faunas are compared with those of a similar age from the United States. The value of the conodonts as index fossils is discussed.

I. History of previous research

Conodonts were first recorded and described by Pander in 1856, and, although they were reported shortly afterwards from several localities in Britain, comparatively little attention has been paid to them in this country. Harley* (1861) figured two types of conodonts in what he considered to be crustacean remains from the Ludlow Bone Bed, and Young (1880) and Mason (1881) reported conodonts from the Silurian and Devonian of England and the Carboniferous of Scotland. Smith (1907*a*) recorded these fossils from the Coal Measures of Scotland and later (1907*b*) described a number of specimens from the Arenig-

* The author has, through the kindness of Dr K. P. Oakley, been able to examine Harley's specimens, which are deposited in the British Museum (Natural History), and has identified them as *Spathognathodus primus* Branson & Mehl (Harley, 1861, Pl. XVII, fig. 15) and *Acodus* sp. (Pl. XVII, figs. 16*a*, *b*).

Llandeilo of the Southern Uplands. More recently Currie, Duncan & Muir-Wood (1937) described conodonts from Skipsey's Marine Band, and Stubblefield (in Mitchell & Stubblefield 1941, 1942, 1945; Edwards & Stubblefield 1948) recorded a number of genera from marine bands of the productive Coal Measures of the Leicestershire and South Derbyshire, the Warwickshire, the South Staffordshire and the Nottinghamshire and Derbyshire coalfields. Stubblefield has also recorded conodonts from the Millstone Grit (Dunham & Stubblefield 1945).

These papers represent the present state of knowledge concerning British conodonts, although during the last twenty-five years numerous papers have been published describing various faunas from the United States. The lack of any systematic detailed study of British conodonts is all the more surprising in view of the repeated demonstration by American workers of the widespread occurrence and stratigraphical value of these Palaeozoic fossils.

II. Zoological affinities of the conodonts

(*a*) *Nature of conodonts*

Conodonts are small tooth-like fossils composed of calcium phosphate, which range from a fraction of a millimetre to more than 2 mm in length. They have been recorded from marine strata ranging from Ordovician to Triassic in age, and exhibit considerable variation in form, the earlier types tending to be simple conical or blade-like forms and the later types tending to be either blade-like or platform-like in form. Conodonts are usually pale amber or brown in colour, being translucent with a shiny surface, but weathering and other chemical changes may give them a black or white opaque appearance.

(*b*) *Zoological affinities*

There is little agreement concerning the zoological affinities of the conodonts. Pander (1856) studied the structure of many specimens and concluded that they represented the teeth of primitive fish. A number of more recent workers have shared Pander's opinion. Thus Ulrich & Bassler (1926, p. 2) regarded the conodonts as the teeth of an extinct group of cyclostome-like fishes, stating that some forms showed affinities with the myxines and others with the selachians. Branson & Mehl (1933, p. 5) and other subsequent writers have recorded many specimens with bone-like material attached to the aboral surface, and Ellison (1944), showing that the chemical composition of conodonts is the same as the mineral matter in fossil and recent bone and teeth, has classified the group as fish or one of the other lower vertebrates.

Harley (1861, pp. 542, 553) suggested conodonts were crustacean remains, representing spines similar to those attached to the margins of the 'carapace' of *Limulus* and the caudal segment of *Squilla*. Loomis (1936) demonstrated the similarity of conodonts to components of molluscan radulae, while Demanet (1939) illustrated what he claimed to be conodonts attached to the gill arches of *Coelacanthus lepturus*. Through the kindness of Dr C. J. Stubblefield, F.R.S., the author has been able to study the original specimens described by Demanet. It seems probable that the structures which Demanet described

are not true conodonts, though they show some resemblance to them. Schmidt (1934, 1950), Scott (1934, 1942), DuBois (1943) and Rhodes (1952) have described conodont assemblages, which are claimed to represent the remains of an individual animal, containing paired conodonts referable to a number of existing 'genera'. Schmidt regarded these assemblages as the remains of Acanthodian fish, while the other workers considered that such assemblages may represent the jaw apparatus of a group of extinct annelids.

Conodonts are, however, quite unlike scolecodonts in their general form, structure and chemical composition. It is therefore suggested that, if they do belong to the annelids, they represent a group distinct from the polychaetes which bore scolecodonts.

Hass (1941) considered that the microstructure of the conodonts and their ability to regenerate broken parts suggested that they functioned as 'internal supports for tissues that were located at a place exposed to stresses upon the exterior of or within the bodies of some genetically related group of marine animals' (1941, p. 71).

Excellent summaries of the literature on the affinities of the conodonts are given by Stauffer & Plummer (1932, pp. 13–20) and Scott (1934, pp. 449–450) and the various opinions are critically reviewed by Ellison (1944, pp. 138–139) and Rhodes (1952, pp. 886–889). The present work offers no new evidence as to the systematic position of the conodonts, about which, in the present state of knowledge, no final conclusion may be given.

(*c*) *Problems of nomenclature*

The lack of knowledge concerning the true function of conodonts has raised considerable problems of nomenclature. The majority of workers have adopted the binomial system and have classified individual specimens into genera and species. This method has proved to be of considerable utilitarian value, but the work of Schmidt, Scott, DuBois and Rhodes, referred to above, indicates that such a classification represents only a 'form' classification. As natural assemblages of conodonts are rare, however, the recommendation of Hass (1941, p. 80) and Scott (1942, p. 295), that the established method of describing individual specimens should be continued, is adopted in the present paper. Subsequent discoveries of natural conodont assemblages will almost certainly reveal that several of the 'genera' described in this and other papers occur in the mouthpiece(?) of a single individual. In spite of this it still appears preferable to retain the established classification, although it should be recognized that it does not represent a true zoological classification.

The author has, unlike some other recent workers, been reluctant to erect new species upon minor variations in form or upon single specimens (except in the few cases where this is clearly stated). Each of the new species described is based upon a large number of specimens and the main variations in form are described. In some cases this variation is conspicuous, but it does not appear to be sufficiently marked to justify its recognition in a new species. Such variation is therefore indicated by the description of varieties within a few species. The lack of knowledge of the true function of the conodonts makes it impossible to apply any extensive infraspecific classification to them. Varieties as defined in the present paper are understood to be distinctive types of individuals within a 'population' (in so far as this term can be applied to a group of conodonts).

III. Stratigraphy of the formations from which conodonts are described

(*a*) *Llandeilo Limestone*

The Llandeilo Series of South Wales consists of a lower grit (the Ffairfâch Grit) followed by blue, brown, sandy, calcareous flags and blue-grey limestones, having a total thickness of about 2500 ft. in the type area but thinning rapidly towards the west. A detailed account of the lithology, fauna and distribution of the Llandeilo Limestone is given in the Memoir on the geology of the country around Ammanford (Strahan, Cantrill, Dixon & Thomas 1907, pp. 22–28).

The locality (Locality 1) from which specimens were collected is a disused quarry in Golden Grove, 300 ft. east-south-east of the Keeper's Lodge at Llanfihangel Aberythych, Carmarthen (National Grid Reference 22/592198). Here 75 ft. of thinly bedded, blue-grey flags and limestones are exposed, dipping southwards at 65°. The limestone overlies the typical Ffairfâch Grit, but to the west and south the limestone and flags are faulted against the mudstones and sandstones of the Ludlow and Wenlock formations.

The most common macrofossils of the limestone are trilobites and brachiopods, but corals, sponges and crinoid remains are also present. *Rafinesquina llandeiloensis*, *Basilicus tyrannus*, *Ogygiocaris buchi* and *Marrolithus* sp. are particularly common in this exposure.

Samples were collected from the section at vertical intervals of 5 ft., and most were found to contain no conodonts, although small numbers of these fossils were present in a few samples. At one horizon in the quarry, however, 55 ft. below the highest bed exposed, conodonts were far more common than in any other bed exposed, but even in this they were comparatively rare.

(*b*) *Gelli-grin Limestone*

The Upper Ordovician rocks of the Bala, Merioneth area, which are briefly described by Elles (1922) and Bancroft (1928), comprise a fossiliferous, shallow-water series of ashes, mudstones, sandstones and limestones. The limestone from which conodonts were obtained forms part of the Gelli-grin Calcareous Ash Series and represents the 'Bala Limestone' of earlier workers. Here, however, it is referred to as the 'Gelli-grin Limestone', in order to avoid confusion over the use of the term 'Bala'. Elles (1922) observed that the lithology of this series changes when traced southwards from Gelli-grin, the type locality, and suggested that the variation in thickness of the sediments between the top of the limestone and the base of the Ashgillian indicates that the limestones are impersistent, appearing at correspondingly higher and lower horizons at various localities. Bancroft (1928), however, has shown from the palaeontological evidence that the Gelli-grin Limestone occurs at a constant horizon in different localities, and that an unconformity at the base of the Ashgillian accounts for the variation in thickness of the intervening sediments.

The locality (Locality 2) from which all the Gelli-grin conodonts were collected is in the shallow quarry (National Grid Reference 23/947355), 1750 ft. due north of Plas Rhiwaldog and 600 ft. east of Y Garnedd, Merioneth. The limestone, about 9 ft. of which is exposed, is dark blue-grey in colour, massive and highly crystalline. Samples were collected from the section at intervals of 6 in. and, while all these contained conodonts,

it was found that the top 12 in. of the limestone were very much richer in these fossils than any other level.

(*c*) *Pen-y-garnedd Limestone*

An account of the lithology, fauna and distribution of the Pen-y-garnedd Limestone is given in the Oswestry Memoir of the Geological Survey (Wedd, C. B., Smith, B., King, W. B. R. & Wray, D. A. 1929, pp. 50 et seq.), and only a brief description is therefore included in the present paper.

The limestone, which is developed in the Berwyn area of north Wales, is Upper Caradocian in age, being generally regarded as the equivalent of the Gelli-grin Limestone (e.g. *Brit. Reg. Geol., North Wales*, p. 40). It is underlain by the Allttair-ffynnon Beds, consisting of thinly bedded sandstones and shales, and is overlain by some 50 ft. of Pen-y-garnedd Shales, containing a thin, but extensively worked, phosphate bed. These shales represent the highest member of the Caradocian and are succeeded by the calcareous shales and mudstones of the Ashgillian.

The exposure (Locality 3) from which conodonts described in the present paper were collected is a disused quarry (National Grid Reference 33/108238) about 900 ft. east of the Powis Arms at Pen-y-garnedd, Montgomeryshire. A detailed description of the succession in this quarry has been given by B. Smith *in* Wedd *et al.* (*Mem. Geol. Surv., Oswestry*, pp. 54–55). The 'limestone' consists of several lenticular beds of thinly bedded limestone and dolomite with intercalated bands of dark shale, having a thin band of ash developed 17 ft. from its base. The total thickness of the limestone exposed in the quarry is 38 ft., but it is recorded as being up to 100 ft. in thickness in the Berwyn Mine, to the west of Llangynog (*Mem. Geol. Surv., Oswestry*, p. 53). The beds in the quarry are inverted, dipping northwards at 80°.

Macrofossils are rare in this exposure, but a number of typical orthids and trilobites are recorded from other localities (*Mem. Geol. Surv., Oswestry*, p. 44). Lewis (1940) has recorded a rich microfauna, consisting mainly of spicules of Siliocospongiae, from the phosphate bed above the limestone.

It has long been considered that the Pen-y-garnedd Limestone is of equivalent age to the Gelli-grin. Thus Davies (1875, p. 359), referring to it as the 'Bala Limestone', considered its fauna to be identical with the fauna of that formation, and B. Smith & W. B. R. King (*Mem. Geol. Surv., Oswestry*, p. 42) write: 'Its position near the top of the Caradocian Series and its fossil-contents indicate that it is of about the same age as the limestones near Bala'. Bancroft states (1945, p. 185) that a 2 ft. bed of crystalline limestone at Bala and Gelli-grin and comparable calcareous deposits in other areas of Wales represent the base of his Upper Longvillian substage. These 'other areas' most probably include the development of the crystalline limestone and dolomite at Pen-y-garnedd.

Professor H. B. Whittington in a letter dated January 1951 writes: 'My work on the stratigraphy and faunas of the Bala area is far from complete, but the results so far obtained suggest that Bancroft (1928, p. 486) was correct in his claim that the crystalline blue limestone of the Gelli-grin Series occurs at the same horizon in different places. This horizon seems to be above those beds yielding *Bancroftina* [*Raymondella*] *typa* and below those containing *Pterygometopus jukesi* (cf. Bancroft 1933). The limestone at Pen-y-garnedd

seems to be at about the same horizon (Whittington 1938, pp. 430–431, Table II). This horizon is at the base of Bancroft's Upper Longvillian stage.'

(*d*) *Aymestry Limestone*

The Aymestry Limestone is generally regarded as an impersistent and extremely variable calcareous development of the highest zones of the Lower Ludlow Shales. The base of the limestone is often difficult to determine; it has been taken by Alexander (1936, p. 109) as the point at which the shales between the limestone beds, which characterize the Lower Ludlow Shales, lose their thin bedding and become irregular, and this line has been accepted in the present paper. The level of the base of the limestone varies, and the thickness and lithology also show striking variations. The limestone is overlain by the *Dayia* or Mocktree Shales which are in turn succeeded by the massive calcareous flags of the Upper Ludlow.

In order to compare the conodont faunas, two separated outcrops were selected, at which the Aymestry Limestone showed considerable differences in development.

The first of these localities (Locality 4) is situated on the main escarpment of the Aymestry Limestone in its type area (Alexander 1936, pp. 104–105). The locality is a large quarry on the south side of the road, 500 yards south-west of Shelderton Rock, Shropshire (National Grid Reference 32/418778), and about 1 mile south-east of the village of Clungunford, Shropshire. Although the base is not visible, the limestone is here estimated to be approximately 100 ft. in thickness, dipping due east at 10°. About 80 ft. of fine, grey, massive limestone are exposed in the quarry, occurring in beds 2 to 3 ft. in thickness, separated by layers of soft, grey, calcareous shales, 1 or 2 in. in thickness. Fossils are less numerous in this development of the limestone than in the 'shell-banks' of View Edge to the north, but *Conchidium knighti* and other characteristic brachiopods, corals, gastropods, cephalopods and Polyzoa are common (Alexander 1936, p. 105). Specimens of the limestone were collected at intervals of 5 ft. throughout the quarry succession and all yielded conodonts, a bed 25 ft. below the highest bed exposed being particularly rich in these fossils. Large numbers of scolecodonts were also present, and a sample from a bed 45 ft. below the top of the quarry left, after digestion with acetic acid, a residue composed almost entirely of hexactinellid sponge spicules. Scales of *Thelodus* are relatively common throughout the limestone.

The second locality (Locality 5) lies to the north-east of Sedgley, south Staffordshire, in a disused quarry on the Aymestry escarpment known as Beacon Hill, 250 yards south-east of Gibbons Farm (map reference of quarry, National Grid 32/923940). In this area, the Silurian rocks form a shallow syncline, pitching to the south, and in Locality 5, which lies on the eastern flank of the fold, some 15 ft. of this limestone are exposed, dipping at 20° west-south-west. The syncline is terminated by an east-west fault passing through Sedgley, to the south of which the limestone reappears in the middle of a faulted anticline. The total thickness of the 'Sedgley Limestone' is estimated to be 20 to 25 ft. The upper portion has yielded *Dayia navicula* and may represent the *Dayia* Shales of Shropshire, while the fauna of the lower portion corresponds closely to that of the Aymestry Limestone of Shropshire (Whitehead & Pocock 1947, p. 9). The limestone is argillaceous, grey-brown in colour, thinly bedded, flaggy and nodular, being separated by thin bands of calcareous

shale. It is underlain by some 500 ft. of Lower Ludlow Shales. It has long been accepted on palaeontological evidence that, in spite of the differences in lithology and thickness, the Aymestry Limestone of Shropshire and the Sedgley Limestone of Staffordshire are equivalent in age, and their almost identical conodont faunas, described in the present work, support this view.

Samples of Aymestry Limestone from three other localities were also studied and yielded similar conodont faunas. The collecting from these localities was, however, less thorough than that from Locality 4 or Locality 5, and lists of fossils are not included, since the faunules obtained were incomplete. The localities are listed below:

Locality 6, South Staffordshire. Map reference, National Grid, 32/919933. Sedgley, Old Quarry 300 yards south-west of All Saints Roman Catholic Church. The limestone, which here forms the core of the South Sedgley anticline noted above, dips east-north-east at 5°. 14 ft. of typical Sedgley Limestone are exposed.

Locality 7. South Staffordshire. Map reference, National Grid 32/908918. Small landslip on western face of Turner's Hill, 50 yards south of old quarry. Turner's Hill is south of Sedgley. This is the locality from which Ball (1951, p. 227) described the Aymestry Bone Bed. Some 8 ft. of argillaceous nodular grey limestone are exposed, and a number of samples of the bone bed which were digested yielded typical Aymestry conodonts.

Locality 8. Shropshire. Map reference, National Grid 32/425806. View Edge Quarry, 200 yards north-east of View Edge Farm. Here some 25 ft. of massive, crystalline, blue-grey limestone are exposed, dipping at 10° south-south-west. This is the typical 'shell-bank' development of the Aymestry Limestone, which is crowded with the remains of *Conchidium knighti*. Conodonts appear to be less common in this development of the limestone than in that at Shelderton Rock (Locality 4).

IV. Formations yielding no conodonts

Samples of the following limestones collected from the localities given below were treated by the method described on p. 268 but failed to yield any conodonts. Although this indicates that conodonts are not common in these formations, further collecting may possibly show them to be present in small numbers at certain horizons.

The Craighead Limestone

National grid reference 26/234014. Deep quarry at Craighead, 3 miles east of Girvan, Ayrshire (see Lamont 1933; Anderson & Pringle 1946). Samples were collected at regular intervals throughout the Shaly-limestone and Breccia-limestone (horizons 4 to 6 of Anderson & Pringle). Scolecodonts are relatively common in the higher members of the Shaly-limestone group.

The Mydrim Limestone

National grid reference 22/289208. Steep embankment at road junction opposite the Post Office at Mydrim, Carmarthenshire. Samples were collected at intervals of 1 ft. throughout the exposure, but because of the argillaceous nature of the limestone it was possible to digest only three samples, each about 2 lb. in weight.

The Robeston Wathen Limestone

National grid reference 22/084160. Old quarry in the dingle, north of the village of Robeston Wathen, Pembrokeshire (see Strahan, Cantrill, Dixon, Thomas & Jones 1914, p. 57). Samples were collected at intervals of 5 ft. throughout the quarry exposure.

The Shoalshook Limestone

National grid reference 12/968170. Railway cutting at Shoalshook, near Haverfordwest, Pembrokeshire. Samples were collected at regular intervals, but only a small quantity of the limestone was digested.

The Hirnant Limestone

National grid reference 23/951297. Small quarry on western slope of Cwm Hirnant at a point due west of Cwm-yr-Aethnen, Merioneth (see Fulcher 1892; Elles 1922, pp. 156–157; Jones 1923; Pugh 1929). Some 25 lb. of limestone were digested.

The Wenlock Limestone

National grid reference 32/575968. Large quarry at Major's Leap, Wenlock Edge, Shropshire. Samples were collected at intervals of 10 ft. throughout the 90 ft. of limestone exposed, about 40 lb. of which were digested.

Samples were also collected at intervals of 10 ft. throughout the compounded type section at Wrens Nest Hill, Staffordshire, described in detail by Butler (1939). About 50 lb. of limestone were dissolved.

Scolecodonts were prolific in most samples from both localities.

V. Methods of study

(*a*) *Extraction of specimens*

All the specimens described in the present study have been extracted from limestones, by digestion in a 10 to 15 % solution of commercial acetic acid. The time taken to disintegrate the rock varies with its lithology, and the amount of material required to give a representative fauna also varies with different formations. Each of the faunas described has involved the digestion of 150 to 300 lb. of material.

When disintegration of the matrix is complete the residue is washed and screened. It has been found that no conodonts remain on a 25-mesh/in. sieve, and only the smallest fragments pass through a 100-mesh/in. sieve. Careful washing and sieving under water will be found to be more satisfactory than the dry sieving described by Branson & Mehl (1933, p. 12) which has resulted in the breaking of many of the larger specimens. Conodonts have a specific gravity of about 3·0 and may be separated from the lighter parts of the residue by the use of heavy liquids, though this too may damage more delicate specimens. The author has therefore searched each residue under a binocular microscope and extracted the conodonts with a fine sable paint brush. Any specimens which have been missed in this visual searching may then be extracted in bromoform.

(*b*) *Illustrations*

The illustrations in the present work were obtained by using a Leica model III*c* camera, adapted for use with a microscope by a standard Micro-Ibso attachment. Details of this

apparatus are given by Morgan & Lester (1938, p. 397). The use of a high-power eyepiece, and an objective containing an iris diaphragm, is an aid in securing the necessary depth of focus.

The conventional descriptive terminology and a number of new descriptive terms are illustrated in the text-figures which accompany the systematic descriptions. These text-figures are generalized drawings designed to show the more conspicuous features of the various genera.

VI. Ordovician conodont faunas

(*a*) *General review of the Llandeilo Limestone conodont fauna*

The Llandeilo Limestone conodont fauna contains specimens referred to eleven genera and sixteen species, five of which are new. Conodonts are comparatively rare in this formation, and the fauna is remarkable in that the majority of forms are appreciably smaller than those of similar species collected from other formations. This dwarfing is particularly marked in all the distacodid species, most of which are represented in the faunas of the other formations studied in this work.

The Llandeilo fauna is characterized by the comparative abundance of the following species: *Oistodus curvatus*, *Paltodus acostatus*, *P. unicostatus*, *Cyrtoniodus complicatus*, *Cordylodus rectilineatus* and *Trichonodella flexa* n.sp. All the other species are rare.

All the specimens studied are somewhat variable in colour, individuals ranging from black to white, the lighter parts being translucent and the whole surface shiny. It has not proved possible to obtain any chemical analyses of their composition.

Comparison with other faunas

There is little agreement concerning the exact American equivalent of the Llandeilo Limestone, but Shimer (1934, Chart A) shows the Llandeilo as broadly equivalent to the Black River or Chazy formations. Dr Alwyn Williams (personal communication, June 1950) states: '... the presence of *Nemagraptus gracilis* in the Black River indicates that any pre-Black River, post-Beekmantown rocks should correlate with the Llandeilo. G. A. Cooper, however, considers that the Llandeilo and Black River are equivalent since both mark the horizon at which the punctate brachiopods first make their appearance, but against this is the fact that I have collected punctate brachiopods from the Upper Llanvirn.' Branson & Mehl (1933, p. 20) consider the base of the Stones River represents the base of the Llandeilo.

It is therefore difficult to give any exact American equivalent of the Llandeilo Limestone, but formations of Black River-Chazyan age may be considered as broadly equivalent.

Three conodont faunas of this age have been described. Stauffer (1930, 1935*b*) has described the fauna of the Decorah Shale and of the Glenwood Beds (1935*a*), and Branson & Mehl (1933) have described that of the Plattin Limestone of Missouri. It should be emphasized again that these faunas can only be considered as broadly equivalent in age to that of the Llandeilo.

The following observations may be made on the distribution of genera in these formations:

(i) The number of genera represented in the Llandeilo fauna is considerably smaller than that in any of the other three faunas.

(ii) All the Llandeilo genera, except *Ambolodus*, *Amorphognathus*, *Gyrognathus* and *Ligonodina*, are present in the Decorah, Glenwood and Plattin formations.

(iii) Reference to Ellison's stratigraphical charts (1946) will show that *Ambolodus* was known previously only from sediments of Richmond age,* that *Ligonodina* was not previously known from any formations older than Middle Silurian (but is now also described on p. 306 from both the Gelli-grin and Pen-y-garnedd Limestones), and that *Amorphognathus* was not known from formations older than the Trenton.

(iv) Further reference to Ellison's paper will show that the following eleven genera from the Plattin, Glenwood and Decorah Beds, none of which are present in the Llandeilo fauna, are not known to occur above the Black River formation: *Acontiodus*, *Bryantodina*, *Cardiodella*, *Chirognathus*, *Curtognathus*, *Erismodus*, *Microcoelodus*, *Neocoleodus*, *Oulodus*, *Stereoconus* (since collected from the Pen-y-garnedd Limestone), *Trucherognathus*.

(v) These facts tend to suggest that the Llandeilo Limestone fauna may be younger in age than the three American faunas with which it has been compared above. If the ranges of genera given by Ellison (1946) are accepted, the presence of *Dichognathus* and *Amorphognathus* would limit its age to Trenton. It will be recalled, however, that only one specimen of each of these genera was present in the Llandeilo.

(vi) The two species, *Cordylodus rectilineatus* and *Cyrtoniodus complicatus*, which are abundant in the Llandeilo, are present in both the Decorah Shale and the Glenwood Beds.

There are three possible explanations of the differences in the faunas of these four formations. One, the possibility of the Llandeilo being later than the other three, has been discussed above. It has already been mentioned that the Llandeilo conodont fauna appears to be a semi-dwarfed one and contains only a comparatively small number of species. It may therefore be that the absence of a number of American genera is connected with this dwarfing of the fauna. Thirdly, it is possible that no great intermingling of conodont faunas took place between the American and Welsh faunal provinces until *Nemagraptus gracilis* times. The evidence provided by the present study is insufficient to indicate which, if any, of these three explanations is correct.

Comparison with the Gelli-grin conodont fauna

Eight of the eleven genera described from the Llandeilo also occur in the Gelli-grin Limestone, and the genus *Ozarkodina*, although not collected from the Gelli-grin or the Pen-y-garnedd, is known to occur above these formations (p. 320). The genera *Cyrtoniodus* and *Dichognathus* appear to be characteristic Middle Ordovician forms (as they are also in the United States), and the species *Cordylodus rectilineatus* and *Ozarkodina tenuis* (both of which are also found in the United States) also appear characteristic of the Middle Ordovician.

None of the four new genera from the Gelli-grin Limestone is present in the Llandeilo, but further collecting will be necessary before it is known whether or not these forms are confined to the Upper Ordovician.

* Recently published work by Branson, Mehl & Branson (1951) suggests, however, that this genus is found only in sediments slightly older than Richmond in age.

(*b*) *General review of the Gelli-grin Limestone conodont fauna*

The Gelli-grin Limestone conodont fauna is characterized by a strong development of a number of genera, of which *Ambolodus*, *Trichonodella* and *Paltodus* are abundant; *Amorphognathus*, *Cordylodus*, *Balognathus* n.g., *Oistodus* and *Distacodus* are common and *Icriodella* n.g., *Sagittodontus* n.g., *Gyrognathus* and *Holodontus* n.g. are less common. *Ligonodina* and *Lonchodus* are present, but rare. *Bryantodina* is doubtfully present. Most of the genera described are represented by a number of species. Thus the fifteen genera described, four of which are new, are represented by a total of thirty species, eighteen of which are new. The frequency of the various species present in the Gelli-grin is indicated in table 2.

The collection from the Gelli-grin consisted of many hundreds of specimens, some of which were fragmentary but most of which were in an excellent state of preservation.

The Gelli-grin specimens are dull black in colour, the vast majority being completely opaque. The chemical composition of conodonts has been discussed by Ellison (1944) and Hass (1941), but the material of which the Gelli-grin specimens are composed appears different from any described by those writers. Thus the Gelli-grin specimens, although they have a specific gravity of 2·85 to 3·0, differ in colour and texture from those described from the United States, but nothing further may be learned until qualitative and quantitative chemical analyses are obtainable.

Comparison of the Gelli-grin Limestone conodont fauna with conodont faunas of a similar age from the United States

Elles (1937, pp. 488, 492) has shown the Gelli-grin Limestone to be of Upper Caradocian age, referring it to the graptolite zone of *Pleurograptus linearis*. Only two conodont faunas of comparable age have been described from the United States.

Branson & Mehl (1933, p. 121) have described the fauna of the Maquoketa-Thebes formation of Missouri, which they first regarded as Upper Maysville-Lower Richmond in age (1933, p. 21), but later considered to be pre-Richmond (Branson *et al.* 1951, p. 3). Graves & Ellison (1941, p. 5), describing various Ordovician conodonts from the Marathon Basin, Texas, include a description of the fauna of the Maravillas formation, which is of a similar age. Shimer (1934, Chart A) correlates these two American formations with the Upper Caradocian of Europe, and Dr Alwyn Williams (personal communication, June 1950) also regards them as approximately equivalent in age to the Gelli-grin Limestone.

The following points may be noted with regard to the relationship between the conodont faunas of these formations:

(1) Four genera, *Ambolodus*, *Amorphognathus*, *Cordylodus*, and *Trichonodella*, are common to all three formations.

(2) Six genera, *Icriodella* n.g., *Sagittodontus* n.g., *Balognathus* n.g., *Holodontus* n.g., *Gyrognathus* and *Drepanodus*, are peculiar to the Gelli-grin Limestone. Of these, *Drepanodus* and *Gyrognathus* are fairly common, but the other four genera, all of which are new, are rare in the Gelli-grin.

(3) Three genera, *Belodus*, *Phragmodus* and *Ozarkodina*, are common to the Maravillas and Maquoketa-Thebes but are apparently absent in the Gelli-grin.

(4) Two genera, *Oistodus* and *Paltodus*, are common to the Gelli-grin and Maravillas but are not recorded from the Maquoketa-Thebes. *Oistodus curvatus* is present in both the former formations.

(5) All three formations contain *Amorphognathus ordovicicus* and *Ambolodus triangularis*.

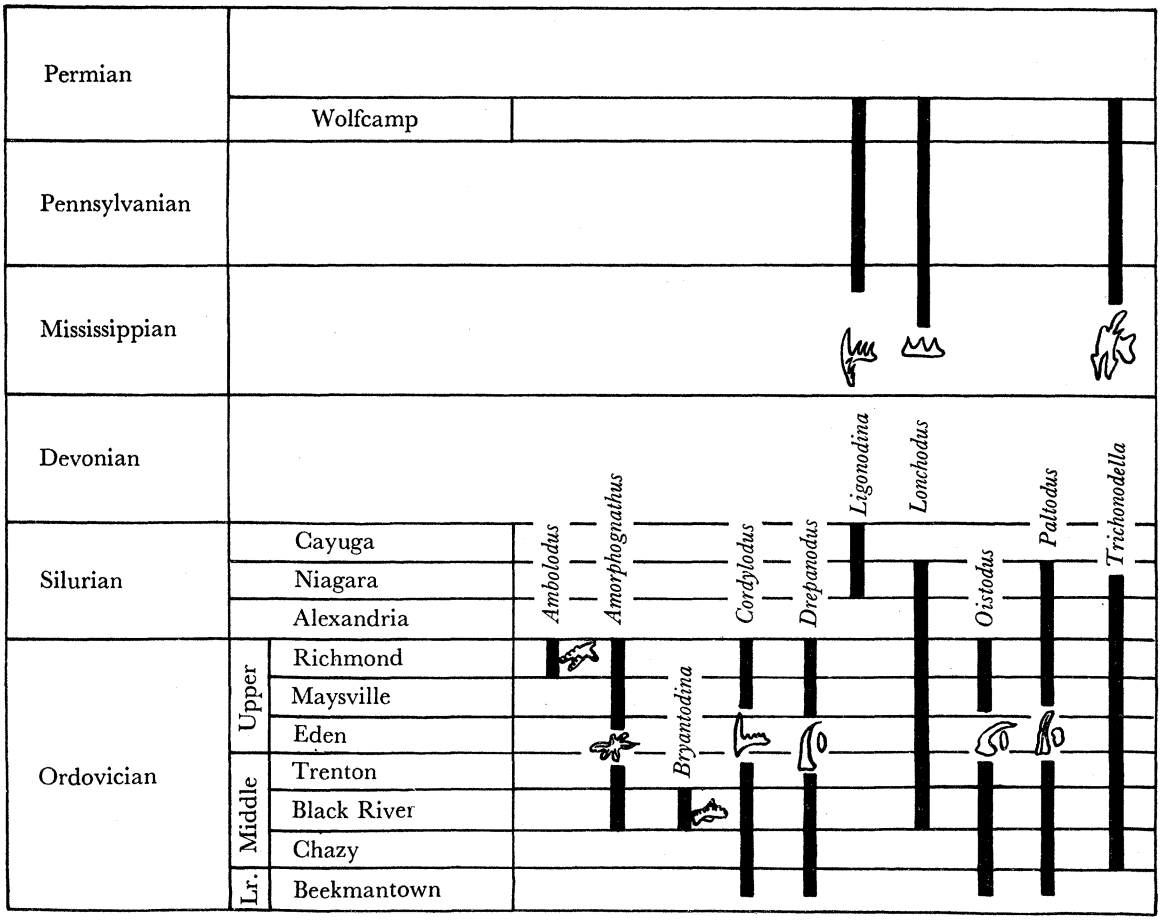
(6) *Trichonodella*, represented by a single species in both the American formations, is common in the Gelli-grin, in which it is also represented by a single species.

(7) *Ligonodina*, which is present, but rare, in the Gelli-grin Limestone, has previously been reported only from Middle Silurian and younger formations.

(8) *Cordylodus* is well represented by a number of species in all three formations.

TABLE 1. STRATIGRAPHICAL RANGES IN THE UNITED STATES OF CONODONT GENERA COLLECTED FROM THE GELLI-GRIN LIMESTONE

Ranges are those given by Ellison (1946)



(9) As in the American Upper Ordovician faunas, none of the characteristic Middle Ordovician forms is present in the Gelli-grin Limestone.

(10) *Bryantodina*, which is doubtfully present, but rare, in the Gelli-grin has been reported previously only from the Black River and Chazy (Middle Ordovician) formations of the United States.

(11) The differences noted above indicate that, though they are strikingly similar, the three faunas are by no means identical. Workers in the United States have shown, however, that formations of a similar age may not possess conodont faunas which are identical in all respects, although they are usually broadly similar.

It is noteworthy that the Gelli-grin conodont fauna shows far less similarity to the Richmond faunas of Kentucky described by Branson *et al.* (1951) than it does to either the Maquoketa-Thebes or the Maravillas. The genera *Rhipidognathus* Branson *et al.* and *Zygognathus* Branson *et al.*, both distinctive and common genera in the Richmond (Branson *et al.* 1951, p. 4), have not been found in the Gelli-grin fauna, which also lacks the great variety of species of *Paltodus* described from the Richmond. The Richmond of Kentucky also lacks the distinctive Gelli-grin genera *Amorphognathus* and *Ambolodus*, both of which are well represented in the Maquoketa-Thebes and the Maravillas.

TABLE 2. CHART TO SHOW THE FREQUENCY OF CONODONT SPECIES IN THE GELLI-GRIN AND PEN-Y-GARNEDD LIMESTONES

a. = abundant. c. = common. r. = rare.

conodont species	Gelli-grin	Pen-y-garnedd
Ambolodus elegans n.sp.	c.	c.
A. pulcher n.sp.	a.	c.
A. robustus n.sp.	c.	c.
A. triangularis s.s. Branson & Mehl	—	c.
A. triangularis var. *indentatus* n.var.	c.	r.
Amorphognathus complicatus n.sp.	—	a.
A. ordovicicus Branson & Mehl	c.	r.
Balognathus expansus n.sp.	c.	r.
Bryantodina? sp.	r.	—
Cordylodus elongatus n.sp.	c.	—
C. geniculatus n.sp.	r.	—
C.? spurius Branson & Mehl	r.	—
Drepanodus altipes Henningsmoen	r.	c.
D. arcuatus Pander	—	r.
D. similaris n.sp.	r.	c.
D. striatus Graves & Ellison	r.	—
Gyrognathus superbus n.sp.	c.	—
Holodontus superbus n.sp.	r.	—
Icriodella superba n.sp.	r.	r.
I. superba var. *acuta* n.var.	r.	r.
I. deforma n.sp.	r.	—
I. elongata n.sp.	r.	—
I. plana n.sp.	r.	—
Ligonodina elongata n.sp.	r.	r.
L. extensa n.sp.	r.	r.
Lonchodus dentatus Stauffer	r.	—
L. distans (Smith)	r.	c.
Oistodus abundans Branson & Mehl	r.	r.
O. breviconus Branson & Mehl	r.	r.
O. suberectus Branson & Mehl	r.	—
Paltodus acostatus Branson & Mehl	a.	a.
P. equicostatus n.sp.	r.	c.
P. unicostatus Branson & Mehl	a.	a.
Phragmodus insculptus Branson & Mehl	—	c.
Sagittodontus robustus n.sp.	r.	—
S. robustus var. *erectus* n.var.	r.	—
S. robustus var. *distaflexus* n.var.	r.	—
Stereoconus maximus n.sp.	—	r.
Trichonodella divaricata n.sp.	—	r.
T. gracilis n.sp.	a.	c.

(*c*) *General review of the Pen-y-garnedd Limestone conodont fauna*

Conodonts are less common in the Pen-y-garnedd Limestone than in the Gelli-grin, and the collection studied, which consists of many hundreds of individual specimens, has involved the digestion of some 300 lb. of rock. The terms 'abundant' and 'common'

applied below are therefore used to describe the relative occurrence of the genera present.

The Pen-y-garnedd conodont fauna is characterized by the strong development of a number of genera, of which *Ambolodus*, *Amorphognathus* and *Paltodus* are the most abundant. *Ambolodus* and *Paltodus* are represented by a number of species, but all except one of the individual specimens of *Amorphognathus* are referred to a single new species, *A. complicatus*. This species is perhaps the most characteristic of all those present in the Pen-y-garnedd Limestone, in almost every sample of which it is represented.

The genera *Drepanodus*, *Lonchodus*, *Oistodus*, *Phragmodus* and *Trichonodella* are also commonly present, being less abundant than those mentioned above. *Drepanodus* and *Oistodus* are represented by a number of different species, *Trichonodella* by two species and *Lonchodus* and *Phragmodus* by only one species. The other genera present, *Balognathus* n.g., *Holodontus* n.g., *Icriodella* n.g. and *Stereoconus*, are rare, each being represented by a single species.

The Pen-y-garnedd conodonts appear similar in chemical composition to those from the Gelli-grin Limestone.

Comparison of the Pen-y-garnedd and the Gelli-grin conodont faunas

The frequency of conodont species in the Gelli-grin and Pen-y-garnedd Limestones is summarized in table 2.

The following points may be noted:

(1) The Gelli-grin and the Pen-y-garnedd Limestone faunas contain representatives of fifteen and twelve genera respectively, of which ten are common to both formations.

(2) The genera *Bryantodina* (doubtfully present), *Cordylodus* (common), and *Sagittodontus* n.g. (rare) are peculiar to the Gelli-grin Limestone.

(3) The genera *Phragmodus* (fairly common) and *Stereoconus* (very rare) are peculiar to the Pen-y-garnedd Limestone. The former genus is represented by a single species, *Phragmodus insculptus*, which is present in both the Maquoketa-Thebes of Missouri and the Maravillas of Texas.

(4) The Gelli-grin fauna contains thirty-one species including five varieties, the Pen-y-garnedd twenty-three species including three varieties. Seventeen species and three varieties are common to both formations.

(5) The frequency of the common species and varieties does not appear to be the same for both formations. This may, in part, be accounted for by the comparative scarcity of conodonts in the Pen-y-garnedd Limestone. More extensive collecting, and the application of statistical methods may modify this apparent discrepancy.

The fact that individual conodont species most probably represent components of a compound jaw apparatus (Scott 1934, 1942; DuBois 1943; Rhodes 1952), should not, however, be overlooked, for it may provide an explanation of the relative abundance of these species. This problem can only be solved by the collection of complete conodont assemblages, and this is impossible when the present method of extraction (p. 268) is employed.

The present study indicates the degree of similarity which may be expected between the conodont faunas of formations of a broadly similar age. It should be noted that the

lithological succession containing the Pen-y-garnedd Limestone is by no means identical with that containing the Gelli-grin Limestone. The similarity of the conodont faunas, in spite of this lithological difference, emphasizes the possible value of these microfossils in problems of local correlation. It may further be observed that this similarity was not obscured despite the relative scarcity of conodonts in the Pen-y-garnedd Limestone.

VII. Silurian conodont faunas

Discussion of the Aymestry Limestone conodont fauna

Conodonts referred to ten genera and sixteen species, eleven of which are new, are described from the Aymestry Limestone. Table 3 shows that all but one of these species have been collected from the outcrops of both Shropshire and south Staffordshire, at which the lithological development of the limestone is strikingly different. By far the most abundant species are *Paltodus acostatus* and *P. unicostatus*. *Ozarkodina typica*, *Prioniodella inclinata*, *Spathognathodus primus* and *Trichonodella aboroflexa* are also abundant, while other species of the genera *Distomodus*, *Hindeodella*, *Plectosphathodus* and *Trichonodella* are common.

Table 4 shows a comparison of the Aymestry fauna with the recorded ranges of American conodont genera as given by Ellison (1946). The present study has revealed a number of important additions to the knowledge of the ranges of conodont genera as recorded in the United States. These amendments should be taken as characteristic only of Britain, but it seems most probable that further collecting in the United States will reveal similar ranges in that country.

Table 3. Frequency of conodont species in the Shropshire and Staffordshire Aymestry Limestone, Localities 4 and 5

a = abundant. c = common. r = rare.

	Shropshire Locality 4	Staffordshire Locality 5
Cordylodus? dubius n.sp.	r.	r.
Distomodus curvatus n.sp.	c.	c.
D. curvatus var. *dentatus* n.var.	r.	r.
D. suberectus n.sp.	r.	r.
Hindeodella equidentata n.sp.	c.	c.
Ligonodina salopia n.sp.	r.	r.
Ozarkodina typica Branson & Mehl	a.	a.
Paltodus acostatus Branson & Branson	a.	a.
P. recurvatus n.sp.	r.	—
P. unicostatus Branson & Mehl	a.	a.
Prioniodella inclinata n.sp.	a.	a.
Plectospathodus elegans n.sp.	r.	r.
P. contrarius n.sp.	c.	c.
P. extensus n.sp.	c.	c.
Spathognathodus primus (Branson & Mehl)	a.	a.
Trichonodella aboroflexa n.sp.	a.	a.
T. symmetrica Branson & Mehl	c.	c.

The chief differences in range (see table 4) are as follows:

(1) *Paltodus* (abundant) and *Distomodus* (common), previously not recorded from beds younger than Middle Silurian, are present in the Upper Silurian.

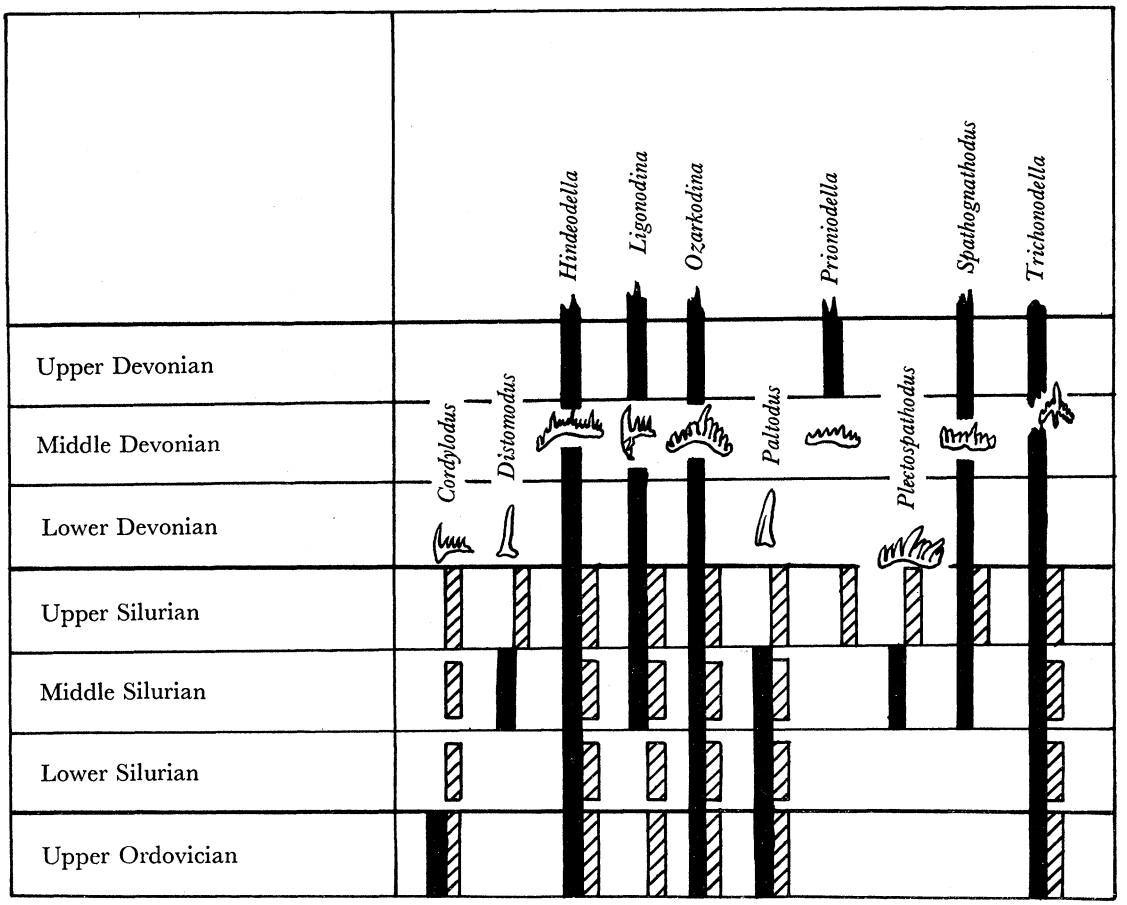
(2) The genus *Prioniodella*, one of the most common Aymestry Limestone genera, was previously known only from and above the Upper Devonian.

(3) The genus *Plectospathodus*, which was previously known only from the Middle Silurian, is represented by a number of common species in the Upper Silurian.

(4) A number of specimens have been tentatively referred to the genus *Cordylodus*. This genus was previously known only from and below the Upper Ordovician.

TABLE 4. STRATIGRAPHICAL RANGES OF CONODONT GENERA FROM THE AYMESTRY LIMESTONE

Full black lines represent ranges in the United States (from Ellison, 1946), shaded lines represent ranges in Britain. No formations younger than Upper Silurian have been studied in Britain. Pre-Upper Ordovician and post-Devonian ranges are not recorded on the chart.



Comparison of the Upper Silurian conodont fauna with that of the Middle Silurian

Only one description of a Middle Silurian conodont fauna has been published. This paper, by Branson & Mehl (1933), described conodonts from the Bainbridge formation of Missouri. The authors included a correlation chart in which they showed the Bainbridge formation to be of similar age to the Wenlock formation of Britain. It was further noted (p. 40) that the Bainbridge fauna contained fewer conodont species than typical Ordovician faunas. Twenty-one species belonging to thirteen genera (one of which was doubtful) were described. Similarly, it is striking that only sixteen species referred to ten genera are recorded from the Upper Silurian in the present study—a considerably smaller number of species than those recorded from the Gelli-grin or Pen-y-garnedd formations.

While the number of genera in these earlier formations was comparable to the number recorded from the Upper Silurian, the genera in the Silurian appear to have developed into only a limited number of species, a few of which have a considerable vertical range. Thus *Paltodus unicostatus*, *P. acostatus* and *Spathognathodus primus* are common in the Lower, Middle and Upper Silurian, and the genus *Ozarkodina* is represented by very similar forms throughout the Silurian and Devonian.

A comparison of the Middle Silurian conodont fauna described by Branson & Mehl with that of the Upper Silurian given in the present paper shows them to be similar in the following respects:

(1) The presence of *Ozarkodina typica*, *Paltodus unicostatus*, *Spathognathodus primus* and *Trichonodella symmetrica* in very large numbers.

(2) The limited occurrence of *Ligonodina*.

(3) The common occurrence of members of the genera *Plectospathodus* and *Trichonodella*.

The two faunas differ in the following respects:

(1) The apparent absence of the following Middle Silurian genera in the Upper Silurian: *Prioniodina*, *Acodus*, *Distacodus*, *Polygnathellus*, *Polygnathoides* and *Euprioniodina*. Of these, however, *Prioniodina*, *Polygnathellus* and *Euprioniodina* have been recorded from the Devonian of the United States.

(2) The apparent absence of the following Upper Silurian genera in the Middle Silurian: *Cordylodus* (which is doubtfully present in the Upper Silurian), *Distomodus* (a genus not known when Branson & Mehl described the Bainbridge conodonts but since recorded from the Lower Silurian) and *Prioniodella*.

Comparison of the Upper Silurian conodont fauna with that of the Devonian

No conodont faunas of Lower Devonian age have been described, but those from the Middle and Upper Devonian of the United States show many differences from the Upper Silurian. The distinctive Devonian genera *Icriodus*, *Palmatolepis*, *Ancyrognathus*, *Polylophodonta* and *Ancyrodella* (Branson & Mehl 1938, p. 157) are all absent from the Upper Silurian. The distacodids, which are so characteristic of the Upper Silurian, are absent from the Devonian, and *Plectospathodus* is also absent from formations of the latter age.

VIII. Systematic palaeontology

The numbers by which type specimens are designated refer to catalogue numbers in the collection, which is desposited in the Geology Department of the University of Birmingham.

Suborder NEURODONTIFORMES Branson & Mehl, 1942

Branson & Mehl's description:

'Conodonts with teeth composed of bundles of fibres.'

Family Trucherognathidae Branson & Mehl, 1944

Branson & Mehl's description:

'Platelike fibrous teeth that rest on the jaw, rather than clasping it, or tip of jaw.'

Genus *AMBOLODUS* Branson & Mehl, 1933

Ambolodus Branson & Mehl, 1933, p. 127.

TYPE SPECIES. *A. triangularis* Branson & Mehl.

Branson & Mehl's generic description:

'More or less triangular or crescent-shaped platform-like dental units with excavated aboral surface, and slightly concave, smooth oral surface with a parapet-like row of closely crowded or fused denticles about the convex border, and a larger spike-like tooth at the apex of the angle of the parapet. On the outer side of the apical denticle is a process varying in length, bearing one small denticle or several denticles forming a keel on a lanceolate plate.'

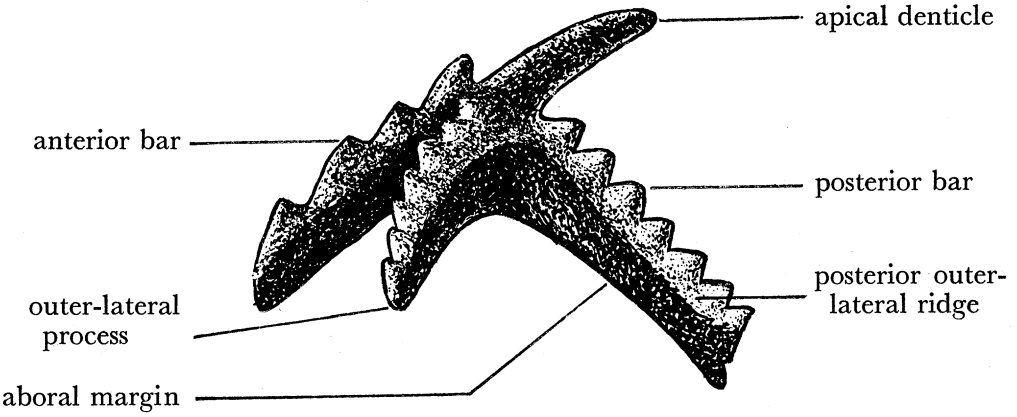


FIGURE 1. *Ambolodus* sp. Outer-lateral view. (Magn. approx. × 100.)

AMBOLODUS ELEGANS n.sp.

(Figures 21 to 25, plate 20)

DIAGNOSIS. A crescent-shaped *Ambolodus* with prominent outer-lateral process, the oral surface of which bears two longitudinal ridges, the anterior one being denticulated.

DESCRIPTION. Slender, crescent-shaped dental units consisting of a strongly arched blade with prominent apical denticle. Denticulated bars on either side of apical denticle of approximately equal length, straight, or very gently curved, slender, distal ends pointed in unbroken specimens, diverging at an angle of about 120° in a vertical plane. Apical denticle approximately three times as wide at base as the largest of the other denticles, inclined posteriorly in line with the anterior bar; laterally compressed with sharp anterior and posterior edges; lateral faces gently convex. Anterior bar bearing up to twelve pointed, laterally compressed denticles, confluent at base, sharp anterior and posterior edges, gently convex lateral faces; increasing in size and inclined posteriorly. Posterior bar bearing five to eight similar, but smaller, denticles on its oral surface. Outer-lateral process directed outwards, backwards and downwards, developed from outer-lateral face of denticle immediately anterior to the apical denticle; oral surface bearing two sharp, longitudinal ridges, the posterior developed from the down-flexing of the posterior outer-lateral ridge and the anterior from the outer-lateral carina of the anterior denticle adjacent to the apical; and anterior longitudinal ridge of the process developed

into a series of ten or more sharply pointed denticles, confluent at their base. Aboral surface of process deeply excavated, the excavation being continuous with that of the rest of the unit. Aboral margin sharply down-flexed, giving lateral ridges along the base, these ridges only feebly developed in some specimens. Basal outline straight or gently bowed in a horizontal plane (inner margin concave).

OCCURRENCE. Gelli-grin and Pen-y-garnedd Limestones.

Holotype: CIB 6*b*. *Paratypes*: CIB 6*c–d*, Loc. 3.

AMBOLODUS PULCHER n.sp.

(Figures 38 to 41, plate 20)

DIAGNOSIS. A strongly arched, slender *Ambolodus* with prominent outer-lateral process, bearing a series of laterally compressed denticles.

DESCRIPTION. Crescent-shaped dental units consisting of a strongly arched, denticulated blade with a prominent apical denticle. Denticulated bars thin, tapering to a point at distal ends; the anterior, long and curved in a vertical plane; the posterior, shorter and straight, diverging at an angle of about 90° in a vertical plane from the anterior. Aboral surface deeply excavated. Anterior bar bearing ten to twelve pointed, confluent, laterally compressed denticles, sharp anterior and posterior edges, gently convex lateral faces, irregular but increasing in size posteriorly. Posterior bar bearing seven or eight similar but smaller denticles. Apical denticle recurved, pointed, sharp anterior and posterior edges, smooth convex lateral faces. Outer-lateral process developed at base of denticle immediately anterior to apical denticle; oral edge narrow, bearing series of irregular, laterally compressed denticles; subtriangular in cross-section. Aboral margin sharply downflexed, giving conspicuous lateral ridges. Posterior outer-lateral ridge very prominent in some specimens. Whole unit is bowed in a horizontal plane so that inner surface is gently concave.

OCCURRENCE. Gelli-grin and Pen-y-garnedd Limestones.

Holotype: CIK 2*a*. *Paratypes*: CIK 2*b–c*, Loc. 3.

REMARKS. This species lacks the sharp posterior-oral longitudinal ridge which is developed on the outer lateral process of *A. elegans* n.sp.

AMBOLODUS ROBUSTUS n.sp.

(Figures 26, 27, 32, 33, plate 20)

DIAGNOSIS. An *Ambolodus* with straight, subequal, anterior and posterior bars and prominent outer-lateral process, the oral surface of which is undenticulated but bears two longitudinal ridges.

DESCRIPTION. Thin, blade-like, arched dental units, with conspicuous apical denticle. Anterior and posterior bars straight and of approximately equal length, with well-developed denticulation on oral surfaces. Apical denticle inclined posteriorly, parallel to anterior bar, laterally compressed, sharp anterior and posterior edges, flat or gently convex lateral faces. Anterior bar bearing eight or nine laterally compressed, sharply

pointed denticles, confluent at their base, increasing in size posteriorly, directed posteriorly, subparallel to apical denticle. Posterior bar bearing seven or eight, less conspicuous, but otherwise similar denticles. Basal outline of unit straight or gently curved (inner margin concave); aboral surface deeply excavated over the entire area; aboral margin of unit sharply down-flexed below base of denticles, so that lateral faces of bars each bear a prominent, straight, lateral ridge. Outer-lateral process developed from base of apical denticle and adjacent anterior denticle, straight, undenticulated, directed outwards and downwards; oral surface bearing two prominent, sharp ridges, converging towards the distal end of the process; the anterior of these ridges is a continuation of the outer-lateral carina of the denticle immediately anterior to the apical denticle; the posterior ridge formed by a down-flexing of the outer-posterior-lateral ridge; the two ridges separated by a shallow concave depression.

Occurrence. Gelli-grin and Pen-y-garnedd Limestones.

Holotype: CIB 5*a*. *Paratypes*: CIB 5*b–d*, Loc. 2.

AMBOLODUS TRIANGULARIS Branson & Mehl

(Figures 28 to 31, plate 20)

A. triangularis Branson & Mehl, 1933, p. 128, Pl. 10, figs. 35–37.

A. triangularis Graves & Ellison, 1941, p. 5, Pl. 3, figs. 29, 33–35.

The descriptive terminology adopted by Branson & Mehl for this species, the only one of this genus previously described, is ambiguous and is therefore replaced by that illustrated in figure 1 (p. 278).

Specimens from both the Gelli-grin and the Pen-y-garnedd Limestones are similar to those described by Branson & Mehl. In some specimens studied the four anterior denticles nearest the apical denticle are conspicuously longer than the others of the anterior bar.

Occurrence. Gelli-grin and Pen-y-garnedd Limestones.

Figured specimens: CIK 4*b*,*c*, Loc. 3.

AMBOLODUS TRIANGULARIS var. *INDENTATUS* n.var.

(Figures 35 to 37, 56, plate 20)

Diagnosis. An *Ambolodus* resembling *A. triangularis* s.s. but having an undenticulated outer-lateral process and an indented aboral margin.

Description. Dental units triangular in general appearance, with crescent-shaped basal outline, consisting of two diverging limbs of approximately equal length. Anterior limb bearing five to seven low, rounded, closely spaced, subequal denticles; posterior limb bearing a series of three similar, but less conspicuous, denticles. Apical denticle stout, pointed, directed posteriorly, parallel to anterior limb, and curved gently inwards; sharp anterior and posterior edges, convex lateral faces. Straight lateral process, directed outwards and downwards, developed at base of apical denticle on outer (convex) side; approximately equal in length to anterior and posterior bars in complete specimens; oral surface flattened, the flattening being a continuation of a faint lateral flattening at base of apical denticle. Aboral surface of unit deeply excavated over its entire area; whole unit

hollow. Aboral margin of unit markedly down-flexed, inner margin deeply indented, having appearance of a round inverted W when seen in lateral view.

Occurrence. Gelli-grin and Pen-y-garnedd Limestones.

Holotype: CIA 3*a*. *Paratypes*: CIA 3*b*, *d*, Loc. 2.

AMBOLODUS sp.

(Figures 171, 203, plate 22)

A single specimen from the Llandeilo Limestone is referred to this genus and, since it appears unlike any existing species, it is described in detail, although a new species is not erected.

Description. Slender crescent-shaped dental unit, with relatively small apical denticle and long tapering anterior and posterior bars. Apical denticle inclined posteriorly so that it lies parallel to anterior bar, short, pointed, laterally compressed with sharp anterior and posterior edges and convex lateral faces, the posterior edge bifurcating near the base of the denticle to form two sharp oral ridges, one of which crowns the proximal portion of the outer-lateral process and the other the adjacent portion of the posterior bar. Anterior bar straight in a vertical plane, gently curved in a horizontal plane (inner margin concave); aboral margins convex at proximal end but gently concave at distal end, so that bar is pointed; subtriangular in cross-section with flat lateral faces; oral surface bearing a series of nine, very short, pointed, subequal, erect, closely spaced denticles. Posterior bar diverging from anterior at an angle of about 90° in a vertical plane, and an angle of about 90° in a horizontal plane, in which it is gently bowed inwardly (inner margin concave); basal outline more slender than that of anterior bar; aboral margin straight, or nearly so; subtriangular in cross-section, lateral faces flat; oral surface bearing a series of ten short denticles, similar in form to those of anterior bar. Outer-lateral process developed at base of apical denticle, directed outwards and downwards; subtriangular in cross-section; faces flat or gently convex; oral surface sharp, bearing series of two or more feebly developed, short, pointed denticles, with flat or gently convex anterior and posterior faces and sharp lateral edges. Aboral surface of whole unit excavated over its entire area by a shallow depression; aboral margin sharply down-flexed.

Occurrence. Llandeilo Limestone.

Figured specimen. CIIL 4*b*, Loc. 1.

Remarks. The denticulation and the general form of the anterior and posterior bars distinguish this specimen from existing species of the genus.

The specimen described was almost complete but was damaged before it was photographed.

Genus *AMORPHOGNATHUS* Branson & Mehl, 1933

Amorphognathus Branson & Mehl, 1933, p. 126.

Type species. *A. ordovicicus* Branson & Mehl.

Branson & Mehl's generic description:

'Irregularly branched asymmetrical dental plates with rays or branches of varying size and extending in varied directions within a common basal plane that is arched or flat.

The rays are more or less lanceolate, usually with a raised margin on the oral surface and a conspicuous longitudinal median crest on the oral side that is crenulate, nodose, or is constructed of more or less fused denticles.'

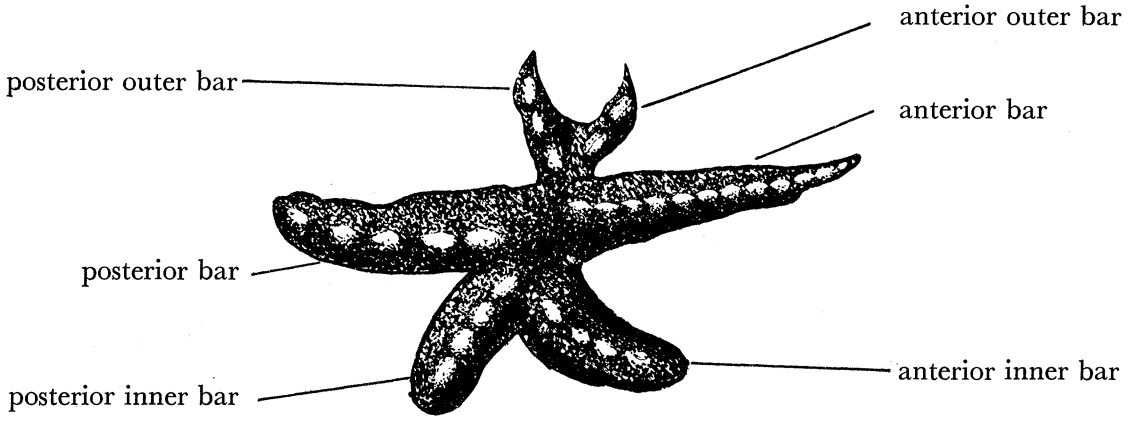


FIGURE 2. *Amorphognathus* sp. Superior view. (Magn. approx. × 100.)

AMORPHOGNATHUS COMPLICATUS n.sp.

(Figures 42, 45, 46, plate 20)

DIAGNOSIS. An *Amorphognathus* consisting of a slender anterior bar, subequal in length to the bulbous posterior bar and also to the unbranched inner bar; two short outer bars diverge from a point which is anterior to the junction of the inner and anterior bars.

DESCRIPTION. Compound, platform-like dental units consisting of slender anterior bar, from which two small outer bars are developed, a posterior bar and an inner bar, the two latter being somewhat bulbous in outline. General plane or aboral surface gently arched upwards, the anterior and posterior bars being more strongly arched than the others. Aboral surface deeply excavated over its whole area. Anterior bar slender, pointed, straight, oral surface bearing nine or ten erect, pointed, confluent, laterally compressed denticles, increasing in size posteriorly. Posterior bar more convex in outline; straight in some specimens, in others posterior portion is flexed outwards, so that it lies parallel to the inner bar; oral surface flat at margins, with elevated central ridge which is developed into a series of small, irregular, rounded denticles. Inner bar straight, but with irregular margins in some specimens; directed anteriorly to make an angle of about 45° with the anterior bar; subequal in length to the anterior and posterior bars; flattened oral margins and sharp, oral, median longitudinal ridge, which is irregularly crenulate. Outer bars short, slender, pointed, developed from the anterior bar at a point slightly anterior to its junction with the inner bar; the anterior-outer bar shorter than the posterior-outer; both having flattened oral margins with sharply denticulate median ridges.

OCCURRENCE. Pen-y-garnedd Limestone.

Holotype: CIH 5*b*. *Paratypes*: CIH 5*c–d*, CIL 1*a–d*, Loc. 3.

REMARKS. This species is broadly similar to *A. ordovicius* Branson & Mehl but differs from it in the single unbranched inner bar, in the characteristic small anterior and posterior outer bars, and in the relative position of the bars.

AMORPHOGNATHUS ORDOVICICUS Branson & Mehl

(Figures 47 to 49, plate 20)

A. ordovicica Branson & Mehl, 1933, p. 126, Pl. 10, fig. 38.
A. ordovicica Graves & Ellison, 1941, p. 5, Pl. 3, figs. 32, 36–38.

The holotype selected by Branson & Mehl is not complete, and their description of the species is based upon a study of the broken parts of other specimens. It therefore seems advisable to record the main characteristics of the more perfect hypotypes collected from the Gelli-grin Limestone.

Orientation. The slender pointed bar is designated the anterior and the opposing somewhat bulbous bar the posterior. The two bars branching from the mid-point of the unit are considered to represent the inner side of the unit and are designated as posterior-inner and anterior-inner bars.

Description. Complex platform-like dental units consisting of four bars, the anterior, posterior and the two inner, of subequal length, and an outer bar of unknown form, which is broken in all the specimens from the Gelli-grin Limestone. General plane of aboral surface gently arched, the anterior-inner and posterior-inner bars being concave transversely. Aboral surface deeply excavated over its whole area. Anterior bar slender, pointed; posterior bar somewhat bulbous in outline; posterior-inner and anterior-inner bars short and bulbous; the anterior-inner bar flexed in a horizontal plane in some specimens so that the anterior margin is concave. Outer lateral bar developed from a point anterior to the base of the inner bars along the anterior bar. It is possible that this bar may be branched, as is that of *A. complicatus* (p. 282). All bars having smooth oral surface with median denticulated ridge and oral marginal furrows, the aboral margin sharply down-turned forming a marginal ledge. Anterior bar bearing series of irregular, pointed, partly fused denticles, increasing in size posteriorly. Posterior bar bearing four to eight stout, stubby denticles set in a gently curving arc along the bar. Each inner bar bearing three to seven similar denticles, which are also set along a gently curved line.

Specimens exhibit a remarkable similarity to one another, there being no appreciable variation in form.

Occurrence. Gelli-grin and Pen-y-garnedd Limestones.

Hypotypes: CIA 1*a–d*, CIA 2*a–c*, Loc. 2.

AMORPHOGNATHUS INAEQUALIS n.sp.

(Figure 204, plate 22)

Diagnosis. An *Amorphognathus* of slender appearance with two comparatively short, subequal, inner bars and longer, subequal anterior and posterior bars. An outer bar is present but is of unknown form.

Description. This species is very similar to *A. ordovicicus*, but differs from it in the relative length of the two inner bars, which are considerably shorter than the anterior and posterior bars. The anterior and posterior inner bars appear to be subequal in length, although the anterior one is broken in the only specimen available. The denticulation of the oral surface of these bars is similar to those of *A. ordovicicus*, although the posterior-

inner bar bears only five and the anterior bar two or more low, rounded, conical denticles. The small outer bar is broken at its proximal end, and the distal end of the posterior bar is more sharply pointed than is the corresponding bar in *A. ordovicicus*. The short inner bars give a more slender appearance to the whole unit.

Occurrence. Llandeilo Limestone.

Holotype: CIIK 4*a*, Loc. 1.

Remarks. Only a single specimen of the genus *Amorphognathus* has been collected from the Llandeilo Limestone. This individual is so distinctive in form and so well preserved, however, that a new species is erected upon it.

Genus *BALOGNATHUS* n.gen.

Complex dental units consisting of a large median cusp, a denticulated anterior bar, and a denticulated posterior platform. Cusp erect or recurved, somewhat laterally flattened, having lateral process at base. Basal plane gently arched. Anterior bar bearing a series of denticles, whose form varies in different species, but which increase in size posteriorly. Posterior platform comprising two ridges, both diverging from the apical denticle. These ridges may or may not be denticulated. Aboral surface deeply excavated. Aboral margin sharply down-flexed.

Type species. *B. expansus* n.sp.

Remarks. This genus appears to be related to *Amorphognathus* Branson & Mehl and may represent a form intermediate between that genus and the simple bar-type conodonts. It lacks the specialized platform development of *Amorphognathus*, and its general characters are those of the bar type. Thus it differs from *Amorphognathus* in the stronger development of the median cusp, which is always conspicuous, and in the anterior bar, which is strongly denticulated, while the platform development is confined to a lateral extension of the posterior 'bar' of the unit. The genus also broadly resembles *Icriodella*, but in that genus the posterior platform is never branched.

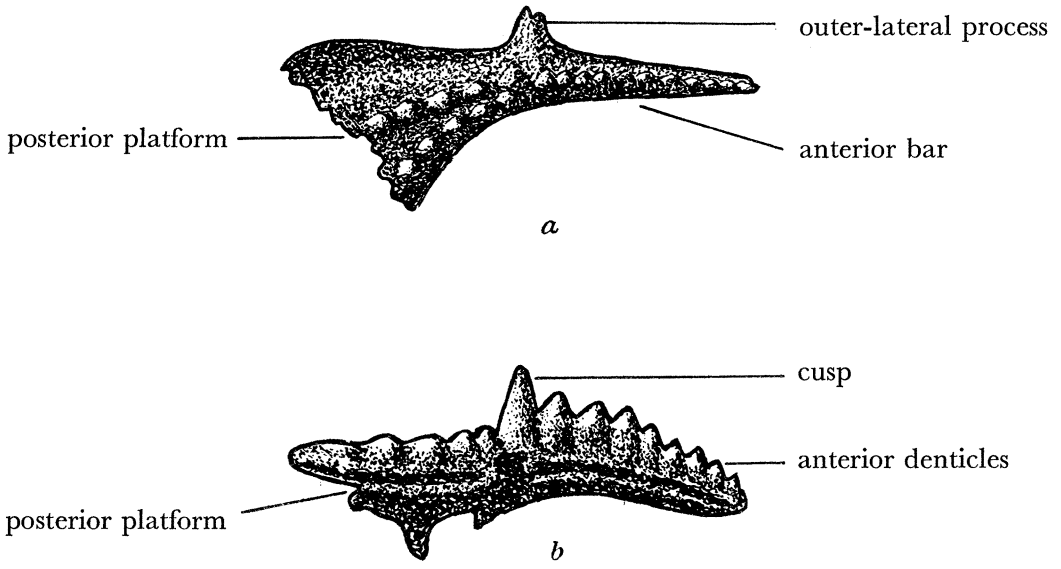


Figure 3. *Balognathus* sp. *a* Superior view. *b* Outer inferior lateral view. (Magn. approx. × 100.)

BALOGNATHUS EXPANSUS n.sp.

(Figures 50 to 53, 57, plate 20)

DIAGNOSIS. A *Balognathus* with well-developed denticulation; conspicuous cusp with rounded inner-lateral face and longitudinal groove on outer-lateral face. Denticulated outer-lateral process. Greatly expanded posterior platform.

DESCRIPTION. Complex dental units; median cusp pointed, erect; inner-lateral face rounded; outer face with faint longitudinal groove, bearing a lateral process at its base. Process directed outwards and downwards; distal end expanded; flat, vertical anterior and posterior faces; oral surface gently concave with sharp marginal ridges; anterior ridge crowned with five or more short, pointed, irregular denticles. Anterior bar having ten to twelve confluent, pointed, erect denticles, increasing in size posteriorly. Posterior portion of unit greatly expanded laterally and developed into two ridges, diverging from the apical denticle, each crowned by three or more short, subequal, conical denticles. Posterior termination of aboral margin of platform flexed gently upwards; base of unit gently arched along its length. Aboral margin sharply down-flexed giving ledge or parapet-like appearance to base; aboral surface deeply excavated.

OCCURRENCE. Gelli-grin and Pen-y-garnedd Limestones.

Holotype: CIB 3*b*. *Paratypes*: CIB 2*a–d*, CIB 3*a*, Loc. 2.

REMARKS. In a number of specimens the denticles of the anterior bar are more irregular than those of typical members of the species. In all other respects, however, the specimens are similar.

Genus *ICRIODELLA* n.gen.

Narrow, elongated, platform-like dental units, with markedly irregular denticulation. Cusp stout, frequently developed at approximately mid-point of unit. Denticles anterior to cusp developed as low, conical projections along elevated oral ridge. Denticles posterior to cusp short, node-like, irregular, but generally decreasing in size posteriorly and having marked lateral elongation, so that, when viewed orally, they appear as a series of transverse bars.

Sides deep and flaring at base, especially at base of cusp, where there is a deep anterior indentation on the outer aboral margin and a deep posterior indentation on the inner aboral margin giving prominent, opposed lateral flanges. Deep aboral excavation extending along entire length of unit.

TYPE SPECIES. *I. superba* n.sp.

ORIENTATION. The feeble denticulation is developed on the anterior end of the unit, so that the transverse denticulation is posterior. The prominent anterior-lateral flange is regarded as being developed on the inner surface of the unit.

REMARKS. This genus exhibits some similarity to the genus *Icriodina* Branson & Mehl. It differs from it, however, in the strong development of the cusp, the confinement of the characteristic transverse bar-like denticulation to the posterior end, and the two lateral flanges, features which are characteristic of the genus *Icriodella*. Like *Icriodina*, it also shows broad similarities to *Icriodus* Branson & Mehl. It may be related to *Scyphiodus* Stauffer,

but the deeply excavated aboral surface is distinctive and the oral surface does not show the three rows of denticles described by Stauffer. It stands very close to *Aphelognathus* Branson *et al.* but it differs from it in the lateral elongation of the posterior denticles. This 'platform development' is so marked that the erection of this new genus seems to be justified. The two genera way well have been functionally different.

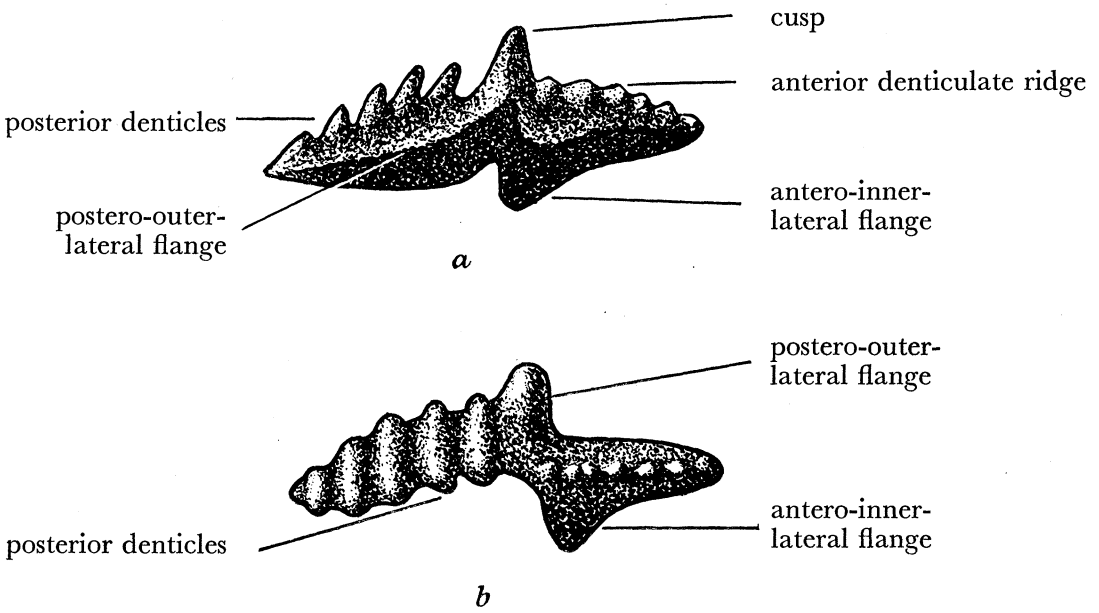


FIGURE 4. *Icriodella* sp. *a* Outer-lateral view. *b* Superior view. (Magn. approx. × 100.)

ICRIODELLA DEFORMA n.sp.

(Figures 68 to 70, plate 20)

DIAGNOSIS. A deep *Icriodella* with a short, feebly denticulated anterior ridge, and an elongated posterior bar bearing seven or more posteriorly inclined, bar-like denticles. Anterior flange feebly developed, posterior flange conspicuous.

DESCRIPTION. Deep, elongated dental units with irregular denticulation. Cusp triangular in cross-section, blunted apex, inclined posteriorly, marked posterior and outer-lateral carinae; developed at point about one-quarter of the length of the unit from the anterior end. Posterior denticles seven or more in number, directed posteriorly, parallel to cusp; subequal in size when viewed laterally; oral surfaces developed into series of blunt, transverse bars, the third and fourth tending to be wider than the rest. Anterior ridge comparatively short; anterior denticulation very feebly and irregularly developed. Anterior-inner flange only feebly developed; posterior-outer flange extended conspicuously outwardly, with concave anterior margin. Sides deep; basal outline gently curved (inner margin concave); aboral surface deeply excavated over its entire area.

OCCURRENCE. Gelli-grin Limestone.

Holotype: CIB 1*b*, Loc. 1.

REMARKS. This species is based upon a single specimen which is, however, sufficiently distinctive and well preserved to justify its recognition.

ICRIODELLA ELONGATA n.sp.

(Figures 79 to 81, plate 20)

DIAGNOSIS. A slender, greatly elongated, gently arched *Icriodella*, with feeble denticulation and a bar-like posterior flange.

DESCRIPTION. Greatly elongated dental units with feeble lateral flanges and poorly developed denticulation. Cusp erect, low, rounded, subcircular in cross-section with feeble inner-lateral and posterior carinae. Nine or more posterior denticles, irregular in form and tending to be irregularly offset laterally relative one to another, with little increase in width of oral surfaces; oral surface of denticles a blunt, slightly irregular ridge, tending to be concave anteriorly, except for the two posterior denticles; posterior denticles separated from the cusp by a shallow undenticulated depression. Portion of unit anterior to cusp triangular in cross-section, very shallow, the oral surface developed into a sharp, slightly irregular, undenticulated ridge, offset laterally towards outer margin. Posterior-lateral flange developed as a thin, horizontal bar-like process, along the oral surface of which the lateral carina of the cusp is extended as a sharp ridge. Anterior flange not strongly developed. Aboral surface deeply excavated. Aboral margin gently concave upwards, having a conspicuous lobe on each side immediately posterior to cusp.

OCCURRENCE. Gelli-grin Limestone.

Holotype: CIF 1*d*, Loc. 2.

REMARKS. This species is based upon a single specimen which is, however, almost complete and sufficiently distinctive to justify its recognition.

ICRIODELLA PLANA n.sp.

(Figures 67, 74, 76, plate 20)

DIAGNOSIS. A feebly denticulated *Icriodella* with bulbous outline, undenticulated anterior ridge and cusp directed outwards and anteriorly.

DESCRIPTION. Slender, shallow dental units with irregular, feebly developed denticulation. Cusp short, blunted, strongly curved out of the line of denticles towards middle of anterior flange; subcircular in cross-section but posterior outer face slightly flattened. Two main posterior denticles, with oral surfaces extended transversely; concave anteriorly and irregularly nodose; posterior denticles separated from the cusp by a gentle depression in which is developed a blunted, short denticle; denticles followed posteriorly by an irregular oral elevation which slopes downwards to form the posterior extremity of the unit. Portion of unit anterior to cusp elevated, undenticulated, sloping downwards towards the anterior tip. Anterior lateral flange shallow, very wide, oral surface gently convex. Posterior lateral flange feebly developed and not extended posterior to cusp. Aboral surface deeply excavated.

OCCURRENCE. Gelli-grin Limestone.

Holotype: CIF 1*c*, Loc. 2.

REMARKS. This species is based upon a single, well-preserved specimen.

ICRIODELLA SUPERBA n.sp.

(Figures 54, 58, 62, 63, 65, 78, plate 20)

DIAGNOSIS. An *Icriodella* with well-developed denticulation, rounded lateral flanges and subequal anterior and posterior portions.

DESCRIPTION. Narrow, elongated dental units with characteristic generic denticulation. Cusp stout, low, sharply pointed or slightly blunted, subcircular in cross-section, developed slightly anterior to the mid-point of unit. Base of cusp developed into prominent, inner-anterior-lateral flange and opposing, but smaller, outer-posterior flange; a transverse line drawn through the cusp, at right angles to the length of the unit, approximately marks the posterior margin of the anterior flange and the anterior margin of the posterior flange. Posterior denticles short, irregular, four or five in number, decreasing in size posteriorly; forming a series of transverse bars, each crowned with a sharp, oral ridge; these denticles separated from the cusp by a smooth, shallow, undenticulated depression. Anterior denticles small, conical, four or five in number, developed at irregular intervals along an elevated anterior ridge, extending from near the apex of the cusp to the anterior tip of the unit. Aboral surface deeply excavated through its length.

OCCURRENCE. Gelli-grin and Pen-y-garnedd Limestones.

Holotype: CIA 6*a*. *Paratypes*; CIA 6*c*, CIB 1*a*, Loc. 2.

ICRIODELLA SUPERBA var. *ACUTA* n.var.

(Figures 59, 60, 64, 66, 71 to 73, 77, plate 20)

DIAGNOSIS. An *Icriodella* similar to *I. superba* s.s. but differing from it in the carination and curvature of the cusp, and the peculiar oral development of the posterior denticles.

DESCRIPTION. Narrow, elongated dental units with characteristic generic denticulation. Stout cusp, curved anteriorly, triangular in cross-section, developed slightly anterior to mid-point of the unit; lateral face of cusp giving rise to anterior flange is flattened; the posterior flange developed from outer-lateral face of cusp, on which a sharp, median carina extends from the tip of the cusp to the aboral margin of the flange; cusp also has strongly developed posterior carina. Posterior denticles five or six in number, short, laterally extended on oral surface forming a series of transverse bars which are highest at the lateral edges, having shallow depressions in the middle, giving the appearance of a double row of short node-like denticles; oral surface of denticles wider than base of unit; conspicuous undenticulated depression between cusp and the first posterior denticle. Anterior ridge extending from cusp to anterior tip of unit; elevated and bearing five, subequal, short, subconical denticles. Aboral surface deeply excavated over its entire area.

OCCURRENCE. Gelli-grin and Pen-y-garnedd Limestones.

Holotype: CIA 6*b*. *Paratype*: CIA 6*d*, Loc. 2.

ICRIODELLA n.sp.

(Figure 61, plate 20)

This specimen differs from all others described in its general outline and in the development of the posterior flange which is straight and bar-like, and extends downwards and

outwards, bearing a sharp oral edge developed from an outer-lateral carina on the cusp.

OCCURRENCE. Gelli-grin Limestone.

Figured specimen: CIF 1*b*, Loc. 2.

Family CHIROGNATHIDAE Branson & Mehl, 1944

Branson & Mehl's description:

'Fibrous conodonts that clasp or tip the end of the jaw ramus.'

Genus *STEREOCONUS* Branson & Mehl, 1933

Stereoconus Branson & Mehl, 1933, p. 27.

TYPE SPECIES. *S. gracilis* Branson & Mehl.

Branson & Mehl's generic description:

'Comparatively slender more or less curved cones without basal excavation or "pulp cavity": lateral faces varying from slightly concave to slightly convex: rounded anterior and posterior edges. Longitudinally fibrous rather than laminar structure.'

STEREOCONUS MAXIMUS n.sp.

(Figures 134, 135, plate 21)

DIAGNOSIS. A short, massive *Stereoconus* with oval basal cross-section. Apex pointed, the distal portion of the cone sharply recurved.

DESCRIPTION. Short, massive cone, base unexpanded, unexcavated. Anterior and posterior edges rounded, lateral faces convex. Lower portion of cone erect, but the blade is sharply recurved at an angle of about 45° at a point about two-thirds of the length of the cone above the base. The tapering is more marked above the point of flexure. Basal outline oval; antero-posterior length about three times the width. Tip of blade curved slightly out of general axis of cone.

OCCURRENCE. Pen-y-garnedd Limestone.

Holotype: CIG 6*d*, Loc. 3.

Suborder CONODONTIFORMES Branson & Mehl, 1944

Branson & Mehl's description:

'Conodonts with laminated teeth of calcium phosphate.'

Family DISTACODIDAE Ulrich & Bassler, 1926

Ulrich & Bassler's description:

'Conodonts consisting of a single, more or less oval tooth or cusp with a small undenticulated basal extension.'

Genus *DISTOMODUS* Branson & Branson, 1947

Distomodus Branson & Branson, 1947, p. 553.

TYPE SPECIES. *D. kentuckyensis* Branson & Branson.

Branson & Branson's generic description:

'Dental units are simple, curved or straight cones, with sharp or blunt anterior and posterior margins. One side nearly flat to gently convex in cross-section, convex longitudinally; the other side gently convex in middle in cross-section, gently concave longitudinally but curving out strongly near base. Outline of base triangular, one side of the cone turning in abruptly from the convexity to a plane to form one edge of the triangle. The front margin projects downward as a fragile prong, but in most specimens this has been broken away. A depression, shaped like a hollow triangular pyramid, extends one-fourth to one-fifth the length of the cone from the base.'

REMARKS. Branson & Branson's only species of this genus, *D. kentuckyensis*, contains a number of widely different forms (cf. Pl. 81, figs, 21, 22, 32, 33, 36, 37, 40, 41), but none of the specimens collected from the Aymestry Limestone can be referred to this species. The specimens here described appear certainly to be included within the genus, but they suggest than Branson & Branson's generic description may need considerable modification. A number of features which they described as characteristic of the genus seem to be of only specific importance. Further collecting will, however, be necessary before any amendment may be made to the original generic description.

DISTOMODUS SUBERECTUS n.sp.

(Figures 207, 208, 210, 211, plate 23)

DIAGNOSIS. A straight, conical *Distomodus* with the blade slightly inclined to the subtriangular base.

DESCRIPTION. Simple, straight, elongated, conical dental units, inclined slightly to base; sharp lateral edges; anterior face flat or very gently convex, the posterior face more strongly convex. Base expanded, subtriangular in form, two corners being formed by the lateral edges; the third formed by a sharp outward flexure of the base of the posterior face; aboral margin irregular; aboral surface excavated with a very shallow conical depression; posterior base of some specimens bears a small stump-like denticle.

OCCURRENCE. Aymestry Limestone.

Holotype: CIID 3*a*. *Paratype*: CID 3*b–d*, Loc. 4.

REMARKS. Further collecting may indicate that specimens bearing the small posterior denticle should be regarded as a distinct species, but the basal portion of those specimens which have no such denticle developed is somewhat irregular and it therefore appears unjustifiable to separate these forms.

DISTOMODUS CURVATUS n.sp.

(Figures 209, 226 to 228, plate 23)

DIAGNOSIS. A *Distomodus* with the blade recurved in its lower portion. Base subtriangular.

DESCRIPTION. Conical, blade-like dental units, distinctly recurved; sharp lateral edges; anterior face flat or gently convex, the posterior face more convex; blade gently recurved in its lower third, the upper two-thirds straight, making an angle of about 70° with the base. Base expanded, subtriangular in outline, the aboral margin of the posterior face being sharply out-flexed to form the third corner of the triangle; aboral margin irregular, base excavated with a shallow conical depression.

OCCURRENCE. Aymestry Limestone.

Holotype: CIID 4*c*. *Paratypes*: CIID4 *b–d*, CIID 5*a–c*, Loc. 4.

DISTOMODUS CURVATUS var. *DENTATUS* n.var.

(Figures 217, 218, 229, 230, plate 23)

DIAGNOSIS. A *Distomodus* similar to *D. curvatus* s.s. except that it bears a single denticle on the expanded base.

DESCRIPTION. In a number of specimens a single very small stub-like, erect denticle is developed on the base of the posterior edge, and the basal anterior edge is somewhat irregular. In all other respects these specimens resemble *Distomodus curvatus* s.s.

OCCURRENCE. Aymestry Limestone.

Holotype: CIID 6*a*. *Types*: CIID 6*b–d*, Loc. 4.

Genus *DREPANODUS* Pander, 1856

Drepanodus Pander, 1856, p. 20.

TYPE SPECIES. *D. arcuatus* Pander (Miller 1889).

Pander's generic description may be translated as follows:

'More or less curved pointed teeth with large, equally sharp anterior and posterior keels and convex, smooth, symmetrical, lateral faces. According to the various ways of bending the following forms may be distinguished....'

Holmes (1928) ignored Miller's selection and designated the first described species as type species (as she did with others of Pander's genera). Branson & Mehl (1944) and various other workers have also ignored Miller's selection and wrongly followed Holmes.

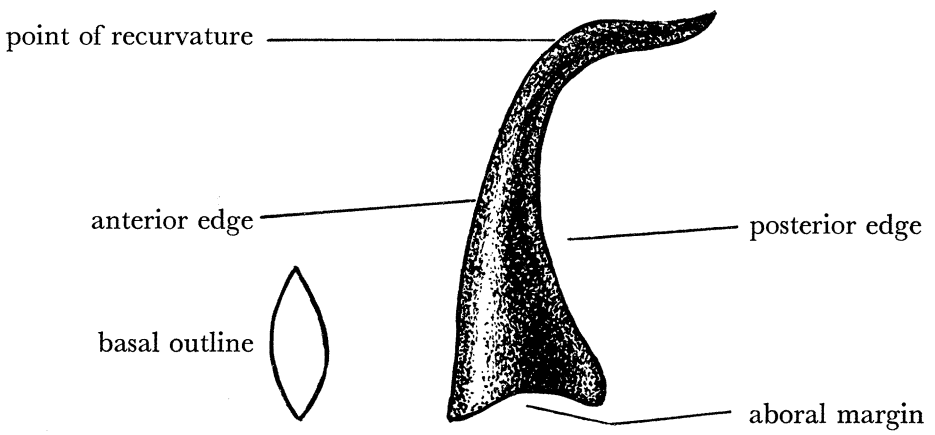


FIGURE 5. *Drepanodus* sp. Lateral view. (Magn. approx. × 100.)

DREPANODUS ALTIPES Henningsmoen

(Figures 102 to 105, plate 21)

D. altipes Henningsmoen, *in* Waern *et al.* 1948, p. 420, Pl. XXV, fig. 14.

Henningsmoen's description is not entirely comprehensive and the present specimens are therefore described in detail.

Description. From an elongated base the blade tapers sharply and is recurved above its mid-point; in some specimens the axis of the apical portion is almost parallel to the base, in others it makes an angle of about 45° with the base. The relative height of the point of recurvature also varies slightly in the specimens studied. Anterior and posterior margins sharp, lateral faces gently convex. (Henningsmoen described the lateral faces as 'more or less flattened' but stated that his material was compressed.) Deep conical aboral cavity. Aboral margin concave upwards or flat when viewed laterally.

Occurrence. Gelli-grin and Pen-y-garnedd Limestones.

Hypotypes: CIH 1*a–d*, CIJ 4*c–d*, Loc. 3.

Remarks. This species stands close to *D. verutus* Hadding but differs from it in its marked lateral compression, the cross-section of *D. verutus* being nearly circular.

Although some of the specimens referred to *D. altipes* are black, opaque and lustrous, the majority are translucent and pearl-white in colour. These translucent specimens include not only all the smaller forms but also some of comparable size to the opaque specimens.

The antero-posterior length of the base shows some variation within this species, but specimens show all gradations from a greatly expanded to an almost unexpanded base, and it is difficult to separate them.

The specimen figured in figure 103, plate 21, shows the flexing of the apical tip which is characteristic of the species *D. arcuatus* Pander. It differs from this species, however, in the sharp curvature of the blade at the point of flexure.

DREPANODUS ARCUATUS Pander

(Figure 110, plate 21)

D. arcuatus Pander, 1856, p. 20.

Pander's illustrations include a number of different forms, but the continuous curvature and characteristic apical flexing of a single specimen from the Pen-y-garnedd Limestone are typical features of this species.

Occurrence. Pen-y-garnedd Limestone.

Figured specimen: CIJ 5*a*, Loc. 3.

DREPANODUS SIMILARIS n.sp.

(Figures 97 to 99, plate 21)

Diagnosis. A simple *Drepanodus* with unexpanded base; the blade continuously recurved, the axis of its distal end making an angle of 60 to 70° with the base.

Description. Long, slender cones; sharp anterior and posterior edges; smooth, convex lateral faces; uniformly recurved through length of cone, the apical portion of the

axis making an angle of 60 to 70° with the base. Convex basal outline; aboral surface very deeply excavated, so that cone is hollow. Antero-posterior length of base about three times the basal width.

OCCURRENCE. Gelli-grin and Pen-y-garnedd Limestones.

Holotype: CIH 2*a*. *Paratypes*: CIH 2*b–d*, Loc. 3.

REMARKS. This species differs from *D. altipes* in the continuous curvature of the cone and its lack of conspicuous basal elongation posteriorly. The species shows some resemblance to *D. arcuatus* Branson & Mehl and *D. subarcuatus* Furnish, but may be readily distinguished from both by its lack of a sharp recurvature above the base, by the large angle which the axis of the cone makes with the base, and by its characteristic aboral excavation.

DREPANODUS STRIATUS Graves & Ellison

(Figures 100, 101, plate 21)

D. striatus Graves & Ellison, 1941, p. 11, Pl. 1, figs. 3, 12.

A single specimen of this species has been collected from the Gelli-grin Limestone.

The base is deeply excavated, but the posterior extension is very slight. The specimen differs slightly from the specimens figured by Graves & Ellison in its more uniform recurvature and gentle lateral twisting of the tip of the cone. The most conspicuous feature of the specimen is the development of the characteristic, fine, uniform striae, parallel to the axis of the cone, over its entire surface.

OCCURRENCE. Gelli-grin Limestone.

Figured specimen: CIH 5*a*, Loc. 2.

Genus *OISTODUS* Pander, 1856

Oistodus Pander, 1856, p. 27.

TYPE SPECIES. *O. lanceolatus* Pander (Holmes 1928).

Pander's original generic description, translated by Stauffer (1935*a*, p. 146):

'A small group is formed by those simple teeth which rest on a very long, broad and hollow base. From among these only a single genus is provisionally established because the character of the different forms is quite similar. They are generally transparent, yellow and of a horny appearance, although they contain lime.'

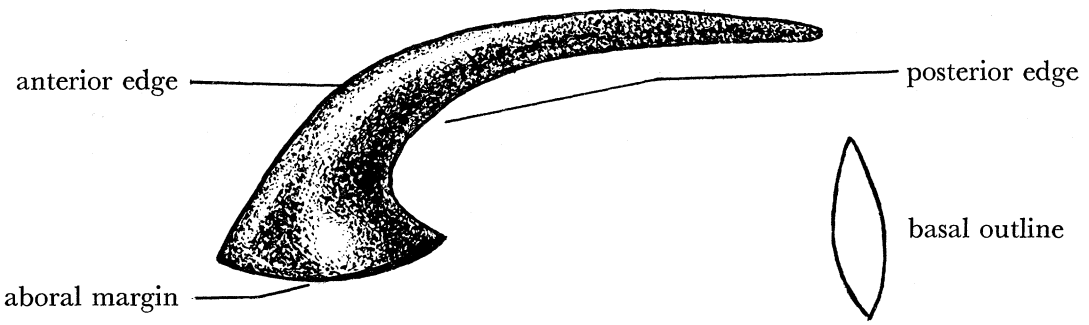


FIGURE 6. *Oistodus* sp. Lateral view. (Magn. approx. × 100.)

REMARKS. It will be noted that a number of forms recorded in the present paper from the Gelli-grin Limestone are also present in the Middle Ordovician. This close resemblance between Middle and Upper Ordovician forms of *Oistodus* finds a counterpart in the similarity of certain Lower and Middle Ordovician forms. Thus Furnish (1938, p. 329) states: 'Several Lower Ordovician forms of *Oistodus* have closely resembled counterparts in the Middle Ordovician, some of which may be conspecific.'

OISTODUS ABUNDANS Branson & Mehl

(Figures 91, 92, plate 21)

O. abundans Branson & Mehl, 1933, p. 109, Pl. 9, figs. 11, 17.

O. abundans Stauffer, 1935*b*, p. 609, Pl. 75, figs. 2, 7, 11–13, 19.

Only three specimens of this species have been collected from the Pen-y-garnedd Limestone, and all three appear to be immature forms. The specimens are considerably smaller than most distacodids and, although the inner parts of the fossils are opaque, the margins are translucent.

The units are strongly compressed laterally, and the basal width is considerably less than one-third of the basal length (Branson & Mehl 1933, p. 109). These individuals further differ from Branson & Mehl's description in the absence of marginal depressions on the inner-lateral face of the blade. Apart from these two differences the units are very similar to those described by Branson & Mehl. They display the characteristic pointed, elongated aboral outline, the marked posterior basal extension, the conical basal excavation and the sharply pointed, slightly inwardly flexed blade, which is recurved at about 45° to the base.

These similarities seem sufficient to justify the inclusion of these specimens within the species. They show a very close resemblance to some of the hypotypes figured by Stauffer (1935*b*, Pl. 75, figs. 2, 7, 11–13, 19).

OCCURRENCE. Pen-y-garnedd Limestone.

Figured specimens: CIG 6*a*, *b*, Loc. 3.

REMARKS. This species differs from *O. lanceolatus* Pander in the absence of the broad, convex, lateral keels on the faces of the blade.

OISTODUS BREVICONUS Branson & Mehl

(Figures 95, 96, plate 21)

O. breviconus Branson & Mehl, 1933, pp. 109–110, Pl. 9, figs. 13, 14.

Only one specimen belonging to this species has been collected. It exhibits all the characteristics given in Branson & Mehl's specific description, although the opaque material of which it is composed makes it impossible to study the exact shape of the basal cavity by transmitted light. The base is laterally compressed but retains the elongate, narrow lens-shape described by Branson & Mehl. The basal portion of the inner-lateral face is marked by a shallow, anterior, concave depression which does not appear to be present in the syntypes of Branson & Mehl, but this slight difference seems insufficient reason for separating the two forms.

OCCURRENCE. Gelli-grin Limestone.

Figured specimen: CIF 2*a*, Loc. 2.

OISTODUS CURVATUS Branson & Mehl

(Figures 82, 83, 89, 90, 157 to 161, plates 21 and 22)

O. curvatus Branson & Mehl, 1933, p. 110, Pl. 9, figs. 4, 10, 12.

O. curvatus Stauffer, 1935*b*, p. 609, Pl. 74, figs. 5, 10, 12, 17, 20–23, 25–29, 31, 33–40, 47–49.

O. curvatus Graves & Ellison, 1941, p. 6, Pl. 3, figs. 17, 21, 24, 27.

O. curvatus Amsden & Miller, 1942, p. 305, fig. 2B.

O. curvatus Branson *et al.*, 1951, p. 9, Pl. 2, figs. 7–10.

Specimens referred to this species agree in all details with Branson & Mehl's description, except that the depressed areas at the edges of the inner lateral surface are inconspicuous. This, however, seems insufficient evidence for separating the two forms. Thus, both Stauffer (1935*b*, p. 609) and Graves & Ellison (1941, p. 6) include within this species a large number of forms showing certain similar minor variations. Pander suggested that the shape of the cross-section was the most important diagnostic feature in the Distacodidae, but Furnish (1938, p. 324) has since shown that this character is very variable in closely related or conspecific forms and is therefore of little value in classification. The present classification of this family is based upon the assumption that the nature of the base and the relation of the base to the cusp are the fundamental characters by which forms should be distinguished (Furnish 1938, p. 324).

Occurrence. Gelli-grin, Pen-y-garnedd and Llandeilo Limestones.

Figured specimens: CIG 4*d*, 5*b–d*, Loc. 3; CIIH 3*a*, *d*, H 4*b*, J 3*a*, Loc. 1.

OISTODUS SUBERECTUS Branson & Mehl

(Figures 93, 94, 166, 167, plates 21 and 22)

O. suberectus Branson & Mehl, 1933, p. 111, Pl. 9, fig. 7.

O. suberectus Stauffer, 1935*a*, p. 147, Pl. 12, figs. 14, 19, 28, 31, 35; 1935*b*, p. 611, Pl. 74, figs. 18, 42, 46.

O. suberectus Branson *et al.*, 1951, pp. 8–9, Pl. 2, figs. 1–4.

Although Branson & Mehl figure only one specimen and this has a straight blade, their specific description clearly includes forms in which the blade is slightly recurved. The single specimen collected from the Gelli-grin Limestone (figures 93, 94, plate 21) has a more marked basal posterior elongation than the type specimen figured by Branson & Mehl, but it is very similar to a specimen referred by Stauffer to this species (1935*a*, Pl. 12, fig. 35). The Llandeilo specimens show no appreciable variation in form from Branson & Mehl's type specimen.

Occurrence. Gelli-grin and Llandeilo Limestones.

Figured specimens: CIF 2*b*, Loc. 3; CIIH 4*a*, *d*, Loc. 1.

OISTODUS VENUSTUS Stauffer, 1935

(Figures 168 to 170, plate 22)

O. venustus Stauffer, 1935*a*, p. 147, Pl. 12, fig. 12.

Stauffer's specific description is inadequate to define the species and to distinguish it from such similar forms as *O. abundans* Branson & Mehl. The species is here taken to

include those forms agreeing with the specific description, in which the antero-posterior length of the base is approximately equal to the length of the cusp. Stauffer's only figured specimen is of this type, though the anterior tip of the base appears to be broken.

OCCURRENCE. Llandeilo Limestone.

Figures specimens: CIIH2*b*,*d*, Loc. 1.

REMARKS. The species differs from *O. breviconus* Branson & Mehl in its rounded anterior basal margin and its less recurved cusp.

Genus *PALTODUS* Pander, 1856

Paltodus Pander, 1856, p. 24.

TYPE SPECIES. *P. subaequalis* Pander (Holmes 1928).

Pander's original description (translated by Stauffer 1935*a*, p. 149):

'In this genus are included all those teeth whose front or rear keels, sometimes both of them, are reduced to a plane or rounded surface, and whose lateral faces are always asymmetrical. They are very remarkable forms which are scarcely equalled by those of living animals.'

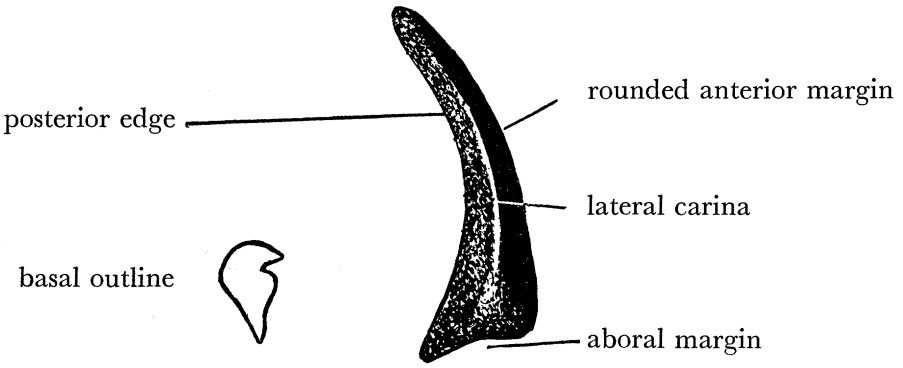


FIGURE 7. *Paltodus* sp. Lateral view. (Magn. approx. × 100.)

PALTODUS ACOSTATUS Branson & Branson

(Figures 111, 112, plate 21; 163, 164, plate 22; 212, 213, plate 23)

P. acostatus Branson & Branson, 1947, p. 554, Pl. 82, figs. 1–5, 23, 24.

This species is represented by a large number of specimens in all four faunas described in this paper. The majority of these specimens are perfectly preserved and therefore allow a more detailed description than that given by Branson & Branson (1947, p. 554).

The units consist of stout cones, regularly recurved throughout their length. The antero-posterior length of the base is two to three times as great as the width at its widest point. Lateral faces tend to be laterally flattened at anterior and posterior edges, but each bears a very broad, convex, longitudinal keel, which tapers uniformly towards the tip of the unit. These broad keels, which are usually developed nearer the anterior edge than the posterior, mark the limits of the greatly elongated, conical, aboral excavation which occupies most of the tooth. Anterior and posterior edges prominent, but tending to be blunted rather than sharp.

OCCURRENCE. Llandeilo, Gelli-grin, Pen-y-garnedd and Aymestry Limestones.

Hypotypes: CIH 4*c–d*, Loc. 2. *Figured specimens*: CIIJ 1*a*, Loc. 1; CIG 3*d*, Loc. 3; CIIC 4*d*, Loc. 4.

PALTODUS EQUICOSTATUS n.sp.

(Figures 106 to 109, plate 21; 162, 165, plate 22)

DIAGNOSIS. A *Paltodus* with a relatively unexpanded base; blade uniformly recurved in apical portion. Anterior margin rounded, posterior margin sharp; lateral faces each bearing a longitudinal carina.

DESCRIPTION. Cusp slender, tapering sharply, strongly but uniformly recurved in its upper third, having no basal expansion. Anterior margin rounded; posterior margin a convex ridge, resulting from the lateral compression of the lower posterior portion of unit. Lateral faces convex, each bearing a short, longitudinal carina developed near the anterior margin, posterior and adjacent to which is a shallow, longitudinal groove. The angle between the aboral margin and the anterior edge is greater than that between the aboral margin and the posterior edge in complete specimens. Base deeply excavated.

OCCURRENCE. Llandeilo, Gelli-grin and Pen-y-garnedd Limestones.

Holotype: CIG 4*a*. *Paratypes*: CIG 4*b–c*, Loc. 3.

REMARKS. This species differs from *P. variablis* Furnish in the absence of any posterior elongation of the base.

The subsymmetrical development of the lateral carinae may lead to confusion of this species with certain forms of *Distacodus*, but it is readily distinguished from all members of this genus by its rounded anterior margin.

The species differs from *P. unicostatus* Branson & Mehl in the development of a lateral carina on each lateral face instead of on only one.

PALTODUS RECURVATUS n.sp.

(Figures 219, 220, plate 23)

DIAGNOSIS. A *Paltodus* with base greatly expanded antero-posteriorly. Blade sharply recurved at mid-height; anterior margin rounded; posterior margin sharp.

DESCRIPTION. Teeth conical, hollow to about mid-height, at which point they are sharply recurved so that, in some specimens, the tip of the cone lies parallel to the base. Base greatly extended in an antero-posterior direction, cone tapering uniformly to mid-height, anterior margin rounded, posterior edge sharp in lower half of tooth but tending to be blunter above this. Anterior portion of lateral faces expanded, posterior portion somewhat laterally compressed to give typical 'paltodid' outline. Walls thin, aboral margin makes an acute angle with anterior margin of cone in most specimens.

OCCURRENCE. Aymestry Limestone.

Holotype: CIID 1*a*. *Paratypes*: CIID 1*b–c*, Loc. 4.

PALTODUS UNICOSTATUS Branson & Mehl

(Figures 84 to 88, plate 21; 155, 156, plate 22; 214 to 216, plate 23)

P. unicostatus Branson & Mehl, 1933, p. 42, Pl. 3, fig. 3.

P. unicostatus Branson & Branson, 1947, p. 554, Pl. 82, figs. 6–8, 11–22.

This species is abundant in all four conodont faunas, and it has been possible to study several hundred specimens. These all exhibit the basic specific characteristics, but there is considerable variation in form within the species. It will be seen from the figured specimens that the main variations occur in the antero-posterior length of the base, the height of the cone and the degree of recurvature. The basal outline, the development of the lateral faces and aboral cavity show no appreciable variation. Branson & Branson (1947, p. 554) mentioned the variation in specimens referred to this species from the Lower Silurian of Kentucky, and suggested that such specimens may represent more than one species. The systematic study of the many complete specimens reveals a perfect gradation in form from the robust to the more slender type, and the constancy of the general form of the lateral faces, the aboral margin and the pulp cavity suggests that further subdivision would be unjustified.

One common feature, not recorded by Branson & Mehl in their specific description, is the gentle flexing of the tip of the blade out of the general axis of the cone. The 'pulp cavity', which is frequently darker in colour than the rest of the fossil, is long and conical in form, tapering regularly and extending up the blade for about two-thirds of its length; its apex is nearer the anterior margin than the posterior. In a number of specimens the base is truncated in a plane normal to the lower part of the anterior margin, but in the majority the angle between the line of the aboral margin and the anterior margin is about 120°.

Occurrence. Llandeilo, Gelli-grin, Pen-y-garnedd and Aymestry Limestones.

Figured specimens: CIIK 1*a*, Loc. 1; CIG 2*a–d*, Loc. 3; CIIC 5*a*, *d*, Loc. 4.

Family Prioniodidae Ulrich & Bassler, 1926

Ulrich & Bassler's description:

'Conodonts somewhat pick shaped in which the handle or bar (posterior part) is denticulated and the anterior part consists of a strongly developed main cusp usually with a variously modified undenticulated downward extension.'

Genus *CORDYLODUS* Pander, 1856

Cordylodus Pander, 1856, p. 33.

Type species. *C. angulatus* Pander (Holmes 1928).

Pander's generic description may be translated as follows:

'Compound teeth with a very long compressed and high base. A large, fairly flat, smooth cusp, with flat arched lateral faces and almost blunt anterior and posterior edges, rises from the base, at first almost vertical but being recurved towards the tip. From the base there arise numerous small teeth which are situated, adjacent to one another, along

the bar, on the concave side of the fang. One could, judging by only the external appearance, confuse this genus with *Belodus*, but the microscopic structure is entirely different.'

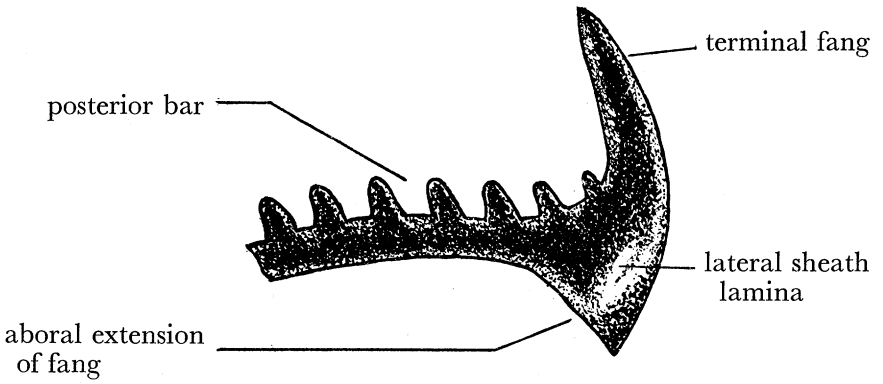


FIGURE 8. *Cordylodus* sp. Lateral view. (Magn. approx. × 100.)

CORDYLODUS? DUBIUS n.sp.

(Figures 221 to 224, plate 23)

DIAGNOSIS. A *Cordylodus*-like dental unit but with no posterior bar. The cone is strongly recurved so that the basal posterior margin is horizontal and bears one or two small, discrete denticles.

DESCRIPTION. Long, slender, pointed cone, base regularly expanded; cone sharply recurved above basal expansion. Oral bar absent (in all specimens studied, which appear to be undamaged), the basal posterior portion of the cone forming the oral surface and bearing one or two short, discrete, pointed, erect denticles, lens-shaped in cross-section with sharp anterior and posterior edges and convex lateral faces. Terminal fang (formed by recurvature of cone) erect to oral surface, long, slender, straight, pointed; outer lateral face and outer lateral sheath lamina convex transversely; inner lateral face and lateral sheath lamina flat or only gently convex; anterior edge of denticle sharp, developed on inner-anterior side; rounded posterior edge; aboral surface deeply excavated. Aboral margin irregular.

OCCURRENCE. Aymestry Limestone.

Holotype: CIIE 2*a*. *Paratypes*: CIIE 2*b–d*, Loc. 4.

CORDYLODUS ELONGATUS n.sp.

(Figures 114 to 118, plate 21)

DIAGNOSIS. A *Cordylodus* with straight, elongated posterior bar bearing seven or more discrete denticles, which increase in size posteriorly. Erect terminal fang with recurved aboral extension.

DESCRIPTION. Posterior bar greatly elongated, straight, with deep aboral longitudinal excavation; sides thin, with no thickening or flexing at aboral margin; oral surface bearing seven or more discrete, laterally compressed, pointed denticles, increasing in size posteriorly; distance between each denticle increasing posteriorly; lateral faces and posterior margins of denticles rounded, anterior edges sharp. Terminal fang of large size, erect or very slightly recurved; offset slightly inwards from line of denticles; outer face convex,

inner face somewhat laterally flattened, the sharp anterior edge being offset inwardly in some specimens. Aboral extension well developed and markedly recurved, terminating in a moderately sharp point. Outer-lateral sheath lamina, thin walled; convex transversely, with an irregularly concave posterior margin. Inner-lateral lamina thin-walled; gently convex in middle; flattened at oral and anterior margins, forming sharp keel along anterior margin of aboral extension of cusp. Aboral surface deeply excavated.

Occurrence. Gelli-grin Limestone.

Holotype: CIC 6*a*. *Paratypes*: CIC 6*b–d*, CIDI*b–d*, Loc. 2.

Remarks. This species is similar to *C. delicatus* Branson & Mehl but differs from it in the recurvature of the aboral extension of the fang. It also stands near to *C. plattinensis* Branson & Mehl but lacks the close anterior packing of the denticles above the lateral laminae. It differs from *C. concinnus* Branson & Mehl in the distinct form of the fang and its aboral extension.

CORDYLODUS GENICULATUS n.sp.

(Figure 113, plate 21)

Diagnosis. A *Cordylodus* with posterior bar gently arched in a vertical plane. Anterior fang sharply geniculated just above its base.

Description. Posterior bar elongated, gently arched in a vertical plane, and gently bowed in a horizontal plane (concave interiorly), the base forming a continuous curve with the posterior margin of the aboral extension; oral surface bearing six or more laterally compressed, discrete, posteriorly inclined, elongated, pointed denticles, which increase in size posteriorly; lateral faces convex; posterior and anterior edges sharp. Posterior bar relatively shallow, with thin walls; deep longitudinal aboral excavation. Fang, subcircular in cross-section with sharp anterior inner edge; greatly elongated; widely expanded at base; pointed, rising erect from anterior portion of bar but sharply recurved at an angle of approximately 80° at a point about one-third of its height above oral surface of bar; upper portion straight in side view but curved inwards from plane to denticles; cusp extended below bar for a short distance (approximately equal to the distance from oral surface of bar to the point of recurvature). Anterior margin of aboral projection straight or very slightly concave, sharp anterior edge slightly offset inwards; posterior margin regularly concave. Outer-lateral lamina thin walled, flat or gently convex; inner-lateral lamina gently concave; subapical cavity deeply excavated.

Occurrence. Gelli-grin Limestone.

Holotype: CID 3*b*. *Paratype*: CID 3*c*, Loc. 2.

CORDYLODUS RECTILINEATUS (Stauffer)

(Figures 172 to 175, plate 22)

Subcordylodus rectilineatus Stauffer, 1935*a*, p. 154, Pl. 11, figs. 30, 32.

Subcordylodus rectilineatus Stauffer, 1935*b*, p. 618, Pl. 73, figs. 7, 23, 28, 29, 33, 39.

Stauffer's original description is applicable to a variety of slightly different forms collected from the Llandeilo but it is difficult to separate these into distinct species (cf.

Stauffer 1935*b*, p. 618). The main variation noted by Stauffer was in the 'robustness' of individuals, but this feature, which is also apparent in the Llandeilo specimens, may be due to differences in age of individuals. It will be noted that Stauffer's figured specimens do not include any complete individuals and in the more complete forms collected from the Llandeilo the denticulate bar, bearing ten denticles when complete, tapers to a point at its posterior tip.

Occurrence. Llandeilo Limestone.
Figured specimens: CIIG 2*b*, G 3*a*,*b*, Loc. 1.

Remarks. The validity of the genus *Subcordylodus* Stauffer (1935*a*, p. 153) has been questioned by subsequent workers. It is omited by Branson & Mehl from their list of generic descriptions (1944) and Ellison (1946, p. 110) has suggested that it may belong to the genus *Cordylodus*. This opinion is here adopted, there being no apparent difference between the two genera except that Stauffer's description of *Subcordylodus* includes only those forms of *Cordylodus* in which the anterior fang is twisted, so that its anterior and posterior edges are out of line with the posterior bar. This feature is, however, a common one among specimens referred to *Cordylodus* (e.g. *C. plattinensis* Branson & Mehl 1933, p. 116, Pl. 8, figs. 34, 36) and appears insufficient to justify the erection of a new genus.

CORDYLODUS? SPURIUS Branson & Mehl

(Figure 133, plate 21)

Cordylodus? spurius Branson & Mehl, 1933, p. 117, Pl. 10, fig. 4.

Representatives of this species from the Gelli-grin Limestone are similar in all respects to Branson & Mehl's type specimens except that the cusp is laterally flattened, the inner-lateral and outer-lateral faces being gently convex. The fang bears sharp anterior and posterior edges, the former being offset inwardly, as in the specimens described by Branson & Mehl.

Occurrence. Gelli-grin Limestone.
Figured specimen: CID 2*b*, Loc. 2.

Genus *CYRTONIODUS* Stauffer, 1935

Cyrtoniodus Stauffer, 1935*a*, p. 140.

Types species. *C. complicatus* Stauffer.
Stauffer's generic description:

'Bar, or base, relatively thick, and deep anteriorly, tapering toward the posterior. It is slightly arcuate at right angles to the plane of the denticles. Under side of base is either notched or excavated through most of its length, with deepest portion of notch, or cavity, beneath the cusp at the anterior end. Cusp, stout, flattened, keeled, curved out of line with the denticles, and extending to a blunt point below the bar. Denticles, flattened, usually five or six, perhaps more, directed toward the posterior, and sub-equal in size. Denticulated edge may be slightly arched.'

CYRTONIODUS COMPLICATUS Stauffer

(Figures 193 to 196, plate 22)

C. complicatus Stauffer, 1935*a*, p. 140, Pl. 11, figs. 44, 46.

C. complicatus Stauffer, 1935*b*, p. 604, Pl. 73, figs. 9, 11–13, 15, 16, 18–20, 25, 27, 32, 38, 41, 42, 47.

Stauffer's specific description is somewhat incomplete, and a brief description of the Llandeilo specimens is therefore given.

Cusp erect to posterior bar, or only very inconspicuously recurved; convex lateral faces, sharp anterior and posterior edges, somewhat laterally compressed; anterior edge straight or very gently recurved; long; blunted tip (not shown in figured specimens), flexed inward, slightly out of line with posterior bar; aboral extension about one-third as long as oral extension, aboral tip pointed (but broken in many specimens), posterior aboral margin concave.

Posterior bar thin, deep anteriorly, the posterior portion straight, tapering almost to a point, the anterior third curved in a vertical plane; aboral surface deeply excavated throughout its length, deepest at junction with cusp where the inner aboral margin is strongly, and the outer aboral margin weakly, flared; oral surface bearing up to five subequal, pointed, laterally compressed, denticles, sharp anterior and posterior edges, gently convex lateral faces; inclined posteriorly; closely crowded but discrete; their basal width approximately one-half to one-third that of the cusp.

Occurrence. Llandeilo Limestone.

Hypotypes: CIIG 1*a–d*, CIIG 2*a*, CIIH 5*a–d*, Loc. 1.

Remarks. This species is very common in the Llandeilo Limestone.

Branson & Mehl figure only one specimen in their description of *Prioniodus? flexuosus* (1933, p. 130, Pl. 10, fig. 16), but both their description and figured specimen closely resemble Stauffer's specimens. Although the author has been unable to study Branson & Mehl's specimens, it seems that their species may include *Cyrtoniodus complicatus*, but until it is possible to study the syntypes, Stauffer's specific name is retained, since the present specimens appear more like Stauffer's figured specimens.

Genus *HINDEODELLA* Ulrich & Bassler, 1926

Hindeodella Ulrich & Bassler, 1926, p. 38. (See also Branson & Mehl 1933, p. 194.)

Type species. *H. subtilis* Ulrich & Bassler.

Ulrich & Bassler's original description:

'Bar long and straight, bearing as many as ten small denticles in front of the strong long main cusp and a long series of numerous small slender denticles often alternating in size behind it, those of each set approximately equal in size.'

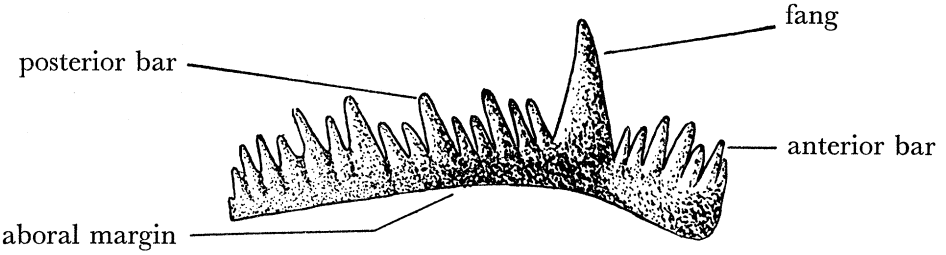


Figure 9. *Hindeodella* sp. Inner lateral view. (Magn. approx. × 100.)

HINDEODELLA EQUIDENTATA n.sp.

(Figures 248, 252 to 254, plate 23)

DIAGNOSIS. A massive *Hindeodella*, with deep bar and discrete denticles. No alternating series of smaller denticles present. Anterior bar in-flexed but not down-flexed.

DESCRIPTION. Bar long, deep, laterally compressed, straight or very slightly curved in a vertical plane; anterior end flexed inwards making an angle of about 130° with the posterior bar; posterior portion flexed gently outwards so that outer-lateral margin is feebly concave; posterior bar about three times as long as the anterior. Denticles of anterior bar five or more in number, long, pointed, subequal, slightly divergent, discrete but closely spaced, laterally compressed with convex faces and sharp edges; about one-half or one-third as wide as fang at base. Fang large, inclined slightly posteriorly and, in some specimens, gently recurved; laterally compressed, sharp edges, convex faces; about twice as long as anterior denticles. Denticles of posterior bar ten or more in number, increasing in size posteriorly, the largest approximately equal in size to those of anterior bar, discrete but closely spaced; pointed, inclined posteriorly. There are no smaller, or germ denticles, present between those of the main series. Aboral margin thin, but expanded beneath fang, excavated throughout its length by a narrow groove.

OCCURRENCE. Aymestry Limestone.

Holotype: CIIB3*a*. *Paratypes*: CIIB3*b–d*, CIIB4*a–d*, Loc. 4.

REMARKS. This species shows some superficial resemblance to *H. transitionis* Branson & Mehl, *H. corpulenta* Branson & Mehl, *H. longidens* Ulrich & Bassler and *H. millerella* Youngquist & Peterson. It differs from the first of these in the absence of down-flexing in the anterior bar and from the other three species in the absence of alternating germ denticles between the main series of the posterior bar.

Genus *HOLODONTUS* n.gen.

Compound dental units consisting of three bars diverging from a main fang. General form that of a deformed pyramid with each bar representing an edge. Anterior fang laterally compressed, deep, almost horizontal but slightly recurved; sharp, elongated, anterior aboral edge which may be denticulated. From oral surface of fang two diverging horizontal lateral bars are developed, of which only one may be denticulated.

TYPES SPECIES. *H. superbus* n.sp.

ORIENTATION. The fang is regarded as anterior, resting horizontally with its tip recurved orally. The two lateral bars then rest horizontally, the one which is denticulate being designated the outer.

REMARKS. The genus shows some resemblance to *Trichonodella* Branson & Branson, but the greatly elongated aboral extension of the fang and its position relative to the lateral bars indicates that it is functionally different. It stands close to *Sagittodontus* but may be readily distinguished from the latter by its well-developed denticulation. The complete lack of denticulation of *Sagittodontus* shows that members of that genus do not represent broken fragments of *Holodontus*.

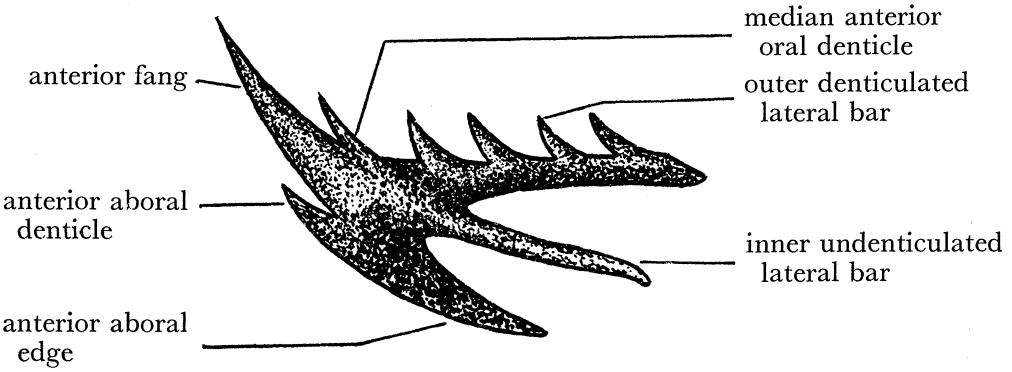


FIGURE 10. *Holodontus* sp. Inner-lateral view. (Magn. approx. × 100.)

HOLODONTUS SUPERBUS n.sp.

(Figures 125 to 127, plate 21)

DIAGNOSIS. *A Holodontus* with conspicuous anterior fang which bears one median oral and one medium aboral denticle; long anterior-aboral process; only the outer-lateral bar is denticulated.

DESCRIPTION. Anterior fang stout; sharp anterior and posterior edges; convex lateral faces; tip recurved orally. Anterior edge developed aborally and posteriorly into long, thin, horizontal process, with sharp aboral edge, bearing a single, laterally compressed, sharp-edged, anteriorly directed denticle with convex lateral faces; this denticle developed below the point of recurvature of the fang. Posterior surface of process (which is presumed to be attached to aboral surface of jaw) deeply excavated. Above this single denticle is developed, on the oral edge of the main fang, a similar horizontal, but slightly recurved, median anterior oral denticle, from the base of which two lateral bars diverge at an angle of about 60°. The outer one bears two or more sharp, elongated denticles, directed outwards and upwards, subcircular in cross-section, with marked posterior-lateral carinae. Inner bar having oral surface developed into sharp undenticulated ridge. Lateral faces of both bars convex and aboral surfaces deeply excavated, so that walls are very thin.

OCCURRENCE. Gelli-grin Limestone.
Holotype: CIF 6*a*. *Paratypes*: CIF 6*b–c*, Loc. 2.

HOLODONTUS sp.

A single incomplete specimen from the Pen-y-garnedd Limestone is referred to this genus. It exhibits all the generic characteristics, but the development of the anterior aboral denticle on the inner side of the aboral projection of the fang and the absence of a median anterior oral denticle exclude it from *H. superbus*.

OCCURRENCE. Pen-y-garnedd Limestone.
Specimen. CIJ 3*d*, Loc. 3.

Genus *LIGONODINA* Ulrich & Bassler, 1926

Ligonodina Ulrich & Bassler, 1926, p. 12.

TYPE SPECIES. *L. pectinata* Ulrich & Bassler.

Ulrich & Bassler's generic description:

'General form of tooth as in *Prioniodus* but distinguished by the development of a series of sucker-like impressions on one side of the downward extension of the main cusp.'

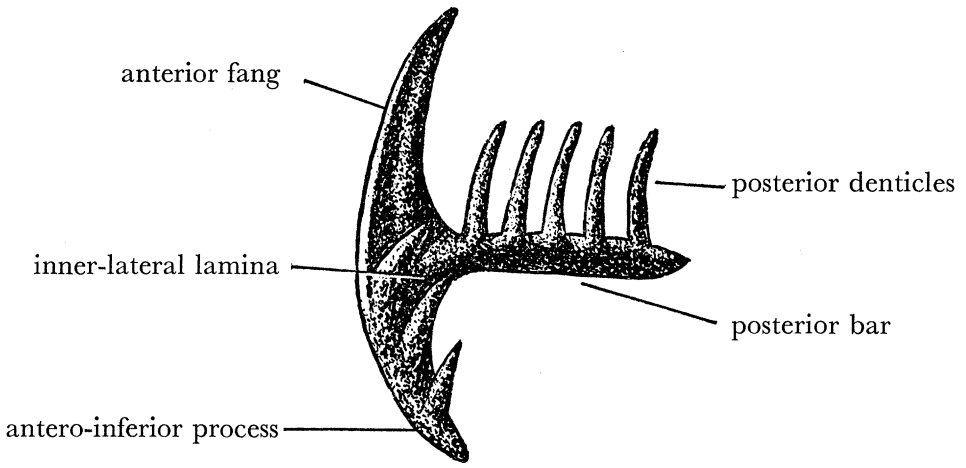


FIGURE 11. *Ligonodina* sp. Inner-lateral view. (Magn. approx. × 100.)

REMARKS. The sucker-like impressions described by Ulrich & Bassler are seen in more perfect specimens to be scars formed by the breaking of a series of denticles developed on the inner side of the aboral projection of the fang. Branson *et al.* have recently (1951, p. 14) established a new genus, *Eoligonodina*, which appears to differ from *Ligonodina* only in the development of a deep, subapical, aboral cavity. This difference, however, seems insufficient to justify the generic separation of the two forms, since typical specimens of *Ligonodina* (e.g. *L. salopia* n.sp.), although the basal walls may be fairly thick, also possess a more or less excavated subapical aboral surface. The three new Ordovician species described below could all be included in the genus *Eoligonodina*, but since there seems to be little reason for not considering them as *Ligonodina*, they are here included in the latter genus.

LIGONODINA ELONGATA n.sp.

(Figures 130, 131, plate 21)

DIAGNOSIS. A *Ligonodina* with stout anterior fang and antero-inferior process. Posterior bar bearing eight or more small, crowded denticles, separated by a single large, erect denticle, which is usually developed between the fifth and sixth denticles.

DESCRIPTION. Anterior fang stout, slightly recurved (but appearing erect in broken specimens); laterally compressed; sharp anterior and posterior edges, convex lateral faces. Antero-inferior process stout; recurved posteriorly to form continuous curve with anterior fang; the angle between this process and the posterior bar filled by lateral laminae, the outer lamina very convex, the inner one flat; anterior-inner surface of process bearing two

or more sharply pointed denticles, with convex faces and sharp lateral edges, the inner-lateral edge continued along process to base of succeeding denticle; denticles directed forwards and inwards, posterior margin of process deeply excavated longitudinally. Posterior bar deep, straight, aboral surface deeply excavated longitudinally; oral surface bearing five or more crowded, erect, germ denticles followed by stout, erect denticle which is laterally compressed, having a subcircular outline; this denticle followed by three or more crowded, erect, germ denticles.

Occurrence. Gelli-grin and Pen-y-garnedd Limestones.

Holotype: CID 6*d*, Loc. 2.

Remarks. This species differs from *L. extensa* n.sp. in the type of denticulation of the posterior bar.

LIGONODINA EXTENSA n.sp.

(Figures 128, 129, plate 21)

Diagnosis. A stoutly constructed *Ligonodina* with strongly denticulated antero-inferior and posterior bars. Aboral surface deeply excavated.

Description. Anterior fang long, stout, subcircular in cross-section with very faint anterior-inner carina, forming almost a right angle with the posterior bar; very gently recurved throughout its length; outer-lateral face expanded at base. Antero-inferior process stout; approximately equal in length to the fang, directed inwards and downwards; straight; bearing two or more discrete, stout denticles on its inner-anterior side; these denticles subcircular in cross-section, but each having one faint, inner-lateral carina which is continued down the process to the base of the succeeding denticle; denticles directed forwards, inwards and backwards with a continuous curve in this direction so that the tips point inwards and backwards. Posterior margin of process deeply excavated longitudinally. Posterior bar deep, narrow, widest at its base, lateral faces convex, base gently curved in a vertical plane, straight in a horizontal plane, bearing three or more discrete denticles, the first three of which increase in size posteriorly; denticles separated by varying distances; erect, pointed, lateral faces convex.

Aboral surface deeply excavated longitudinally throughout its length, the excavation being continuous with the subapical cavity; walls thin.

Occurrence. Gelli-grin and Pen-y-garnedd Limestones.

Holotype: CIE 3*a*, Loc. 2.

Remarks. The species shows some resemblance to *L. flexuosa* Branson & Mehl and *L. acuta* Branson & Mehl, but differs from both in the deep excavation of the aboral surface of the posterior bar. It is the form of the aboral surface (representing the nature of attachment) that Branson & Mehl consider to be of diagnostic value in the classification of the genus (1933, p. 199).

Many species are characterized by the development of the largest denticles midway along the length of the posterior bar. No complete specimens of the species *L. extensa* have yet been found, and it cannot therefore be stated whether or not this species shows a similar characteristic denticulation, or whether the increase in size posteriorly seen in the first three denticles is continued along the length of the bar.

LIGONODINA SALOPIA n.sp.

(Figures 245, 257, 260, plate 23)

DIAGNOSIS. A stoutly constructed *Ligonodina* with massive recurved anterior fang, straight posterior bar and discrete denticulation.

DESCRIPTION. Terminal fang long, stout, strongly recurved posteriorly throughout its length; gently flexed inwards; subcircular in cross-section but slightly compressed laterally, with feebly rounded anterior margin; the posterior basal portion somewhat flattened in some specimens. Antero-inferior process stout and long, directed inwards, forwards and downwards in a gentle flexure and slightly twisted. Denticles of this process six or more, subcircular in cross-section but with feeble lateral edges, discrete, stout, long, pointed, subequal, one-third or one-half as wide at base as terminal fang; regularly recurved outwards and backwards roughly parallel to the terminal fang. Posterior bar stout, straight, deep, the width decreasing posteriorly; lateral faces flat to gently convex; oral surface bearing a series of discrete, posteriorly inclined, pointed denticles, with convex lateral faces and sharp anterior and posterior edges, increasing in size posteriorly (no specimen studied has the posterior bar complete). Aboral-inner margin of bar developed into an inconspicuous lateral ledge, in some specimens. Aboral surface widest below terminal fang, lateral edges sharp, excavated by a shallow convex depression, which is most strongly developed beneath the terminal fang.

OCCURRENCE. Aymestry, Limestone.

Holotype: CIIB 5*a*. *Paratypes*: CIIB 5*b–d*, Loc. 4.

REMARKS. This species bears some resemblance to *L. silurica* Branson & Mehl, but differs from it in the lack of curvature of the posterior bar and the discrete denticulation.* It is distinguished from *L. delicata* Branson & Mehl by its more gentle inward and downward flexing of the anterior bar. The species also resembles *L. kentuckyensis* Branson & Branson but differs from it in the recurvature of the terminal fang (which in Branson & Branson's figures seems to be almost erect). Branson & Branson note, however, that none of their specimens was complete and their specific description is therefore vague. Further study may show that this new species should be included in their species *L. kentuckyensis*, but it appears at present to be distinct.

LIGONODINA VALMA n.sp.

(Figures 184, 185, plate 22)

DIAGNOSIS. A *Ligonodina* with short, stout, anterior fang, long, straight antero-inferior process and straight posterior bar, which bears a series of crowded, erect, short, pointed, subequal denticles.

DESCRIPTION. Terminal fang short and stout; gently recurved near its base, its upper portion tending to be straight and making an obtuse angle with the posterior bar; convex

* Branson & Mehl's figured specimens and description (1933, p. 48, Pl. 3, figs. 18–20) of this species are somewhat inadequate. Little detail is given in the description, and the specimen in fig. 18 appears quite different in its denticulation from the other two specimens represented in figs. 19 and 20.

lateral faces, sharp anterior and posterior edges, the former edge slightly offset inwardly. Antero-inferior process long, slender, straight; directed backwards, making an angle of about 45° with the posterior bar; the angle between the two filled by lateral laminae, the inner one of which is concave transversely and the outer flat or gently convex; inner-oral surface bearing a series of six or more pointed denticles, compressed antero-posteriorly and having gently convex anterior and posterior faces and sharp lateral edges; denticles directed forwards and inwards, closely crowded, their bases confluent but their apices discrete; lateral faces of inferior process somewhat compressed, flat or gently convex, posterior-aboral surface excavated by longitudinal groove. Posterior bar deep, straight, elongated, aboral surface excavated by a longitudinal groove, lateral walls flat or gently convex, the inner face bearing a faint longitudinal ridge in some specimens; oral surface bearing a series of six or more short, crowded, pointed, subequal, erect denticles, with gently convex lateral faces and sharp anterior and posterior edges.

Occurrence. Llandeilo Limestone.

Holotype: CIIK 2*a*. *Paratypes*: CIIK 2*b–d*, Loc. 1.

Genus *LONCHODUS* Pander, 1856

Centrodus Pander, 1856, p. 31 (*non* Giebel, 1848, *nec* McCoy, 1848).
Lonchodus Pander, 1856, p. 80.

Type species. *Centrodus simplex* Pander (Ulrich & Bassler 1926, p. 42).

Pander's generic description may be translated as follows (Stauffer 1935*a*, p. 144):

'Very slender vertical, inclined or bent teeth which are directed in one or two different ways, and which rest on a horizontal base....Smaller denticles may arise between the larger ones....The general character of the genus may be defined as slender, pointed and lamellar teeth, occurring singly or interchanging with small teeth of varying size and number, and which rest on a horizontal or convex base.'

Ulrich & Bassler (1926, p. 42), in commenting on this genus, write:

'The genus *Lonchodus*...is undoubtedly based upon broken incomplete remains of teeth which...might belong to any one of several distinct genera.'

This seems probable in some cases. The generic name is therefore used, in the sense suggested by Ulrich & Bassler, as a means of classifying incomplete fragments which, for the sake of completeness, are figured in the present paper. Stauffer in his earlier papers (1930, 1932) erected a number of rigid species which he founded upon minor denticular variations, but, in his later work (1935*a*, e.g. Pl. 10, figs. 1–7), the specific descriptions are widened to include forms which are only broadly similar. In view of the incomplete nature of the specimens here referred to this genus the latter procedure has been adopted in the present paper.

It should be noted, however, that *Lonchodus* has been shown to be a valid genus in the Pennsylvanian conodont faunas of Illinois (Rhodes 1952), where it does not represent broken fragments of other genera.

LONCHODUS DENTATUS Stauffer

(Figure 122, plate 21)

L. dentatus Stauffer, 1930, p. 123, Pl. 10, figs, 5, 6, 8.
L. dentatus Stauffer, 1935*a*, p. 145, Pl. 10, figs. 10, 11.

Specimens of this species from the Gelli-grin differ somewhat from those of Stauffer in that the denticles are flattened laterally, having convex lateral faces and sharp anterior and posterior edges. The basal bar is straight or very gently curved in a horizontal plane and deeply excavated by a longitudinal aboral groove. Sides of bar thin.

Occurrence. Gelli-grin Limestone.
Figured specimen: CID 4*a*, Loc. 2.

LONCHODUS DISTANS (J. Smith)

(Figures 119, 120, 123, plate 21)

Centrodus distans Smith, 1907*b*, p. 244, Pl. V, fig. 7.
? *Lonchodus* sp. Stauffer, 1930, Pl. 10, fig. 14.

Smith's specific description:

'On a straight beam a few simple conical teeth stand at right angles and some distance apart.'

It will be noted that Smith's original description will admit the inclusion of a wide variety of forms within the species but, in view of the doubtful value of this genus, it seems advisable to retain the present broad conception of the species.

Individuals collected from the Gelli-grin and Pen-y-garnedd Limestones are similar to Smith's figured specimen except in the shorter length of their denticles. Basal bar stout, solid, subcircular in cross-section, each side having a thin longitudinal carina; aboral surface convex, unexcavated. Denticles discrete, erect, short, conical, subequal in size; space separating each denticle about five times the width of the denticles at mid-height. Oral surface of bar is gently concave between denticles.

Occurrence. Gelli-grin and Pen-y-garnedd Limestones.
Figured specimens: CIE 1*b*, Loc. 2; CIH 6*c–d*, Loc. 3.

Genus *PHRAGMODUS* Branson & Mehl, 1933

Phragmodus Branson & Mehl, 1933, p. 98.

Type species. *P. primus* Branson & Mehl.

Branson & Mehl's generic description:

'Vertically extended, laterally compressed dental units modified to sheathe the anterior end of the mandible. The inferior margin is continued anteriorly as an exceptionally long, straight or vertically curved denticle, and a similar denticle extends more or less vertically from the oral anterior corner of the sheath. The space along the anterior margin between the larger denticles is either smooth or set with a few small slender denticles. The oral margin is either short with few or no denticles, or produced into a posterior horizontal denticulate bar of appreciable length.'

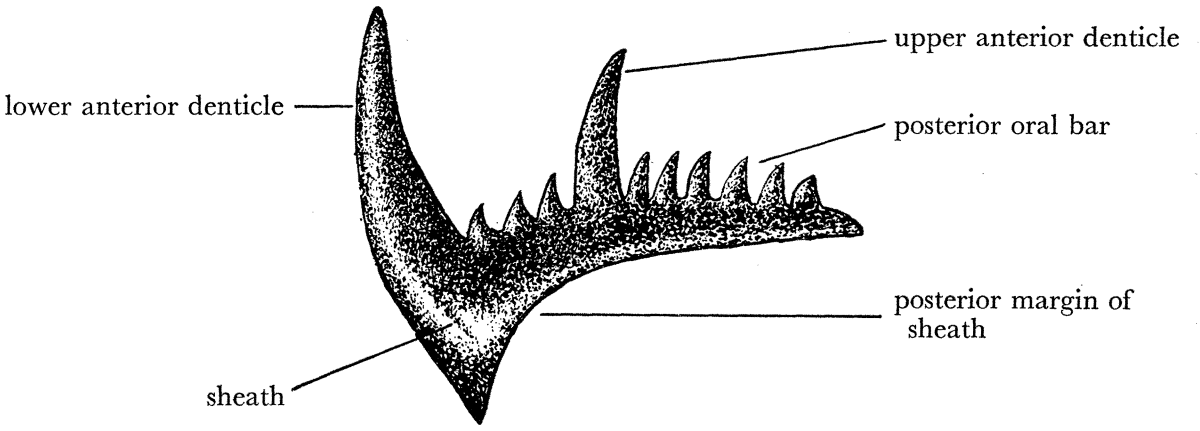


FIGURE 12. *Phragmodus* sp. Lateral view. (Magn. approx. × 100.)

PHRAGMODUS INSCULPTUS Branson & Mehl, 1933

(Figures 136, 153, 154, plate 21)

P. insculptus Branson & Mehl, 1933, p. 124, Pl. 10, figs. 32–34.
P. insculptus Graves & Ellison, 1941, p. 6, Pl. 3, fig. 1.

The specimens of this species obtained from the Pen-y-garnedd Limestone are all incomplete, and none of them shows the smaller upper anterior denticle described by Branson & Mehl. The lower anterior denticle and sheath agree in all respects with the specific description. The sheath of some individuals shows a short, anterior, aboral projection of the lower anterior denticle, which is separated from the sheath proper by a V-shaped notch. The aboral projection has a sharp anterior edge and convex lateral faces, the posterior margin being deeply excavated.

OCCURRENCE. Pen-y-garnedd Limestone.
Figured specimens: CIG 1*a*,*c*, Loc. 3.

Genus *SAGITTODONTUS* n.gen.

General appearance barb-like; single, large, stout denticle, triangular in cross-section with three more or less flattened faces and sharp dividing edges, the lower part of each face usually having a wide, shallow depression. Unit expanded at base into hemi-pyramidal form. Edges gently curved. Irregular aboral margin; aboral surface deeply excavated so that whole unit is hollow.

TYPE SPECIES. *S. robustus* n.sp.

ORIENTATION. The convex edge of the cusp is designated as the anterior and the cusp is therefore curved posteriorly.

REMARKS. One specimen of this genus shows irregular indentations along one of the edges but these cannot be identified as denticles and the genus appears to be characterized by a lack of secondary denticulation. The relationship of this genus to existing genera is uncertain. It bears a superficial resemblance to *Trichonodella* and may have had a similar function, but it differs from that genus in its lack of symmetry and denticulation.

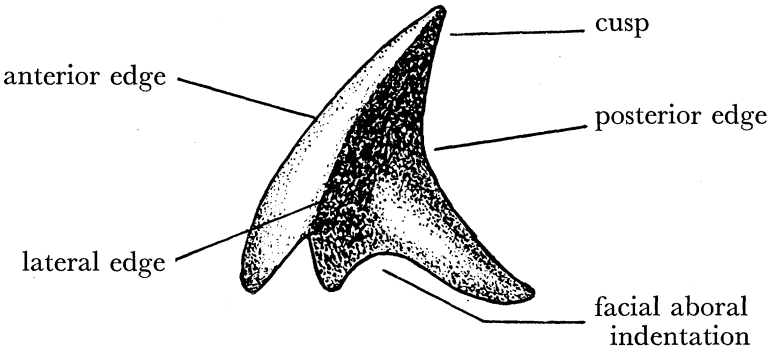


FIGURE 13. *Sagittodontus* sp. Lateral view. (Magn. approx. × 100.)

SAGITTODONTUS ROBUSTUS n.sp.

(Figures 141, 142, plate 21)

DIAGNOSIS. A *Sagittodontus* with convex anterior edge and with shallow basal depressions on each of the faces, the aboral margins of which are feebly indented.

DESCRIPTION. General appearance barb-like; single, large, stout denticle, triangular in cross-section, having flat faces divided by sharp edges. Cusp gently curved posteriorly, giving the appearance of a deformed hemi-pyramid. Shallow depression at base of each face extending midway to tip of cusp. Edges of varying length; the anterior edge convex, the other two concave. Base irregular and deeply excavated; whole unit is hollow; aboral margin of each face feebly indented. One edge (the longest) is immediately posterior to the convex anterior edge of the cusp, the third edge lying at right angles to the latter so that the angles of the triangular outline of the base are approximately 90°, 30° and 60°.

OCCURRENCE. Gelli-grin Limestone.

Holotype: CIA 4*a*. *Paratypes*: CIA 4*c*, CIA 5*b*, Loc. 2.

REMARKS. The most conspicuous variation in this species lies in the variation in length and degree of curvature of the edges and in the downward extent of the faces. This variation is so marked in some specimens that two varieties within the species are described.

SAGITTODONTUS ROBUSTUS var. *ERECTUS* n.var.

(Figures 143, 151, 152, plate 21)

DIAGNOSIS. A *Sagittodontus* similar to *S. robustus s.s.* but with straight anterior edge and very deep indentations of the aboral margins of the faces.

DESCRIPTION. This variety resembles *S. robustus* s.s. in general form but differs from it in the following respects. Anterior edge straight or convex; posterior and lateral edges concave, the unit having a more erect appearance than *S. robustus* s.s. Aboral margin of faces very deeply indented in the form of a sharp, inverted V, the aboral extension of the faces being only one-third of the distance between the apex of the cusp and the base of the unit formed by the extension of the edges. Faces have median, shallow, concave depression. Outline of base similar to *S. robustus* s.s.

OCCURRENCE. Gelli-grin Limestone.

Holotype: CIA 4*b*. *Paratype*: CIA 5*a*, Loc. 2.

SAGITTODONTUS ROBUSTUS var. *DISTAFLEXUS* n.var.

(Figures 137, 138, plate 21)

DIAGNOSIS. A *Sagittodontus* resembling *S. robustus* s.s., but having feeble indentations of the aboral facial margins and elongated edges, the distal portions of which are flexed upwards.

DESCRIPTION. This variety resembles *S. robustus* s.s. in general form and in the outline of its base, but differs from it in the elongation and marked outward flexing of the anterior and lateral edges, which become concave upwards at their distal ends. The facial indentations on the aboral margin are similar to those in *S. robustus* s.s.

OCCURRENCE. Gelli-grin Limestone.

Holotype: CIA 4*d*, Loc. 2.

Genus *TRICHONODELLA* Branson & Branson, 1947

Trichognathus Branson & Mehl, 1933, p. 36 (*non* Berthod).
Trichonodella Branson & Branson, 1947, p. 551.
Trichonodella Branson & Mehl, 1948, p. 527.

TYPE SPECIES (here chosen). *T. brassfieldensis* Branson & Branson.

REMARKS. *Trichonodella* Branson & Branson has priority over *Trichonodella* Branson & Mehl, and the type species must be chosen from the two genosyntypes, *T. brassfieldensis* Branson & Branson and *T. carinata* Branson & Branson.

Branson & Mehl's generic description (of *Trichognathus*):

'Dental units consisting of an arched denticulate bar symmetrical in reference to the axis of the apical denticle. Apical denticle curved posteriorly, the posterior aboral margin produced laterally into a horizontally extending more or less bar-like process.'

Note. 'The orientation of these dental units is assumed as transverse to the jaw for convenience of description.'

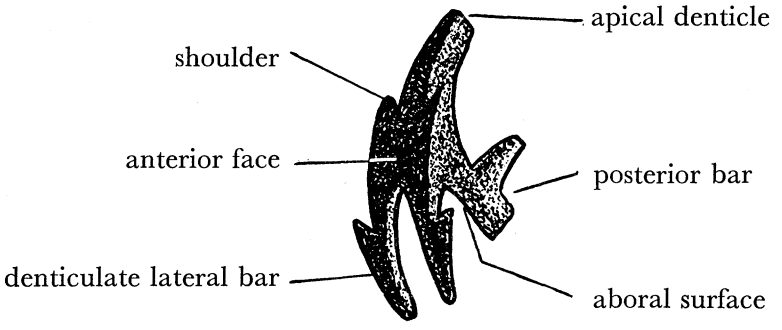


FIGURE 14. *Trichonodella* sp. Antero-lateral view. (Magn. approx. × 100.)

TRICHONODELLA ABOROFLEXA n.sp.

(Figures 231, 241, 242, plate 23)

DIAGNOSIS. A *Trichonodella* with slender, apical denticle and deep, laterally compressed, lateral bars, diverging at an angle of 150 to 170° and bearing denticles which are

coalesced at their base. The posterior aboral margin of the apical denticle is conspicuously up-flexed and is produced posteriorly.

DESCRIPTION. Lateral bars thin and deep, with slight downward flexure below the apical denticle from which they diverge at an angle of 150 to 170°. Lateral bars straight, each bearing eight or nine partly sheathed, erect, subequal denticles, their bases confluent but their apices discrete, with gently convex, anterior and posterior faces and sharp lateral edges. Apical denticle elongated, pointed, slender, recurved at about 45° to the plane of the lateral bars; subtriangular in cross-section; anterior face gently concave at base, with sharp lateral edges; posterior edge sharp and prominent at base but inconspicuous near apex where the cross-section of the denticle tends to be lens-shaped, with anterior and posterior faces gently convex and lateral edges sharp. Anterior base of denticle feebly emarginate; posterior basal margin of denticle most conspicuously developed posteriorly and upwards into a long, narrow, indented, flexure. Aboral surface widest below apical denticle, excavated throughout its length by shallow longitudinal groove which is continuous with the shallow excavation of the base of the apical denticle.

OCCURRENCE. Aymestry Limestone.
Holotype: CIIB1*a*. *Paratypes*: CIIB1*b–d*, Loc. 4.

TRICHONODELLA DIVARICATA n.sp.

(Figures 124, 140, 145, 146, plate 21)

DIAGNOSIS. A *Trichonodella* with feeble denticulation but of stout construction. Lateral bars diverge at an angle of 30 to 40°, elongated posterior bar bearing more strongly developed conical denticles than those of lateral bars.

DESCRIPTION. Lateral bars stout, gently recurved posteriorly, diverging at an angle of 30 to 40°; inner lateral surface of lateral bars excavated longitudinally; outer lateral edge feebly denticulated with series of small, closely set, stubby denticles which, when broken, give oral surfaces a serrated appearance. Apical denticle stout, sharply pointed, subtriangular in cross-section near base but becoming subcircular near apex; gently recurved, so that it forms a continuous arc with the lateral bars. Posterior bar elongated, straight, developed at right angles to the distal portion of the apical denticle; subtriangular in cross-section, oral edge bearing series of three or more short, discrete conical denticles, directed subparallel to the apical denticle; lateral faces of bar straight; base deeply excavated.

OCCURRENCE. Pen-y-garnedd Limestone.
Holotype: CIJ2*a*. *Paratypes*: CIJ2*b–d*, CIJ4*a*, Loc. 3.

TRICHONODELLA FLEXA n.sp.

(Figures 181 to 183, 188, 189, 191, 192, plate 22)

DIAGNOSIS. A *Trichonodella* with laterally twisted lateral bars, which diverge at an angle of 50 to 80°. Apical denticle subtriangular in cross-section near its base but lens-shaped in its distal portion; its posterior aboral margin sharply flexed but undenticulated.

DESCRIPTION. Base composed of two lateral bars, diverging at an angle to 50 to 80° from the base of the apical denticle; lateral bars in same vertical plane, long, deep, laterally compressed, walls thin, aboral surface deeply excavated; lateral bars flexed in a vertical plane so that aboral margin is directed posteriorly; width becoming less at distal ends which are spatulate (in unbroken specimens), oral surface of each bar bearing five unequal denticles, those nearest the apical denticle subparallel to it, the lower ones divergent, all slightly recurved posteriorly, the second and third (from the apical denticle) being the largest, those near the ends of the bars tending to be smaller; denticles discrete, except for the first which is confluent with, or closely approximated to, the apical denticle; denticles laterally compressed, gently convex anterior and posterior faces, sharp lateral edges; wide at base, tapering to a point.

Apical denticle long, pointed, recurved, posterior edge sharp, lateral faces convex, anterior basal margin flat or gently concave with sharp lateral edges which coalesce at about mid-height of denticle, so that above this the denticle is lens-shaped in cross-section with sharp anterior and posterior edges, and gently convex lateral faces; posterior base of cusp expanded to form a conspicuous aboral lip-like emargination which is undenticulated but has sharp oral carina, a continuation of the sharp oral edge of the apical denticle; base deeply excavated.

OCCURRENCE. Llandeilo Limestone.

Holotype: CIIG 4*a*. *Paratypes*: CIIG 4*b–d*, CIIG 5*a–d*, CIIG 6*a–d*, Loc. 1.

REMARKS. This species differs from both *T. pumila* Branson & Mehl and *T. erecta* Branson & Mehl in the absence of a denticulated posterior process. It shows a strong resemblance to *T. inopinatus* Stauffer, but differs from it in the characteristic shape of the cross-section of the apical denticle. It differs from *T. undulata* Branson *et al.* in the form of its posterior aboral flexure and from *T. nitida* Branson *et al.* in the shape of the apical denticle and of its posterior aboral flexure.

TRICHONODELLA GRACILIS n.sp.

(Figures 144, 147 to 150, plate 21)

DIAGNOSIS. A slender *Trichonodella*, with lateral bars uniformly recurved to form a continuous curve with the apical denticle in lateral view. Lateral bars diverging at a small angle, appearing subparallel in anterior view, the denticles of these bars widely spaced. Bar-like posterior process bearing discrete denticles.

DESCRIPTION. Bilaterally symmetrical dental units of delicate construction. Lateral bars with posterior curvature in vertical plane, shallow, sharply bent at the apex of the arch and diverging at such a small angle that they appear almost parallel; whole aboral surface of unit deeply excavated. Oral surface of each lateral bar bearing two or three conical, discrete, equal or subequal denticles, spaced at regular intervals along the bar. These denticles lie in the plane of the two bars and are all developed parallel to the apical denticle when seen in the anterior or posterior view. When the two denticles adjacent to the apical denticle are broken, as they often are, they give the appearance of a horizontal 'shoulder'. Apical denticle elongated, conical and sharply pointed; recurved posteriorly; rounded in cross-section; the posterior basal portion slightly flattened; base produced posteriorly into prominent bar-like process, directed backwards and downwards;

the oral surface bearing up to four discrete, slender, erect, conical denticles. This process is broken in the majority of specimens.

OCCURRENCE. Gelli-grin and Pen-y-garnedd Limestones.

Holotype: CIC 1*a*. *Paratypes*: CIC 1*b–d*, CIC 2*a*, *b*, *d*, Loc. 2.

REMARKS. Of all specimens previously recorded, this species most closely resembles that from the Grass Creek Shale of Missouri, referred by Branson & Mehl to *Trichognathus* sp. (1933, Pl. 16, fig. 27). Although Branson & Mehl's specimen is incomplete and no description is given, *T. gracilis* will be seen to differ from it in its more slender construction.

The species also resembles a specimen figured by Branson & Mehl (1944, Pl. 93, figs. 62, 63), and referred by them to *T. delicata*, but *T. gracilis* is again of more slender construction and bears a smaller number of more widely separated lateral denticles.

TRICHONODELLA INCLINATA n.sp.

(Figures 176, 177, 186, plate 22)

DIAGNOSIS. A *Trichonodella* with lateral bars diverging at an angle of about 30° and strongly recurved in continuous curve with the apical denticle in lateral view. Posterior bar greatly elongated, with denticles which alternate in size and are inclined subparallel to the apical denticle and those of the lateral bars.

DESCRIPTION. Lateral bars stout, diverging at an angle of about 30° below the apical denticle, gently recurved at their junction with the apical denticle but their distal ends straight, making an angle of 30 to 40° with the posterior bar; posterior aboral surfaces deeply excavated longitudinally; anterior oral surface bearing a series of four or more confluent, pointed denticles, their apices discrete; strongly compressed antero-posteriorly with gently convex anterior and posterior faces and sharp lateral edges; directed forwards and upwards so that they lie parallel to the apical denticle. Apical denticle stout and relatively short, strongly compressed antero-posteriorly in its distal portion with sharp lateral edges and gently convex anterior and posterior faces; becoming subtriangular nearer its base with feeble posterior edge; gently recurved near its base but distal portion straight, directed forwards and upwards. Posterior bar straight, greatly elongated; lateral walls flat; aboral surface excavated longitudinally; oral surface bearing a series of eight or more short, pointed, laterally compressed denticles, with sharp anterior and posterior edges and gently convex lateral faces, directed anteriorly so that they lie subparallel to the apical denticle; denticles unequal in size, arranged in 'hindeodellid' series with usually two, but rarely one or three, smaller denticles separating each of the larger ones.

OCCURRENCE. Llandeilo Limestone.

Holotype: CIIK 3*a*. *Paratypes*: CIIK 3*b–d*, Loc. 1.

TRICHONODELLA SYMMETRICA (Branson & Mehl)

(Figures 232, 256, plate 23)

Trichognathus symmetrica Branson & Mehl, 1933, p. 50, Pl. 3, figs. 33, 34.

Representatives of this species collected from the Aymestry Limestone exhibit an almost perfect similarity in form to Branson & Mehl's original specimens. The general form of the

units, the characteristic development of the apical denticle and the arrangement of the lateral denticles are identical, the only difference being that in all specimens studied the angle of divergence of the lateral bars is about 90° and not 60° as stated by Branson & Mehl. Reference to the two syntypes figured by Branson & Mehl will show, however, that the angles of divergence of both are approximately 90° and not 60° as quoted in their specific description.

The two straight lateral bars are very gently flexed in a horizontal plane, diverging at an angle of about 160°. The aboral surface is blade-like and unexcavated except for a shallow depression below the extended base of the apical denticle.

Occurrence. Aymestry Limestone.

Figured specimens: CIIA 6*a*, *b*, Loc. 4.

Family Prioniodinidae Ulrich & Bassler, 1926

Ulrich & Bassler's description:

'Similar to the Prioniodidae but the base of tooth or bar is denticulated both forward and back, the main cusp not being terminal but set in the midst of a series of smaller denticles.'

Genus *BRYANTODINA* Stauffer, 1935

Bryantodina Stauffer, 1935*a*, p. 131.

Type species. *Bryantodina typicalis* Stauffer.

Stauffer's generic description:

'Base deep at anterior end, shallow at posterior, elongate, straight or slightly arched, and beneath the cusp having a shallow flaring cavity which extends farther along the deep, than along the shallow end of the base....Denticles of medium length, laterally, flattened and with keeled edges. There are usually four to six denticles in front of the cusp, and five to eight posterior to it.'

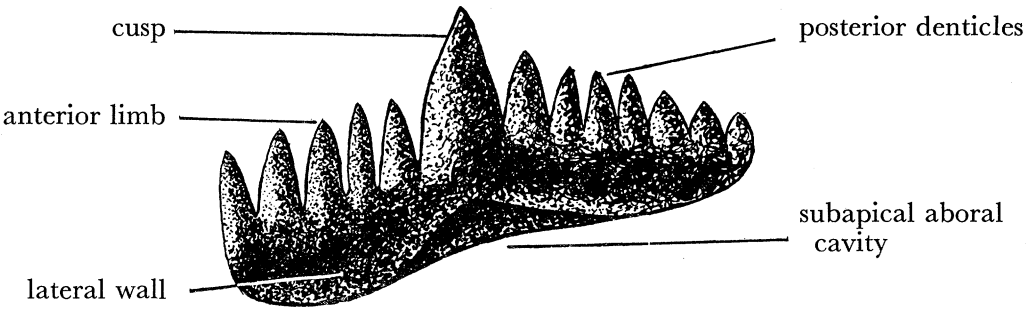


Figure 15. *Bryantodina* sp. Lateral view. (Magn. approx. × 100.)

BRYANTODINA? sp.

(Figure 34, plate 20)

A single incomplete specimen is the only representative of this genus found in the Gelli-grin Limestone. Although it is unlike any previously described species, and is

therefore described in detail, it seems undesirable to erect a new species upon one incomplete specimen.

DESCRIPTION. Base long, straight, deep anteriorly, the lateral walls thin and slightly convex; the subapical aboral cavity having a feeble, flaring, lateral flange. Anterior limb bearing four subequal denticles in two separated groups, within which denticles are confluent, or nearly so. Denticles sharp, erect, crowded, laterally compressed, convex lateral faces, sharp anterior and posterior edges. Cusp erect, about twice as wide at base as other denticles; laterally compressed, convex lateral faces; sharp anterior and posterior edges; followed posteriorly by one or more denticles, of which the first (and possibly the others) is similar in form to those developed anteriorly to the apical denticle. Subapical cavity shallow, flaring laterally, extending midway along anterior bar and a very short distance posteriorly (ending below the first posterior denticle) as a narrow groove.

OCCURRENCE. Gelli-grin Limestone.

Figured specimen: CIE 5*d*, Loc. 2.

REMARKS. The distinctive arrangement of the denticles of the anterior limb excludes this specimen from any previously described species.

Genus *DICHOGNATHUS* Branson & Mehl, 1933

Dichognathus Branson & Mehl, 1933, p. 35.

TYPE SPECIES. *D. primus* Branson & Mehl.

Branson & Mehl's generic description:

'Complex units consisting of an antero-posteriorly (?) elongate, arched row of denticles with deeply excavated and more or less laterally flared base; an approximately mid-length recurved denticle, the largest. Lateral surface of unit markedly offset inward immediately anterior to largest denticle and aborally extended beneath outer side of largest denticle. Arch in front of and behind largest denticle of varied length and crowned with a few denticles.'

Branson & Mehl observe (1933, p. 112):

'...We have selected a few distinctive forms as "trends" which we here record as species, regardless of the fact that we sometimes find it difficult to decide to which species a given specimen should be referred.'

DICHOGNATHUS cf. *D. TYPICUS* Branson & Mehl

(Figures 178 to 180, plate 22)

D. typica Branson & Mehl, 1933, p. 113, Pl. 9, figs. 27–29.

D. typicus Stauffer, 1935*a*, p. 141, Pl. 11, figs. 2, 3, 5, 8, 10.

D. typicus Stauffer, 1935*b*, p. 604, Pl. 71, fig. 23.

A single specimen from the Llandeilo Limestone is compared with this species. It is broadly similar in form to Branson & Mehl's and Stauffer's figured specimens, but differs from them in the rather more elongated apical denticle and the feeble denticulation of all three oral edges (anterior, posterior and inner). In view, however, of the fact that this is

the only specimen of the genus collected from the Llandeilo and also of the somewhat wide conception of the species, it seems preferable to compare it with this species.

OCCURRENCE. Llandeilo Limestone.

Figured specimen: CIIK 6*a*, Loc. 1.

Genus *GYROGNATHUS* Stauffer, 1935

Gyrognathus Stauffer, 1935*a*, p. 144.

TYPE SPECIES. *G. primus* Stauffer.

Stauffer's generic description:

'Base, thick, highly arched, neither limb straight but slightly twisted in opposite directions. Cusp, just posterior to the highest part of the arch. Underside of base, excavated throughout and deepest beneath the cusp.

'Cusp, of moderate size, preceded by two small denticles and then by a series of five or six large denticles, decreasing in size towards the anterior. Posterior limb of the base has three or four similar denticles.'

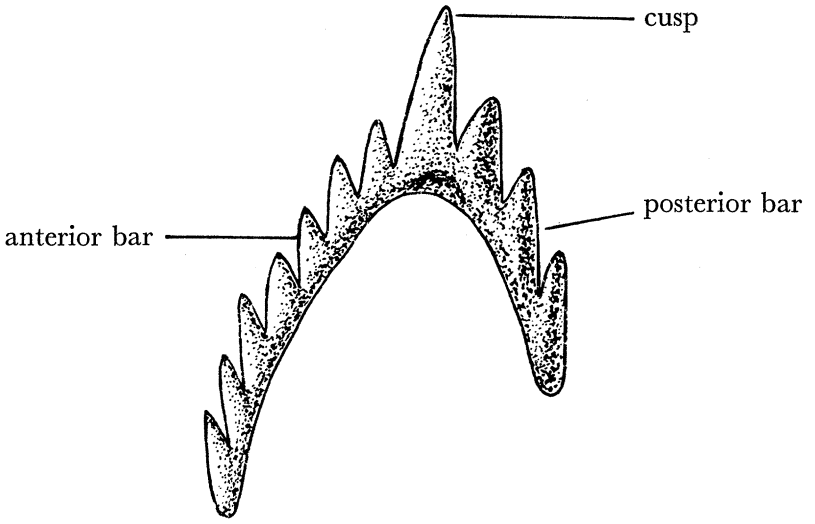


FIGURE 16. *Gyrognathus* sp. Lateral view. (Magn. approx. × 100.)

REMARKS. Ellison (1946, p. 108) has suggested that this genus may represent a form of the genus *Oulodus* Branson & Mehl. The present study suggests, however, that the genus is valid and contains specimens which cannot be included within Branson & Mehl's later definition of the genus *Oulodus* (1944, p. 244). It seems advisable to retain the genus *Gyrognathus* to include those forms resembling *Oulodus*, in which the aboral surface is not laterally expanded but is thin and blade-like. It is suggested that Stauffer's description of two small denticles separating the larger denticles of the anterior bar from the cusp does not represent a characteristic generic but a specific feature.

GYROGNATHUS ELONGATUS n.sp.

(Figures 201, 202, 205, 206, plate 22)

DIAGNOSIS. A *Gyrognathus* with greatly elongated anterior bar. Strongly arched in both vertical and horizontal planes. Denticulation well developed. Denticles and anterior and posterior bars strongly laterally compressed.

DESCRIPTION. Asymmetrical dental units with greatly elongated anterior bar, conspicuous cusp and short posterior bar. Anterior bar thin, deep, strongly curved proximally in a vertical and in a horizontal plane but its distal portion almost straight in both planes; oral surface bearing eleven discrete, short, pointed denticles, with gently convex lateral faces and sharp edges; subequal in size, but with a tendency to be a little smaller towards the distal end of the bar. Cusp developed just posterior to rounded apex of arch, similar in form to, but two or three times as large as, the anterior denticles. Posterior bar short, straight, deep, thin, oral surface bearing two large, laterally compressed, pointed denticles, with flat lateral faces and sharp edges, subequal in size to the cusp. Aboral surface of whole unit thin, excavated by a shallow longitudinal groove.

OCCURRENCE. Llandeilo Limestone.

Holotype: CIIK 5*a*. *Paratypes*: CIIK 5*b–d*, Loc. 1.

GYROGNATHUS? SUPERBUS n.sp.

(Figure 132, plate 21)

DIAGNOSIS. A stoutly constructed *Gyrognathus?*, the anterior and posterior bars having a pronounced vertical flexure but a feeble horizontal flexure; posterior aboral margin of apical denticle developed into a knob-like process. Denticles discrete, conical.

DESCRIPTION. Anterior and posterior bars having gentle lateral curvature, which, when seen in anterior view, makes them appear continuous with the laterally recurved apical denticle. Anterior and posterior bars sharply bent at apex, diverging at an angle of 60 to 80°; aboral surface deeply excavated; anterior bar bearing two or three, and the posterior bar bearing up to five, discrete, regularly spaced, subequal, conical denticles, subcircular in cross-section, tending to have slight lateral recurvature; the two uppermost denticles are confluent with, or very near to the base of, the apical denticle; apical denticle long, subcircular in cross-section pointed, recurved laterally; the outer lateral basal portion developed into a small rounded projection, the base of which is deeply excavated, being continuous with the aboral cavity below the apical denticle.

OCCURRENCE. Gelli-grin Limestone.

Holotype: CIC 4*a*. *Paratypes*: CIC 4*b–d*, CIE 3*b–d*, CIE 4*a*, Loc. 2.

REMARKS. One specimen from the Gelli-grin Limestone which is referred to this species shows a marked recurvature of the apical denticle (which points almost horizontally). The outer aboral lateral process is more elongated in a lateral direction but the aboral margin remains horizontal.

Genus *OZARKODINA* Branson & Mehl, 1933

Ozarkodina Branson & Mehl, 1933, p. 51.

TYPE SPECIES. *O. typica* Branson & Mehl.

Branson & Mehl's generic description:

'Compound dental units consisting of a thin, blade-like, denticulate arched bar with a denticle of superior size mid-length and approximately an equal number of parallel subequal smaller denticles on either side of it. Denticles laterally compressed, sharp-edged, more or less confluent to actually sheathed. Base excavated beneath large denticle.'

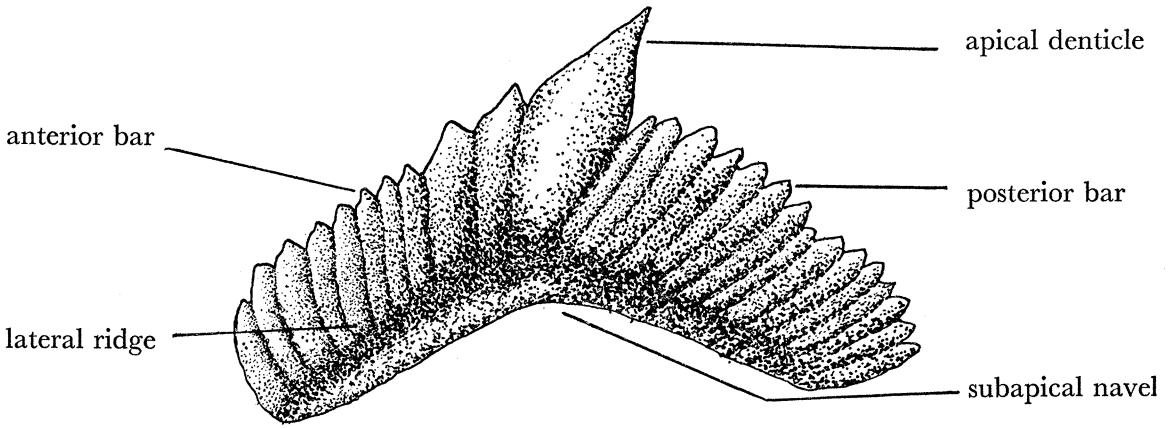


FIGURE 17. *Ozarkodina* sp. Lateral view. (Magn. approx. × 100.)

REMARKS. The feeble arching and the greater depth of the anterior end of the bar make it difficult to distinguish members of the species described below from the genus *Bryantodina*. Stauffer (1935*a*, p. 148), discussing the differences between *Bryantodina* and *Ozarkodina*, states that the latter genus may be distinguished by its arched base, greater similarity of the two bars, and its wide deep excavation beneath the cusp. Members of the present species completely bridge the gap between the two genera and may be equally well referred to either. It seems, therefore, that further collecting may involve a modification of the present conception of the two genera. The most convenient method may be to restrict the genus *Ozarkodina* to include those specimens in which the aboral surface is blade-like with a prominent subapical navel, and to refer all other specimens in which the excavation is extended longitudinally, irrespective of the degree of arching of the aboral margin or the depth of the anterior bar, to the genus *Bryantodina*.

OZARKODINA TENUIS Branson & Mehl, 1933

(Figures 187, 197 to 200, plate 22)

O. tenuis Branson & Mehl, 1933, p. 128, Pl. 10, figs. 19–21, 23.

O. tenuis Graves & Ellison, 1941, pp. 6–7, Pl. 3, figs. 3, 6.

Representatives of this species are common in the Llandeilo Limestone. Individuals of varying size show no appreciable variation in general characteristics and agree in all respects with Branson & Mehl's description.

OCCURRENCE. Llandeilo Limestone.

Figured specimens: CIIH1*a–d*, 2*a*, Loc. 1.

OZARKODINA TYPICA Branson & Mehl

(Figures 251, 261, 262, plate 23)

O. typica Branson & Mehl, 1933, p. 51, Pl. 3, figs. 43–45.

Branson & Mehl's description of the genus and of this species were based upon a number of incomplete specimens, and, although their figured specimens do not include any individual with a complete posterior bar, the specimens collected from the Aymestry Limestone show a very close similarity in form.

The species is common in the Aymestry, and the large number of unbroken specimens collected has enabled a careful study of the species to be made. The following description is therefore included.

DESCRIPTION. Base broadly arched at mid-length, the two bars diverging at an angle of about 135°; ends of bars spatulate. Whole unit thin and laterally compressed, with inner lateral face very slightly concave in a horizontal plane. Apical denticle conspicuous; basal width about four times that of minor denticles; situated at approximately the mid-point of unit; width increasing from base to level of tip of adjacent denticles, from which level it tapers sharply to a point; inner lateral face gently convex; outer lateral face flat or very feebly convex; sharp anterior and posterior edges; inclined posteriorly; the tip, in some specimens, inclined inwards. Minor denticles subequal, completely sheathed except for pointed apices; about eight to twelve on either side of main denticle, to which they tend to be parallel. Aboral surface unexpanded, excavated throughout its length by a very thin, but distinct, groove developed on either side of a prominent subapical navel around which, on most specimens, the aboral margins tend to be developed into a flange. Inner-lateral faces of some specimens bear a faint lateral ridge at mid-height, developed parallel to the base.

When viewed in transmitted light the germ denticles are seen to extend almost to the base of the unit. A number of specimens reveal the presence of suppressed denticles.

The main variation within the specimens referred to this species is in the length. In some specimens (e.g. figure 262, plate 23) the unit has the proportions of a roughly equilateral triangle in lateral view, but in others (e.g. figure 251, plate 23) the anterior and posterior bars are considerably elongated, although in all other features the individuals are similar.

OCCURRENCE. Aymestry Limestone.

Hypotypes: CIIA 1*a–d*, CIIA 2*a*, *b*, Loc. 4.

Genus *PLECTOSPATHODUS* Branson & Mehl, 1933

Plectospathodus Branson & Mehl, 1933, p. 47.

TYPE SPECIES. *P. flexuosus* Branson & Mehl.

Branson & Mehl's generic description:

'Compound dental units consisting of a thin, blade-like bar set with sharp-edged confluent "sheathed" denticles with a larger denticle near mid-length; denticles perpendicular to bar or slightly inclined to somewhat divergent. Blade down-curved at the ends and one end flexed along the basal plane of the unit and more or less twisted. Base slightly excavated.'

REMARKS. In establishing this genus Branson & Mehl described only one species. The only illustrations of this species are two figures of incomplete syntypes, and the specific description given is wide enough to apply to members of the genus here referred to three distinct species. Branson & Mehl note the considerable variation among specimens referred to the species *P. flexuosus*, and it is probable that a study of their specimens may show that some individuals, referred by them to this species, should be referred to one or other of the new species described below.

ORIENTATION. Although Branson & Mehl do not define the orientation of specimens it is clear from their specific description that they regard the bar as lying transversely to the jaw and being recurved posteriorly in a horizontal plane.

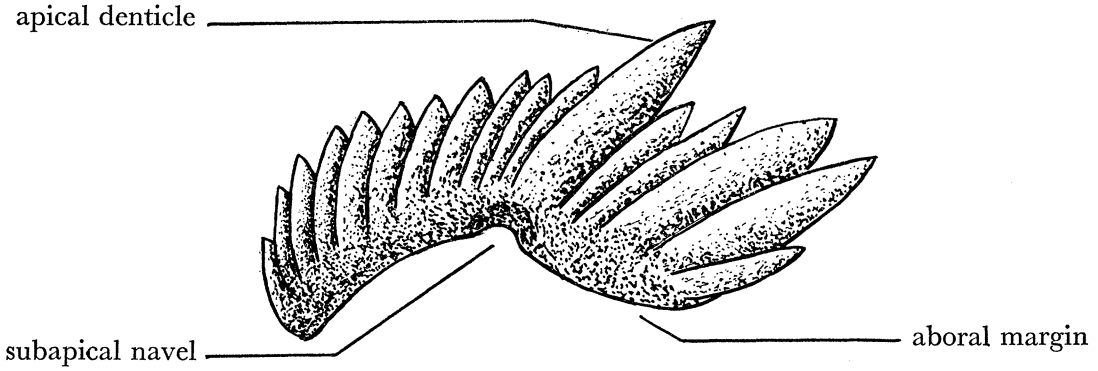


FIGURE 18. *Plectospathodus* sp. Posterior view. (Magn. approx. × 100.)

PLECTOSPATHODUS CONTRARIUS n.sp.

(Figures 225, 247, 249, 250, plate 23)

DIAGNOSIS. A *Plectospathodus* with deep, laterally compressed bars, diverging at an angle of 130 to 150° in a vertical plane and sharply flexed in a horizontal plane. Apical denticle conspicuous, long, pointed. Denticles of bars sheathed but their apices discrete, all tending to be inclined towards distal end of the longer bar (which bears the shorter series of denticles).

DESCRIPTION. Two thin, straight, deep, laterally compressed bars, diverging at an angle of 130 to 150° in a vertical plane. The bar bearing the apical denticle also bears eight or more sheathed, subequal denticles, lying subparallel to the apical denticle, their apices sharp, with convex anterior and posterior faces and sharp lateral edges, slightly inclined towards the distal end of the bar. Apical denticle conspicuous, long, pointed, about five times as wide at base as adjacent denticles, gently convex anterior and posterior faces, sharp lateral edges. Other lateral bar flexed sharply posteriorly at an angle of about 135°; oral surface bearing eight or more unequal, sheathed, slightly divergent denticles, all of which have a very gentle posterior recurvature at right angles to the axis of the bar; the denticles near the middle of the bar are the longest, having pointed discrete apices, convex faces and sharp lateral edges. Aboral margin of both bars straight; aboral surface thin, blade-like with a shallow, thin longitudinal groove and a shallow, inconspicuous, subcentral navel.

OCCURRENCE. Aymestry Limestone.

Holotype: CIIA 3*a*. *Paratypes*: CIIA 3*b–d*, CIIA 4*a*, Loc. 4.

REMARKS. From the specific description and figured specimens it appears that *Hindeodella confluens* Branson & Mehl might include this species, but, since the author has been unable to study Branson & Mehl's specimens, the present species is erected.

PLECTOSPATHODUS ELEGANS n.sp.

(Figures 255, 263, 264, plate 23)

DIAGNOSIS. A *Plectospathodus* with very deep laterally compressed bars and sheathed denticles with discrete apices. Gently bowed in a horizontal plane; lateral bars diverging at an angle of about 120° in a vertical plane. Median denticles of shorter bar the longest; all denticles tending to be inclined towards the distal end of this bar.

DESCRIPTION. Two thin, deep, laterally compressed bars, flexed at an angle of about 120° in a vertical plane. The shorter bar straight, bearing seven or more sheathed, unequal, slightly divergent, denticles, only the apices of which are discrete, with convex anterior and posterior faces and sharp lateral edges. Posterior base of apical denticle, which is included in the shorter bar, flared to give a basal navel. The fourth and fifth denticles of this shorter bar are the largest, being approximately equal in size to the apical denticle. The longer bar flexed posteriorly throughout its length, bearing eleven or more sheathed, subequal denticles, subparallel to apical denticle, their apices pointed, with convex anterior and posterior faces and sharp lateral edges. Aboral surface unexpanded and blade-like, unexcavated except for shallow subapical navel. Denticles slightly divergent but tending to point towards distal end of the shorter bar. Members of this species when viewed in transmitted light show that the denticles taper towards their base and extend almost to the aboral margin of the bars.

OCCURRENCE. Aymestry Limestone.

Holotype: CIIA 2*c*. *Paratypes*: CIIA 2*d*, CIIA 4*b–d*, Loc. 4.

PLECTOSPATHODUS EXTENSUS n.sp.

(Figures 236 to 240, plate 23)

DIAGNOSIS. A *Plectospathodus* with bars continuously curved in a vertical plane and slightly bowed in a horizontal plane. Denticles somewhat laterally compressed, partly sheathed, apices discrete, pointed, divergent, but those of the bar which bears the larger ones inclined towards its distal end; conspicuous subapical aboral lip.

DESCRIPTION. Two thin, deep, somewhat laterally compressed elongated bars, straight or continuously curved in a vertical plane and very gently bowed in a horizontal plane (anterior edge convex); faces of bars convex; oral surfaces bearing series of unequal, pointed, partly sheathed denticles, all of which have gently convex anterior and posterior faces and sharp lateral edges. Denticles of variable length, the largest, developed near the end of the bar towards which the denticles, are inclined, being about three times the size of the smallest. Apical denticle conspicuous, usually as large as, or only slightly smaller than, the largest of the other denticles; gently recurved posteriorly; posterior aboral margin developed into conspicuous lip. Aboral surface of unit blade-like, expanded below apical denticle where it is excavated by a shallow navel; a shallow longitudinal groove extends along its length.

OCCURRENCE. Aymestry Limestone.

Holotype: CIIA 4*d*. *Paratypes*: CIIA 5*a–c*, CIIB 2*b–d*, CIIE 3*a–d*, Loc. 4.

REMARKS. It will be noted from the figured specimens that the degree of vertical curvature of the bars shows considerable variation.

Genus *PRIONIODELLA* Ulrich & Bassler, 1926

Prioniodella Ulrich & Bassler, 1926, p. 18.

TYPE SPECIES. *P. normalis* Ulrich & Bassler.

Ulrich & Bassler's generic description:

'Like *Prioniodina* except that the denticles are subequal, none being particularly larger than the other.

'One end of the bar, supposed to be the posterior because of the slant of the denticles, is commonly produced into a blunt process. The denticles are always close, either discrete throughout or more or less coalescent, agreeing in the latter feature with *Bryantodus*. The lack of a readily distinguishable main cusp separates this genus from both *Prioniodina* and *Bryantodus*.'

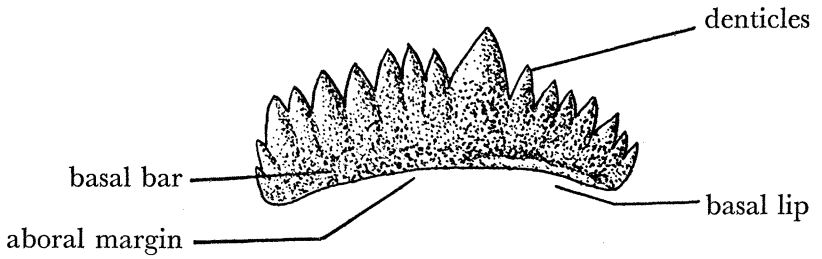


FIGURE 19. *Prioniodella* sp. Lateral view. (Magn. approx. × 100.)

PRIONIODELLA INCLINATA n.sp.

(Figures 233 to 235, plate 23)

DIAGNOSIS. A *Prioniodella* with deep basal bar, straight or gently arched in a vertical plane, with submedian aboral lip. Denticles laterally compressed, pointed, being largest in the median portion of the bar.

DESCRIPTION. Basal bar deep, ends spatulate in form, somewhat laterally flattened but stout; straight or gently arched in a vertical plane; gently bowed in a horizontal plane, so that the inner surface is concave; outer and inner lateral faces gently convex. Oral surface bearing eleven to thirteen stout, short denticles, confluent at base, their discrete apices approximately equal in length to the depth of the bar; denticles closely spaced, inclined slightly posteriorly; those in the middle half of the bar are slightly greater in width and height than those in the terminal portions; the eighth or ninth denticles from the anterior end usually slightly larger than the rest but not conspicuously so; denticles pointed, gently convex lateral faces, sharp anterior and posterior edges. Beneath the largest denticle, which is usually just posterior to the mid-point of the bar, the aboral margin is out-flexed horizontally to give a prominent lip on both the inner and outer sides. Aboral surface decreasing in width towards both ends, excavated throughout its length by a sharp, V-shaped, longitudinal groove which is deepest below the largest denticle.

OCCURRENCE. Aymestry Limestone.

Holotype: CIIC2*a*. *Paratypes*: CIIC2*b–d*, CIIC3*a–d*, Loc. 4.

REMARKS. Specimens referred to this species show some variation in the degree of curvature, in the relative size of the denticles and in the development of the aboral lip.

Genus *SPATHOGNATHODUS* Branson & Mehl, 1941

Spathodus Branson & Mehl, 1933, p. 46 (*non* Boulenger, 1900).
Spathognathodus Branson & Mehl, 1941, p. 98.

TYPE SPECIES. *S. primus* (Branson & Mehl).

Branson & Mehl's generic description:

'Compound, straight, blade-like dental units with nearly straight aboral margin, and oral margin curved or straight but highest at or near anterior end. A short lateral expansion near mid-length produces on the otherwise comparatively sharp aboral edge a cuplike excavation or navel....Oral edge or crest consisting of a single row of "germ denticles", evident in transmitted light, completely sheathed to form a continuous crenulate oral edge. Oral surface of mid-length basal expansion or navel typically smooth but in some species bearing one or a few separate denticles.'

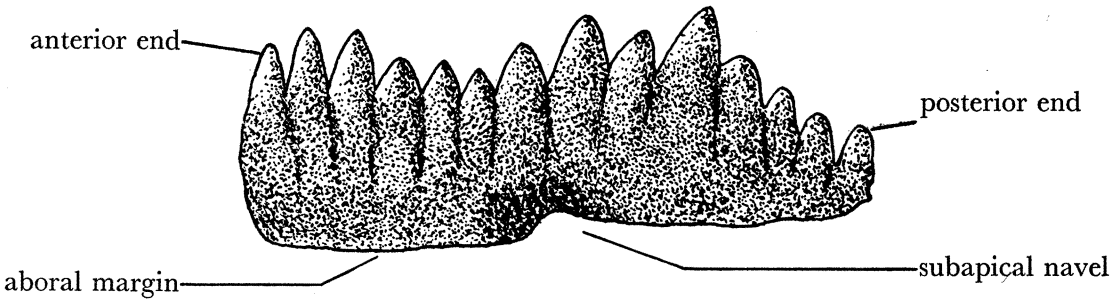


FIGURE 20. *Spathognathodus* sp. Lateral view. (Magn. approx. × 100.)

SPATHOGNATHODUS PRIMUS (Branson & Mehl)

(Figures 243, 256, 258, 259, plate 23)

Spathodus primus Branson & Mehl, 1933, p. 46, Pl. 3, figs. 25–30.
Spathognathodus primus Branson & Branson, 1947, p. 550, Pl. 81, fig. 2; Pl. 82, figs. 29, 36, 37.

This species is abundant in the Aymestry Limestone, and the many perfect specimens collected show a remarkable similarity in form both to one another and to Branson & Mehl's figured specimens. There is no apparent difference in form between young and mature individuals, but many of the larger specimens (e.g. figure 259) have fragments of flesh-coloured bone-like material attached to the aboral navel.

OCCURRENCE. Aymestry Limestone.
Figured specimens: CIIB 6*c*, *d*, CIIC 1*c*, *d*, Loc. 4.

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Description of plates 20 to 23

Catalogue numbers refer to specimens deposited in the Geology Department of the University of Birmingham

Plate 20

Conodonts from the Gelli-grin and Pen-y-garnedd Limestones. (Figures 42, 45, 46, 50 to 53, 57, 59, 60, 66, 68 to 70, 73, 79 to 81: ×41. All other figures: ×65.)

Figures 21 to 25. *Ambolodus elegans* n.sp.

21. Inner-lateral view of specimen CIK 1*c*.
22. Inner-lateral view of holotype CIB 6*b*.
23. Outer-lateral view of specimen CIK 1*d*.
24. Inner-lateral view of holotype CIB 6*b*.
25. Outer-lateral view of specimen CIK 1*c*.

Figures 26, 27, 32, 33. *Ambolodus robustus* n.sp.

26. Inner-lateral view of holotype CIB 5*a*.
27. Outer-lateral view of holotype CIB 5*a*.
32. Outer-lateral view of specimen CIK 1*a*.
33. Inner-lateral view of specimen CIK 1*a*.

Figures 28 to 31. *Ambolodus triangularis* Branson & Mehl

28. Inner-posterior lateral view of specimen CIK 4*c*.
29. Superior view of specimen CIK 4*b*.
30. Inner-lateral view of specimen CIK 4*b*.
31. Outer-lateral view of specimen CIK 4*c*.

FIGURE 34. *Bryantodina?* sp. Lateral view of specimen CIE 5*d*.

FIGURES 35 to 37, 56. *Ambolodus triangularis* var. *indentatus* n.var.

35. Outer-lateral view of paratype CIA 3*b*.
36. Inferior view of paratype CIA 3*b*.
37. Superior inner view of specimen CIK 3*c*.
56. Outer-lateral view of paratype CIL 2*a*.

FIGURES 38 to 41. *Ambolodus pulcher* n.sp.

38. Outer-lateral view of holotype CIK 2*a*.
39. Inner-lateral view of broken specimen CIF 1*a*.
40. Outer-lateral view of broken specimen CIF 1*a*.
41. Inner-lateral view of holotype CIK 2*a*.

FIGURES 42, 45, 46. *Amorphognathus complicatus* n.sp.

42. Superior lateral view of paratype CIL 1*d*.
45. Inferior view of holotype CIH 5*b*.
46. Superior view of holotype CIH 5*b*.

FIGURES 43, 44, 55. *Gyrognathus superbus* n.sp.

43, 44. Lateral views of paratype CIE 3*d*.
55. Lateral view of paratype CIE 4*b*.

FIGURES 47 to 49. *Amorphognathus ordovicicus* Branson & Mehl.

47. Superior view of hypotype CIA 1*c*.
48. Superior view of hypotype CIA 1*a*.
49. Inferior view of hypotype CIA 1*a*.

FIGURES 50 to 53, 57. *Balognathus expansus* n.sp.

50. Superior view of holotype CIB 3*b*.
51. Superior view of paratype CIB 2*a*.
52. Inner-lateral view of holotype CIB 3*b*.
53. Superior outer-lateral view of paratype CIB 2*a*.
57. Outer-interior lateral view of holotype CIB 3*b*.

FIGURES 54, 58, 62, 63, 65, 78. *Icriodella superba* n.sp.

54. Superior view of paratype CIB 1*a*.
58. Outer-lateral view of paratype CIB 1*a*.
62. Superior view of holotype CIA 6*a*.
63. Outer-lateral view of holotype CIA 6*a*.
65. Outer-lateral view of specimen CIK 6*b*.
78. Inner-lateral view of holotype CIA 6*a*.

FIGURES 59, 60, 64, 66, 71 to 73, 77. *Icriodella superba* var. *acuta* n.sp. et var.

59. Outer inferior lateral view of holotype CIA 6*b*.
60. Superior view of holotype CIA 6*b*.
64. Superior view of specimen CIH 6*a*.
66. Superior outer lateral view of holotype CIA 6*b*.
71. Inner-lateral view of specimen CIH 6*a*.
72. Inferior view of specimen CIH 6*a*.
73. Inferior inner-lateral view of holotype CIA 6*b*.
77. Outer-lateral view of specimen CIH 6*a*.

FIGURE 61. *Icriodella* sp. Superior outer-lateral view of specimen CIF 1*b*.

FIGURES 67, 74, 76. *Icriodella plana* n.sp.

67. Outer-lateral view of holotype CIF 1*c*.
74. Superior view of holotype CIF 1*c*.
76. Inner-lateral view of holotype CIF 1*c*.

FIGURES 68 to 70. *Icriodella deforma* n.sp.

68. Inner-lateral view of holotype CIB 1*b*.
69. Superior view of holotype CIB 1*b*.
70. Outer-lateral view of holotype CIB 1*b*.

FIGURES 79 to 81. *Icriodella elongata* n.sp.

79. Superior view of holotype CIF 1*d*.
80. Outer-lateral view of holotype CIF 1*d*.
81. Inferior inner-lateral view of holotype CIF 1*d*.

PLATE 21

Conodonts from the Gelli-grin and Pen-y-garnedd Limestones.
Figures 82, 89, 90, 137, 138, 141 to 143, 151, 152: ×41. All other figures: ×65.

FIGURES 82, 83, 89, 90. *Oistodus curvatus* Branson & Mehl.

82. Lateral view of specimen CIG 5*c*.
83. Lateral view of specimen CIG 4*d*.
89. Lateral view of specimen CIG 5*b*.
90. Lateral view of specimen CIG 5*a*.

FIGURES 84 to 88. *Paltodus unicostatus* Branson & Mehl.

84, 88. Lateral views of specimen CIG 2*d*.
85. Lateral view of specimen CIG 2*b*.
86. Lateral view of specimen CIG 2*a*.
87. Lateral view of specimen CIG 2*c*.

FIGURES 91, 92. *Oistodus abundans* Branson & Mehl.

91. Superior lateral view of specimen CIG 6*b*.
92. Lateral view of specimen CIG 6*a*.

FIGURES 93, 94. *Oistodus suberectus* Branson & Mehl. Lateral views of specimen CIF 2*b*.

FIGURES 95, 96. *Oistodus breviconus* Branson & Mehl. Lateral views of specimen CIF 2*a*.

FIGURES 97 to 99. *Drepanodus similaris* n.sp.

97. Lateral view of holotype CIH 2*a*.
98, 99. Lateral views of specimen CIH 3*b*.

FIGURES 100, 101. *Drepanodus striatus* Graves & Ellison. Lateral views of specimen CIH 5*a*.

FIGURES 102 to 105. *Drepanodus altipes* Henningsmoen.

102. Lateral view of specimen CIH 1*c*.
103. Lateral view of specimen CIH 1*a*.
104. Lateral view of specimen CIJ 4*d*.
105. Lateral view of specimen CIJ 4*c*.

FIGURES 106 to 109. *Paltodus equicostatus* n.sp.

106, 108. Lateral views of paratype CIG 4*c*.
107, 109. Lateral views of holotype CIG 4*a*.

FIGURE 110. *Drepanodus arcuatus* Pander. Lateral view of specimen CIJ 5*a*.

FIGURES 111, 112. *Paltodus acostatus* Branson & Branson. Lateral views of specimen CIG 3*d*

FIGURE 113. *Cordylodus geniculatus* n.sp. Outer-lateral view of holotype CID 3*b*.

FIGURES 114 to 118. *Cordylodus elongatus* n.sp.

114. Outer-lateral view of holotype CIC 6*a*.
115. Inner-lateral view of holotype CIC 6*a*.
116. Outer-lateral view of paratype CID 2*a*.
117. Outer-lateral view of paratype CIC 6*c*.
118. Outer-lateral view of paratype CID 1*b*.

FIGURES 119, 121, 123. *Lonchodus distans* (Smith.)

119. Lateral view of specimen CIH 6*d*.
121. Lateral view of specimen CIH 6*c*.
123. Lateral view of specimen CIE 1*b*.

FIGURE 120. (?) *Lonchodus* sp. Lateral view of specimen CIE 1*a*.

FIGURE 122. *Lonchodus dentatus* Stauffer. Lateral view of specimen CID 4*a*.

FIGURES 124, 140, 145, 146. *Trichonodella divaricata* n.sp.

124. Posterior lateral view of paratype CIJ 2*d*.
140. Anterior lateral view of paratype CIJ 2*c*
145. Anterior lateral view of paratype CIJ 4*a*.
146. Posterior lateral view of paratype CIJ 4*a*.

FIGURES 125 to 127. *Holodontus superbus* n.sp.

125. Outer-lateral view of holotype CIF 6*a*.
126, 127. Inner-lateral views of holotype CIF 6*a*.

FIGURES 128, 129. *Ligonodina extensa* n.sp.

128. Outer-lateral view of holotype CIE 3*a*.
129. Inner-lateral view of holotype CIE 3*a*.

FIGURES 130, 131. *Ligonodina elongata* n.sp.

130. Inner-lateral view of holotype CID 6*d*.
131. Outer-lateral view of holotype CID 6*d*.

FIGURE 132. *Gyrognathus? superbus* n.sp. Lateral view of paratype CIC 4*d*.

FIGURE 133. *Cordylodus? spurius* Branson & Mehl. Outer-lateral view of specimen CID 2*b*.

FIGURES 134, 135. *Stereoconus maximus* n.sp. Lateral views of holotype CIG 6*b*.

FIGURES 136, 153, 154. *Phragmodus insculptus* Branson & Mehl.

136. Lateral view of specimen CIG 1*c*.
153, 154. Lateral views of specimen CIG 1*a*.

FIGURES 137, 138. *Sagittodontus robustus* var. *distaflexus* n.gen., sp. et var. Lateral views of holotype CIA 4*d*.

FIGURE 139. *Gyrognathus?* sp. Lateral view of specimen CIE 5*a*.

FIGURES 141, 142. *Sagittodontus robustus* n.sp. Lateral views of holotype CIA 4*a*.

FIGURES 143, 151, 152. *Sagittodontus robustus* var. *erectus* n.sp. et var.

143. Lateral view of paratype CIA 5*a*.
151, 152. Lateral views of holotype CIA 4*b*.

FIGURES 144, 147 to 150. *Trichonodella gracilis* n.sp.

144. Lateral view of holotype CIC 1*a*.
147. Anterior lateral view of paratype CIC 2*d*.
148. Anterior lateral view of paratype CIC 1*c*.
149. Posterior lateral view of paratype CIC 1*c*.
150. Lateral view of paratype CIC 1*c*.

PLATE 22

Conodonts from the Llandeilo Limestone
All figures × 65

FIGURES 155, 156. *Paltodus unicostatus* Branson & Mehl. Lateral views of specimen CIK 1*a*.

FIGURES 157 to 161. *Oistodus curvatus* Branson & Mehl.

157, 161. Lateral views of specimen CIIH 3*a*.
158. Lateral view of specimen CIIH 3*d*.
159. Lateral view of specimen CIIJ 3*a*.
160. Lateral view of specimen CIIH 4*b*.

FIGURES 162, 165. *Paltodus equicostatus* n.sp. Lateral views of specimen CIIH 6*c*.

FIGURES 163, 164. *Paltodus acostatus* Branson & Branson. Lateral views of specimen CIIJ 1*a*.

FIGURES 166, 167. *Oistodus suberectus* Branson & Mehl.

166. Lateral view of specimen CIIH 4*d*.
167. Lateral view of specimen CIIH 4*a*.

FIGURES 168 to 170. *Oistodus venustus* Stauffer.

168. Lateral view of specimen CIIH 2*b*.
169. Superior lateral view of specimen CIIH 2*d*.
170. Lateral view of specimen CIIH 2*d*.

FIGURES 171, 203. *Ambolodus* sp.

171. Inferior inner lateral view of specimen CIIK 4*b*.
203. Superior inner lateral view of specimen CIIK 4*b*.

FIGURES 172 to 175. *Cordylodus rectilineatus* (Stauffer).

172. Lateral view of specimen CIIG 2*b*.
173. Lateral view of specimen CIIG 3*a*.
174. Lateral view of specimen CIIG 3*b*.
175. Lateral view of specimen CIIG 2*d*.

FIGURES 176, 177, 186. *Trichonodella inclinata* n.sp.

176. Lateral view of paratype CIIK 3*c*.
177. Posterior view of paratype CIIK 3*c*.
186. Anterior lateral view of paratype CIIK 3*c*.

FIGURES 178 to 180. *Dichognathus* cf. *D. typicus* Branson & Mehl.

178. Anterior lateral view of specimen CIIK 6*a*.
179. Outer (?) lateral view of specimen CIIK 6*a*.
180. Inner (?) lateral view of specimen CIIK 6*a*.

FIGURES 181 to 183, 188, 189, 191, 192. *Trichonodella flexa* n.sp.

181. Posterior view of paratype CIIG 6*d*.
182. Posterior lateral view of paratype CIIG 6*a*.
183. Posterior view of paratype CIIG 4*c*.
188. Anterior view of holotype CIIG 4*a*.
189. Posterior view of holotype CIIG 4*a*.
191. Posterior view of paratype CIIG 4*d*.
192. Posterior view of paratype CIIG 6*a*.

FIGURES 184, 185. *Ligonodina valma* n.sp.

184. Inner lateral view of holotype CIIK 2*a*.
185. Outer lateral view of paratype CIIK 2*d*.

FIGURES 187, 197 to 200. *Ozarkodina tenuis* Branson & Mehl.

187. Lateral view of specimen CIIH 1*b*.
197. Lateral view of specimen CIIH 1*d*.
198. Lateral view of specimen CIIH 1*c*.
199. Lateral view of specimen CIIH 2*a*.
200. Lateral view of specimen CIIH 1*a*.

FIGURE 190. *Trichonodella* sp. Posterior view of specimen CIIK 4*d*.

FIGURES 193 to 196. *Cyrtoniodus complicatus* Stauffer.

193. Lateral view of specimen CIIH 5*b*.
194. Lateral view of specimen CIIH 5*c*.
195. Lateral view of specimen CIIH 5*a*.
196. Lateral view of specimen CIIG 1*a*.

FIGURES 201, 202, 205, 206. *Gyrognathus elongatus* n.sp.

201. Lateral view of paratype CIIK 5*c*.
202. Lateral view of paratype CIIK 5*b*.
205, 206. Lateral views of holotype CIIK 5*a*.

FIGURE 204. *Amorphognathus inaequalis* n.sp. Superior lateral view of holotype CIIK 4*a*.

PLATE 23

Conodonts from the Aymestry Limestone
All figures × 41

FIGURES 207, 208, 210, 211. *Distomodus suberectus* n.sp.

207. Anterior view of paratype CIID 3*c*.
208. Anterior view of paratype CIID 3*d*.
210. Posterior view of paratype CIID 3*c*.
211. Posterior lateral view of paratype CIID 3*d*.

FIGURES 209, 226 to 228. *Distomodus curvatus* n.sp.

209. Lateral view of paratype CIID 4*d*.
226. Posterior view of paratype CIID 4*d*.
227. Lateral view of paratype CIID 4*b*.
228. Posterior lateral view of paratype CIID 4*d*.

FIGURES 212, 213. *Paltodus acostatus* Branson & Branson. Lateral views of specimen CIIC 4*d*.

FIGURES 214 to 216. *Paltodus unicostatus* Branson & Mehl.

214. Lateral view of specimen CIIC 5*a*.
215, 216. Lateral views of specimen CIIC 5*d*.

FIGURES 217, 218, 229, 230. *Distomodus curvatus* var. *dentatus* n.sp. and var.

217. Anterior view of holotype CIID 6*a*.
218. Posterior lateral view of holotype CIID 6*a*.
229. Lateral view of paratype CIID 6*b*.
230. Inferior lateral view of holotype CIID 6*a*.

FIGURES 219, 220. *Paltodus recurvatus* n.sp. Lateral views of paratype CIID 1*c*.

FIGURES 221 to 224. *Cordylodus* (?) *dubius* n.sp.

221, 223. Lateral views of holotype CIIE 2*a*.
222. Posterior view of holotype CIIE 2*a*.
224. Lateral view of paratype CIIE 2*c*.

FIGURES 225, 247, 249, 250. *Plectospathodus contrarius* n.sp.

225. Posterior view of paratype CIIA 3*c*.
247. Posterior view of paratype CIIA 3*d*.
249. Anterior view of paratype CIIA 3*b*.
250. Posterior view of paratype CIIA 3*b*.

FIGURES 231, 241, 242. *Trichonodella aboroflexa* n.sp.

231. Anterior view of holotype CIIB 1*a*.
241. Posterior lateral view of paratype CIIB 1*b*.
242. Posterior view of holotype CIIB 1*a*.

FIGURES 232, 246. *Trichonodella symmetrica* Branson & Mehl.

232. Posterior view of specimen CIIA 6*a*.
246. Anterior view of specimen CIIA 6*b*.

FIGURES 233 to 235. *Prioniodella inclinata* n.sp.

233. Lateral view of paratype CIIC 2*c*.
234. Lateral view of paratype CIIC 2*b*.
235. Lateral view of paratype CIIC 3*a*.

FIGURES 236 to 240. *Plectospathodus extensus* n.sp.

236. Anterior view of paratype CIIB 2*b*.
237. Posterior view of paratype CIIB 2*d*.
238. Posterior view of paratype CIIB 2*b*.
239. Posterior view of paratype CIIB 2*a*.
240. Posterior view of paratype CIIA 5*c*.

FIGURES 243, 256, 258, 259. *Spathognathodus primus* (Branson & Mehl.)

243. Lateral view of specimen CIIC 1*c*.
256. Lateral view of specimen CIIC 1*d*.
258. Lateral view of specimen CIIB 6*c*.
259. Lateral view of specimen showing bone-like material attached to its aboral margin CIIB 6*d*.

FIGURE 244. *Ozarkodina* sp. Lateral view of specimen CIID 5*d*.

FIGURES 245, 257, 260. *Ligonodina salopia* n.sp.

245. Outer lateral view of paratype CIIB 5*b*.
257. Inner lateral view of paratype CIIB 5*b*.
260. Inner lateral view of holotype CIIB 5*a*.

FIGURES 248, 252 to 254. *Hindeodella equidentata* n.sp.

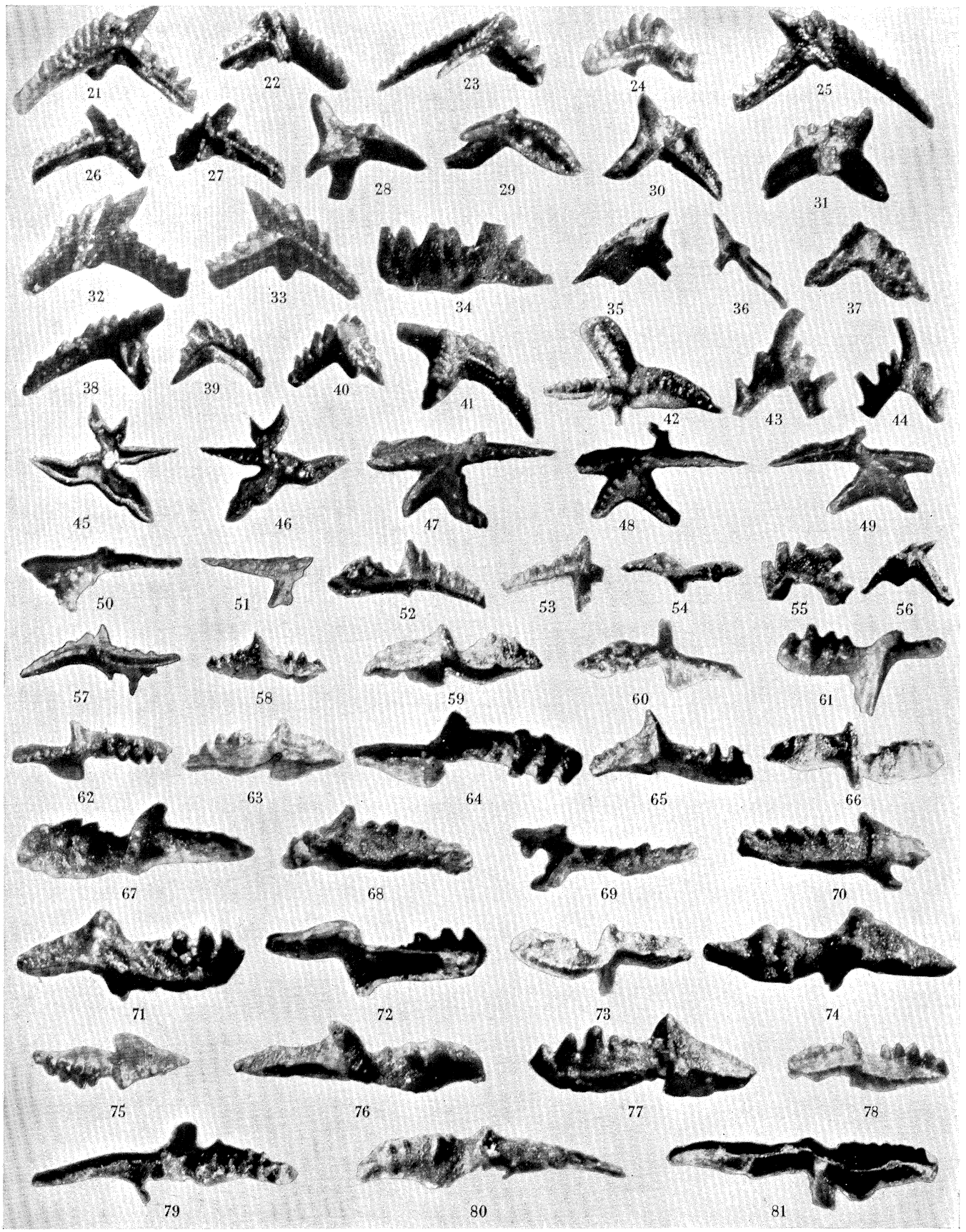
248. Outer lateral view of holotype CIIB 3*a*.
252. Inner lateral view of paratype CIIB 4*b*.
253. Inner lateral view of holotype CIIB 3*a*.
254. Superior view of holotype CIIB 3*a*.

FIGURES 251, 261, 262. *Ozarkodina typica* Branson & Mehl.

251. Lateral view of specimen CIIA 1*b*.
261. Lateral view of specimen CIIA 1*a*.
262. Lateral view of specimen CIIA 1*c*.

FIGURES 255, 263, 264. *Plectospathodus elegans* n.sp.

255. Posterior view of paratype CIIA 4*c*.
263. Anterior view of holotype CIIA 2*c*.
264. Posterior view of holotype CIIA 2*c*.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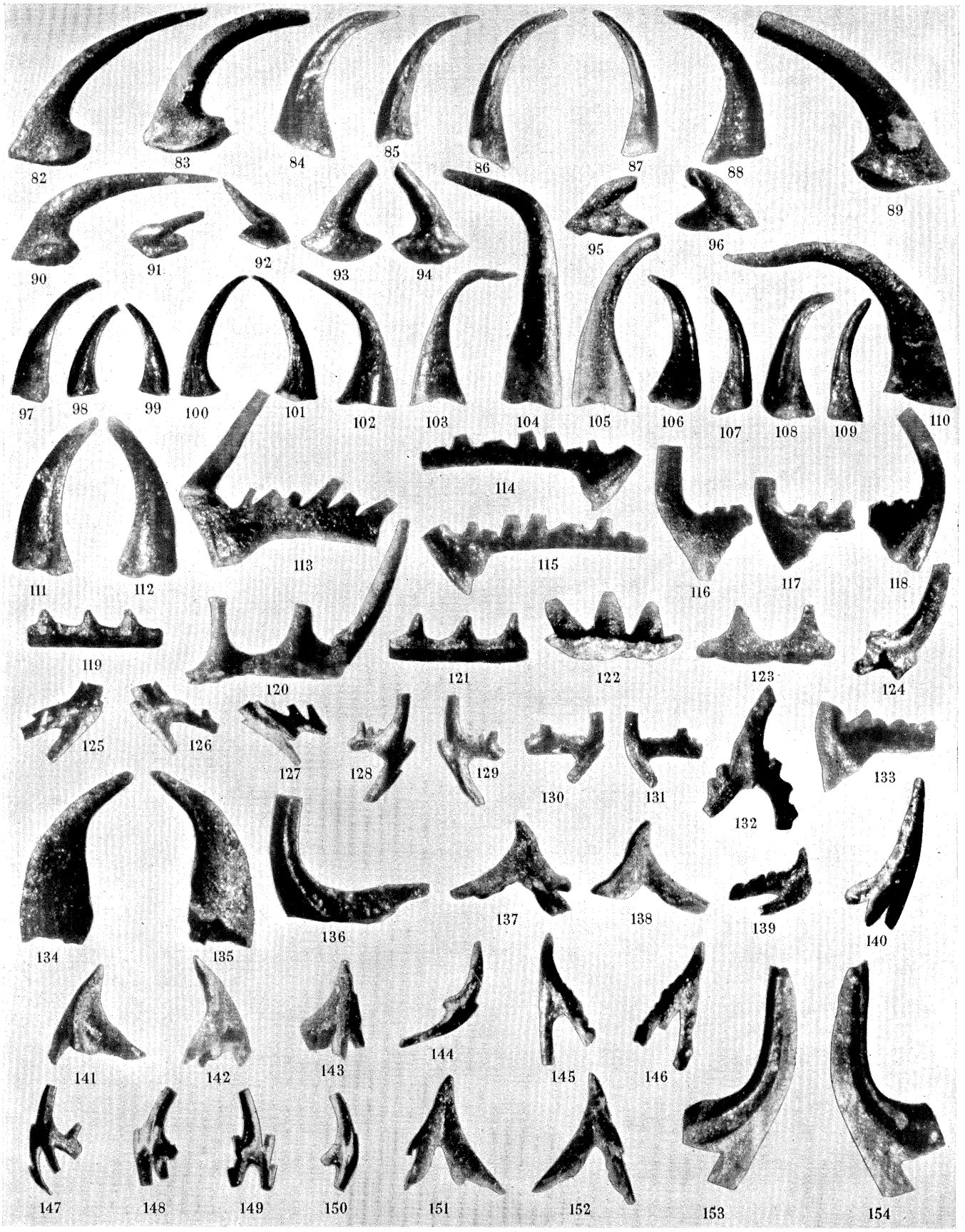
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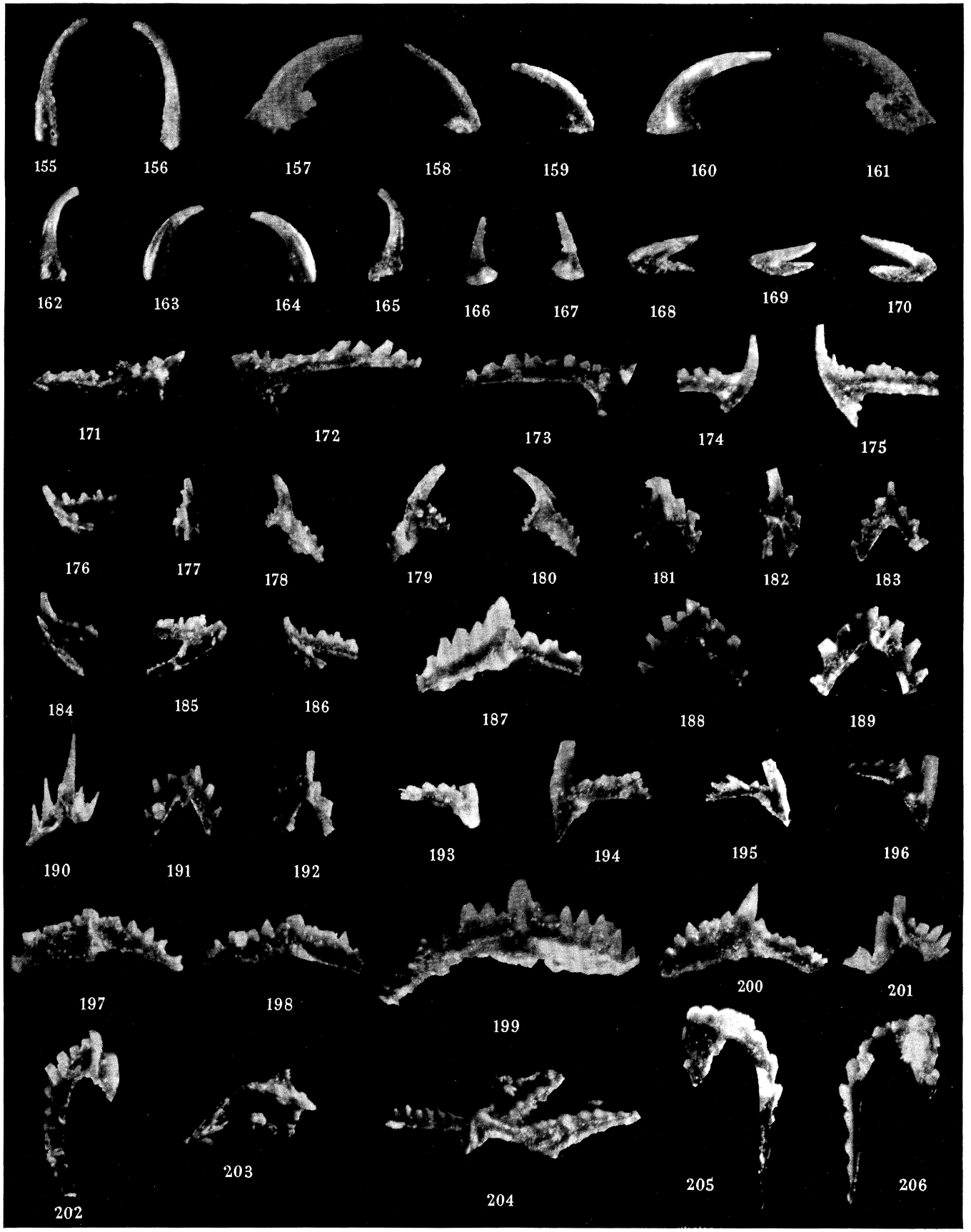
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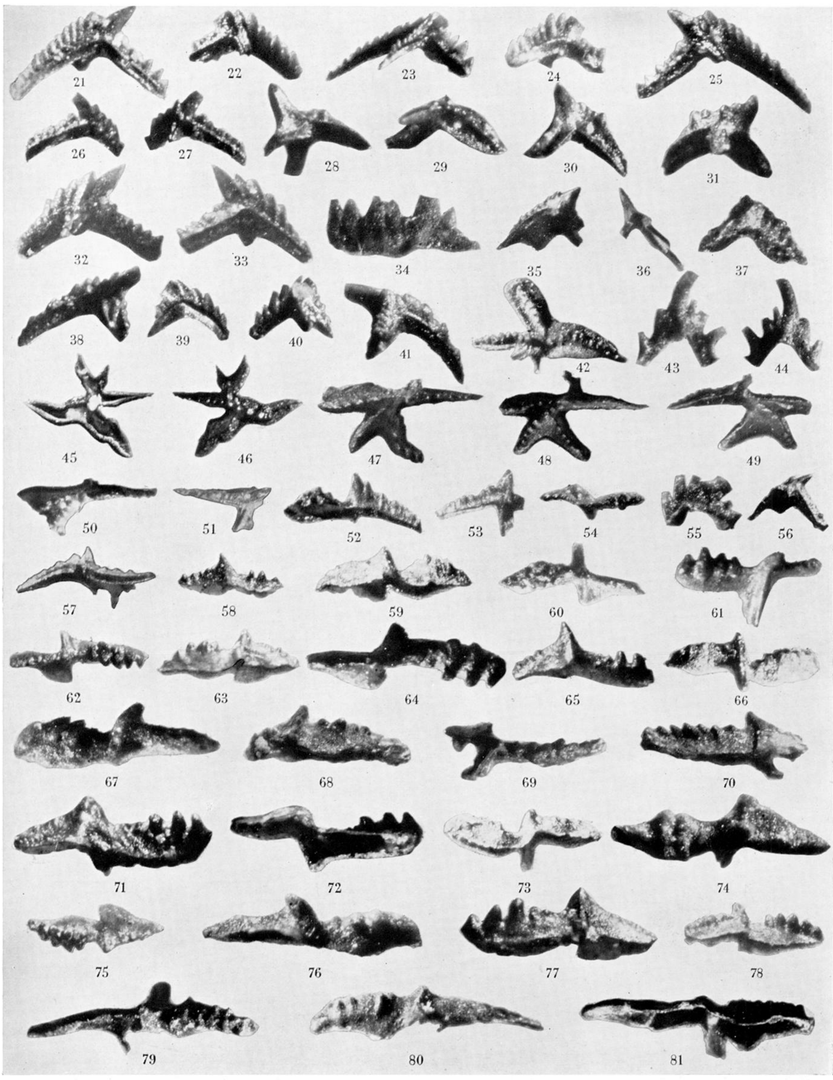

PLATE 20

Conodonts from the Gelli-grin and Pen-y-garnedd Limestones. (Figures 42, 45, 46, 50 to 53, 57, 59, 60, 66, 68 to 70, 73, 79 to 81: ×41. All other figures: ×65.)

FIGURES 21 to 25. *Ambolodus elegans* n.sp.

21. Inner-lateral view of specimen CIK 1*c*.
22. Inner-lateral view of holotype CIB 6*b*.
23. Outer-lateral view of specimen CIK 1*d*.
24. Inner-lateral view of holotype CIB 6*b*.
25. Outer-lateral view of specimen CIK 1*c*.

FIGURES 26, 27, 32, 33. *Ambolodus robustus* n.sp.

26. Inner-lateral view of holotype CIB 5*a*.
27. Outer-lateral view of holotype CIB 5*a*.
32. Outer-lateral view of specimen CIK 1*a*.
33. Inner-lateral view of specimen CIK 1*a*.

FIGURES 28 to 31. *Ambolodus triangularis* Branson & Mehl

28. Inner-posterior lateral view of specimen CIK 4*c*.
29. Superior view of specimen CIK 4*b*.
30. Inner-lateral view of specimen CIK 4*b*.
31. Outer-lateral view of specimen CIK 4*c*.

FIGURE 34. *Bryantodina?* sp. Lateral view of specimen CIE 5*d*.

FIGURES 35 to 37, 56. *Ambolodus triangularis* var. *indentatus* n.var.

35. Outer-lateral view of paratype CIA 3*b*.
36. Inferior view of paratype CIA 3*b*.
37. Superior inner view of specimen CIK 3*c*.
56. Outer-lateral view of paratype CIL 2*a*.

FIGURES 38 to 41. *Ambolodus pulcher* n.sp.

38. Outer-lateral view of holotype CIK 2*a*.
39. Inner-lateral view of broken specimen CIF 1*a*.
40. Outer-lateral view of broken specimen CIF 1*a*.
41. Inner-lateral view of holotype CIK 2*a*.

FIGURES 42, 45, 46. *Amorphognathus complicatus* n.sp.

42. Superior lateral view of paratype CIL 1*d*.
45. Inferior view of holotype CIH 5*b*.
46. Superior view of holotype CIH 5*b*.

FIGURES 43, 44, 55. *Gyrognathus superbus* n.sp.

43, 44. Lateral views of paratype CIE 3*d*.
55. Lateral view of paratype CIE 4*b*.

FIGURES 47 to 49. *Amorphognathus ordovicicus* Branson & Mehl.

47. Superior view of hypotype CIA 1*c*.
48. Superior view of hypotype CIA 1*a*.
49. Inferior view of hypotype CIA 1*a*.

FIGURES 50 to 53, 57. *Balognathus expansus* n.sp.

50. Superior view of holotype CIB 3*b*.
51. Superior view of paratype CIB 2*a*.
52. Inner-lateral view of holotype CIB 3*b*.
53. Superior outer-lateral view of paratype CIB 2*a*.
57. Outer-interior lateral view of holotype CIB 3*b*.

FIGURES 54, 58, 62, 63, 65, 78. *Icriodella superba* n.sp.

54. Superior view of paratype CIB 1*a*.
58. Outer-lateral view of paratype CIB 1*a*.
62. Superior view of holotype CIA 6*a*.
63. Outer-lateral view of holotype CIA 6*a*.
65. Outer-lateral view of specimen CIK 6*b*.
78. Inner-lateral view of holotype CIA 6*a*.

FIGURES 59, 60, 64, 66, 71 to 73, 77. *Icriodella superba* var. *acuta* n.sp. et var.

59. Outer inferior lateral view of holotype CIA 6*b*.
60. Superior view of holotype CIA 6*b*.
64. Superior view of specimen CIH 6*a*.
66. Superior outer lateral view of holotype CIA 6*b*.
71. Inner-lateral view of specimen CIH 6*a*.
72. Inferior view of specimen CIH 6*a*.
73. Inferior inner-lateral view of holotype CIA 6*b*.
77. Outer-lateral view of specimen CIH 6*a*.

FIGURE 61. *Icriodella* sp. Superior outer-lateral view of specimen CIF 1*b*.

FIGURES 67, 74, 76. *Icriodella plana* n.sp.

67. Outer-lateral view of holotype CIF 1*c*.
74. Superior view of holotype CIF 1*c*.
76. Inner-lateral view of holotype CIF 1*c*.

FIGURES 68 to 70. *Icriodella deforma* n.sp.

68. Inner-lateral view of holotype CIB 1*b*.
69. Superior view of holotype CIB 1*b*.
70. Outer-lateral view of holotype CIB 1*b*.

FIGURES 79 to 81. *Icriodella elongata* n.sp.

79. Superior view of holotype CIF 1*d*.
80. Outer-lateral view of holotype CIF 1*d*.
81. Inferior inner-lateral view of holotype CIF 1*d*.

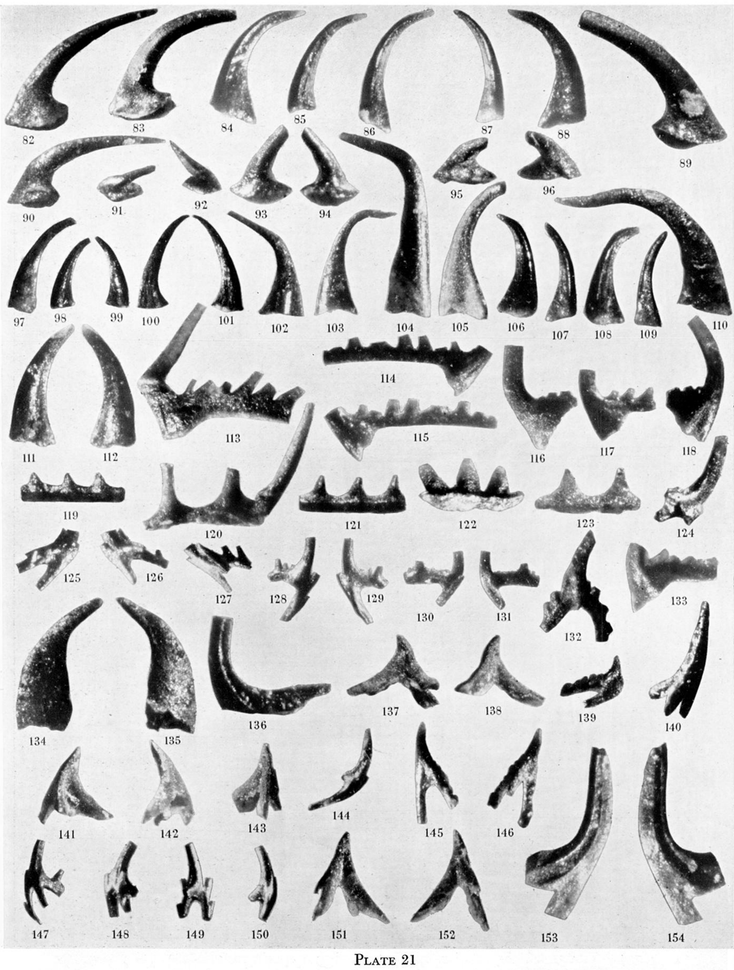

PLATE 21

Conodonts from the Gelli-grin and Pen-y-garnedd Limestones.
Figures 82, 89, 90, 137, 138, 141 to 143, 151, 152: × 41. All other figures: × 65.

FIGURES 82, 83, 89, 90. *Oistodus curvatus* Branson & Mehl.

82. Lateral view of specimen CIG 5*c*.
83. Lateral view of specimen CIG 4*d*.
89. Lateral view of specimen CIG 5*b*.
90. Lateral view of specimen CIG 5*a*.

FIGURES 84 to 88. *Paltodus unicostatus* Branson & Mehl.

84, 88. Lateral views of specimen CIG 2*d*.
85. Lateral view of specimen CIG 2*b*.
86. Lateral view of specimen CIG 2*a*.
87. Lateral view of specimen CIG 2*c*.

FIGURES 91, 92. *Oistodus abundans* Branson & Mehl.

91. Superior lateral view of specimen CIG 6*b*.
92. Lateral view of specimen CIG 6*a*.

FIGURES 93, 94. *Oistodus suberectus* Branson & Mehl. Lateral views of specimen CIF 2*b*.

FIGURES 95, 96. *Oistodus breviconus* Branson & Mehl. Lateral views of specimen CIF 2*a*.

FIGURES 97 to 99. *Drepanodus similaris* n.sp.

97. Lateral view of holotype CIH 2*a*.
98, 99. Lateral views of specimen CIH 3*b*.

FIGURES 100, 101. *Drepanodus striatus* Graves & Ellison. Lateral views of specimen CIH 5*a*.

FIGURES 102 to 105. *Drepanodus altipes* Henningsmoen.

102. Lateral view of specimen CIH 1*c*.
103. Lateral view of specimen CIH 1*a*.
104. Lateral view of specimen CIJ 4*d*.
105. Lateral view of specimen CIJ 4*c*.

FIGURES 106 to 109. *Paltodus equicostatus* n.sp.

106, 108. Lateral views of paratype CIG 4*c*.
107, 109. Lateral views of holotype CIG 4*a*.

FIGURE 110. *Drepanodus arcuatus* Pander. Lateral view of specimen CIJ 5*a*.

FIGURES 111, 112. *Paltodus acostatus* Branson & Branson. Lateral views of specimen CIG 3*d*

FIGURE 113. *Cordylodus geniculatus* n.sp. Outer-lateral view of holotype CID 3*b*.

FIGURES 114 to 118. *Cordylodus elongatus* n.sp.

114. Outer-lateral view of holotype CIC 6*a*.
115. Inner-lateral view of holotype CIC 6*a*.
116. Outer-lateral view of paratype CID 2*a*.
117. Outer-lateral view of paratype CIC 6*c*.
118. Outer-lateral view of paratype CID 1*b*.

FIGURES 119, 121, 123. *Lonchodus distans* (Smith.)

119. Lateral view of specimen CIH 6*d*.
121. Lateral view of specimen CIH 6*c*.
123. Lateral view of specimen CIE 1*b*.

FIGURE 120. (?) *Lonchodus* sp. Lateral view of specimen CIE 1*a*.

FIGURE 122. *Lonchodus dentatus* Stauffer. Lateral view of specimen CID 4*a*.

FIGURES 124, 140, 145, 146. *Trichonodella divaricata* n.sp.

124. Posterior lateral view of paratype CIJ 2*d*.
140. Anterior lateral view of paratype CIJ 2*c*
145. Anterior lateral view of paratype CIJ 4*a*.
146. Posterior lateral view of paratype CIJ 4*a*.

FIGURES 125 to 127. *Holodontus superbus* n.sp.

125. Outer-lateral view of holotype CIF 6*a*.
126, 127. Inner-lateral views of holotype CIF 6*a*.

FIGURES 128, 129. *Ligonodina extensa* n.sp.

128. Outer-lateral view of holotype CIE 3*a*.
129. Inner-lateral view of holotype CIE 3*a*.

FIGURES 130, 131. *Ligonodina elongata* n.sp.

130. Inner-lateral view of holotype CID 6*d*.
131. Outer-lateral view of holotype CID 6*d*.

FIGURE 132. *Gyrognathus? superbus* n.sp. Lateral view of paratype CIC 4*d*.

FIGURE 133. *Cordylodus? spurius* Branson & Mehl. Outer-lateral view of specimen CID 2*b*.

FIGURES 134, 135. *Stereoconus maximus* n.sp. Lateral views of holotype CIG 6*b*.

FIGURES 136, 153, 154. *Phragmodus insculptus* Branson & Mehl.

136. Lateral view of specimen CIG 1*c*.
153, 154. Lateral views of specimen CIG 1*a*.

FIGURES 137, 138. *Sagittodontus robustus* var. *distaflexus* n.gen., sp. et var.
Lateral views of holotype CIA 4*d*.

FIGURE 139. *Gyrognathus?* sp. Lateral view of specimen CIE 5*a*.

FIGURES 141, 142. *Sagittodontus robustus* n.sp. Lateral views of holotype CIA 4*a*.

FIGURES 143, 151, 152. *Sagittodontus robustus* var. *erectus* n.sp. et var.

143. Lateral view of paratype CIA 5*a*.
151, 152. Lateral views of holotype CIA 4*b*.

FIGURES 144, 147 to 150. *Trichonodella gracilis* n.sp.

144. Lateral view of holotype CIC 1*a*.
147. Anterior lateral view of paratype CIC 2*d*.
148. Anterior lateral view of paratype CIC 1*c*.
149. Posterior lateral view of paratype CIC 1*c*.
150. Lateral view of paratype CIC 1*c*.

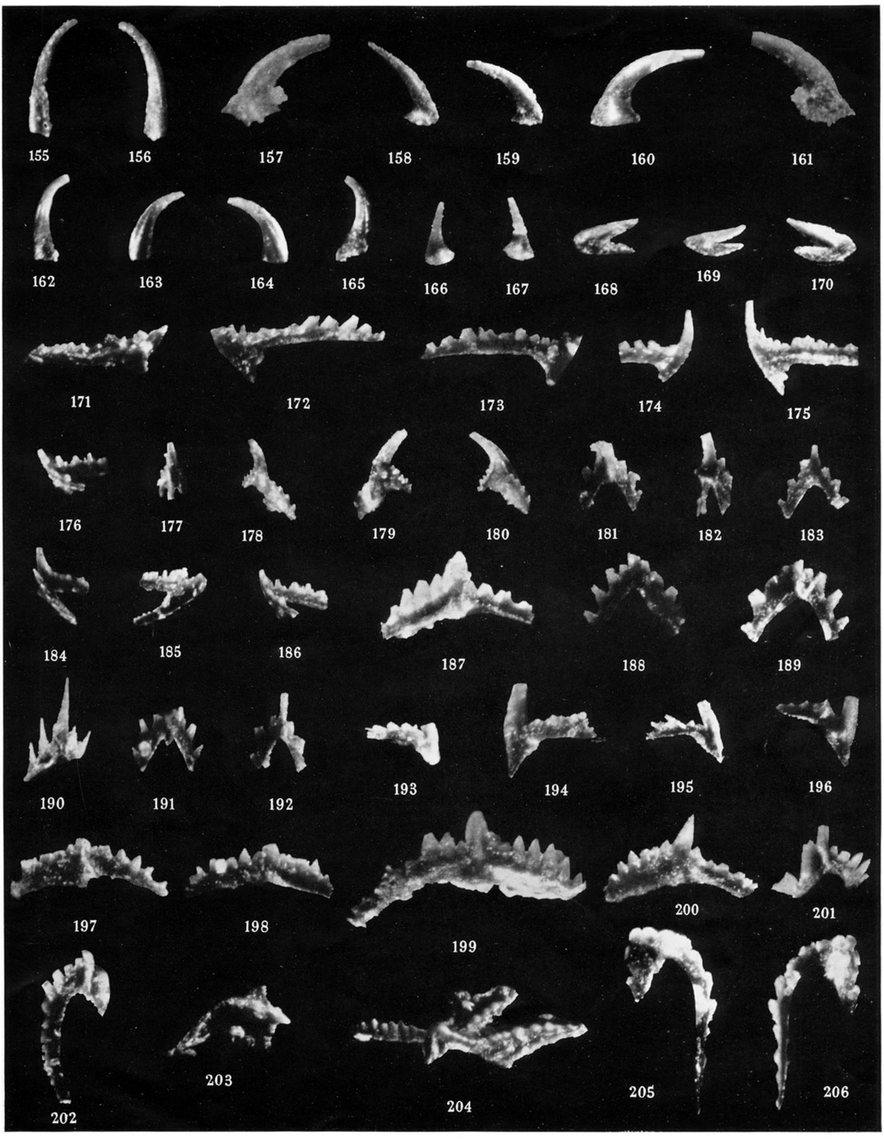

PLATE 22

Conodonts from the Llandeilo Limestone
All figures × 65

FIGURES 155, 156. *Paltodus unicostatus* Branson & Mehl. Lateral views of specimen CIK 1*a*.

FIGURES 157 to 161. *Oistodus curvatus* Branson & Mehl.

157, 161. Lateral views of specimen CIIH 3*a*.
158. Lateral view of specimen CIIH 3*d*.
159. Lateral view of specimen CIIJ 3*a*.
160. Lateral view of specimen CIIH 4*b*.

FIGURES 162, 165. *Paltodus equicostatus* n.sp. Lateral views of specimen CIIH 6*c*.

FIGURES 163, 164. *Paltodus acostatus* Branson & Branson. Lateral views of specimen CIIJ 1*a*.

FIGURES 166, 167. *Oistodus suberectus* Branson & Mehl.

166. Lateral view of specimen CIIH 4*d*.
167. Lateral view of specimen CIIH 4*a*.

FIGURES 168 to 170. *Oistodus venustus* Stauffer.

168. Lateral view of specimen CIIH 2*b*.
169. Superior lateral view of specimen CIIH 2*d*.
170. Lateral view of specimen CIIH 2*d*.

FIGURES 171, 203. *Ambolodus* sp.

171. Inferior inner lateral view of specimen CIIK 4*b*.
203. Superior inner lateral view of specimen CIIK 4*b*.

FIGURES 172 to 175. *Cordylodus rectilineatus* (Stauffer).

172. Lateral view of specimen CIIG 2*b*.
173. Lateral view of specimen CIIG 3*a*.
174. Lateral view of specimen CIIG 3*b*.
175. Lateral view of specimen CIIG 2*d*.

FIGURES 176, 177, 186. *Trichonodella inclinata* n.sp.

176. Lateral view of paratype CIIK 3*c*.
177. Posterior view of paratype CIIK 3*c*.
186. Anterior lateral view of paratype CIIK 3*c*.

FIGURES 178 to 180. *Dichognathus* cf. *D. typicus* Branson & Mehl.

178. Anterior lateral view of specimen CIIK 6*a*.
179. Outer (?) lateral view of specimen CIIK 6*a*.
180. Inner (?) lateral view of specimen CIIK 6*a*.

FIGURES 181 to 183, 188, 189, 191, 192. *Trichonodella flexa* n.sp.

181. Posterior view of paratype CIIG 6*d*.
182. Posterior lateral view of paratype CIIG 6*a*.
183. Posterior view of paratype CIIG 4*c*.
188. Anterior view of holotype CIIG 4*a*.
189. Posterior view of holotype CIIG 4*a*.
191. Posterior view of paratype CIIG 4*d*.
192. Posterior view of paratype CIIG 6*a*.

FIGURES 184, 185. *Ligonodina valma* n.sp.

184. Inner lateral view of holotype CIIK 2*a*.
185. Outer lateral view of paratype CIIK 2*d*.

FIGURES 187, 197 to 200. *Ozarkodina tenuis* Branson & Mehl.

187. Lateral view of specimen CIIH 1*b*.
197. Lateral view of specimen CIIH 1*d*.
198. Lateral view of specimen CIIH 1*c*.
199. Lateral view of specimen CIIH 2*a*.
200. Lateral view of specimen CIIH 1*a*.

FIGURE 190. *Trichonodella* sp. Posterior view of specimen CIIK 4*d*.

FIGURES 193 to 196. *Cyrtoniodus complicatus* Stauffer.

193. Lateral view of specimen CIIH 5*b*.
194. Lateral view of specimen CIIH 5*c*.
195. Lateral view of specimen CIIH 5*a*.
196. Lateral view of specimen CIIG 1*a*.

FIGURES 201, 202, 205, 206. *Gyrognathus elongatus* n.sp.

201. Lateral view of paratype CIIK 5*c*.
202. Lateral view of paratype CIIK 5*b*.
205, 206. Lateral views of holotype CIIK 5*a*.

FIGURE 204. *Amorphognathus inaequalis* n.sp. Superior lateral view of holotype CIIK 4*a*.

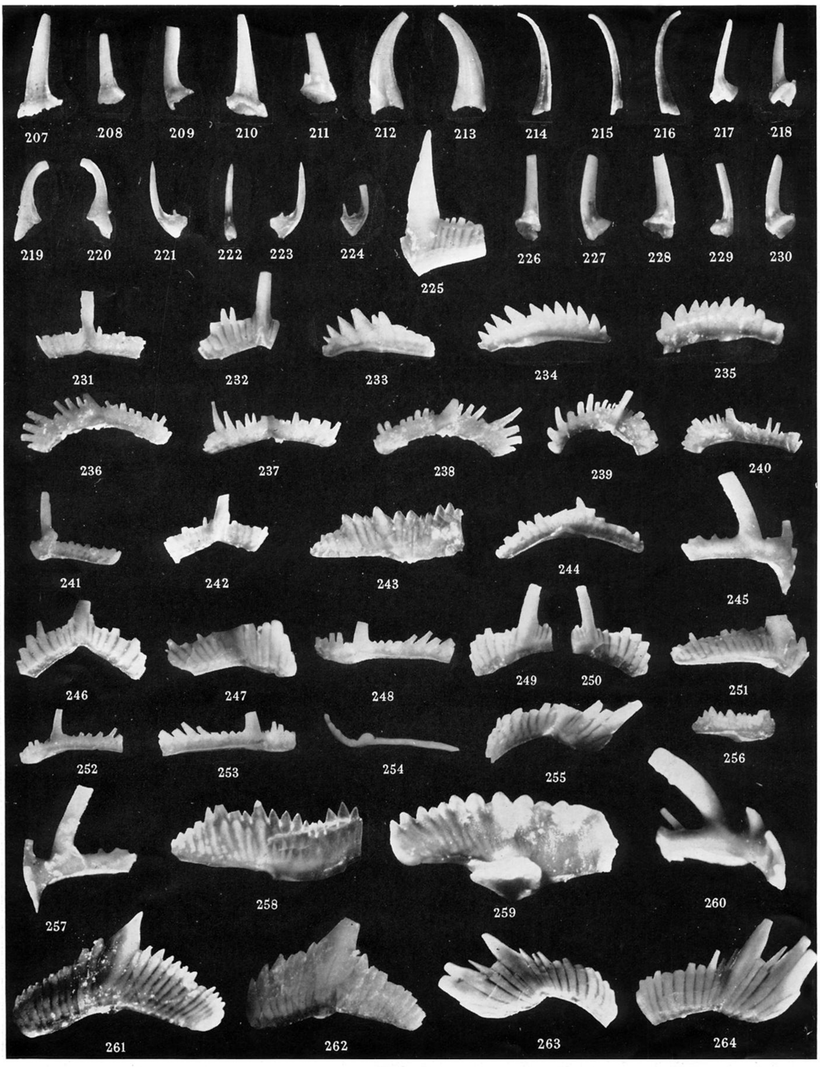

PLATE 23

Conodonts from the Aymestry Limestone
All figures ×41

FIGURES 207, 208, 210, 211. *Distomodus suberectus* n.sp.

207. Anterior view of paratype CIID 3*c*.
208. Anterior view of paratype CIID 3*d*.
210. Posterior view of paratype CIID 3*c*.
211. Posterior lateral view of paratype CIID 3*d*.

FIGURES 209, 226 to 228. *Distomodus curvatus* n.sp.

209. Lateral view of paratype CIID 4*d*.
226. Posterior view of paratype CIID 4*d*.
227. Lateral view of paratype CIID 4*b*.
228. Posterior lateral view of paratype CIID 4*d*.

FIGURES 212, 213. *Paltodus acostatus* Branson & Branson. Lateral views of specimen CIIC 4*d*.

FIGURES 214 to 216. *Paltodus unicostatus* Branson & Mehl.

214. Lateral view of specimen CIIC 5*a*.
215, 216. Lateral views of specimen CIIC 5*d*.

FIGURES 217, 218, 229, 230. *Distomodus curvatus* var. *dentatus* n.sp. and var.

217. Anterior view of holotype CIID 6*a*.
218. Posterior lateral view of holotype CIID 6*a*.
229. Lateral view of paratype CIID 6*b*.
230. Inferior lateral view of holotype CIID 6*a*.

FIGURES 219, 220. *Paltodus recurvatus* n.sp. Lateral views of paratype CIID 1*c*.

FIGURES 221 to 224. *Cordylodus* (?) *dubius* n.sp.

221, 223. Lateral views of holotype CIIE 2*a*.
222. Posterior view of holotype CIIE 2*a*.
224. Lateral view of paratype CIIE 2*c*.

FIGURES 225, 247, 249, 250. *Plectospathodus contrarius* n.sp.

225. Posterior view of paratype CIIA 3*c*.
247. Posterior view of paratype CIIA 3*d*.
249. Anterior view of paratype CIIA 3*b*.
250. Posterior view of paratype CIIA 3*b*.

FIGURES 231, 241, 242. *Trichonodella aboroflexa* n.sp.

231. Anterior view of holotype CIIB 1*a*.
241. Posterior lateral view of paratype CIIB 1*b*.
242. Posterior view of holotype CIIB 1*a*.

FIGURES 232, 246. *Trichonodella symmetrica* Branson & Mehl.

232. Posterior view of specimen CIIA 6*a*.
246. Anterior view of specimen CIIA 6*b*.

FIGURES 233 to 235. *Prioniodella inclinata* n.sp.

233. Lateral view of paratype CIIC 2*c*.
234. Lateral view of paratype CIIC 2*b*.
235. Lateral view of paratype CIIC 3*a*.

FIGURES 236 to 240. *Plectospathodus extensus* n.sp.

236. Anterior view of paratype CIIB 2*b*.
237. Posterior view of paratype CIIB 2*d*.
238. Posterior view of paratype CIIB 2*b*.
239. Posterior view of paratype CIIB 2*a*.
240. Posterior view of paratype CIIA 5*c*.

FIGURES 243, 256, 258, 259. *Spathognathodus primus* (Branson & Mehl.)

243. Lateral view of specimen CIIC 1*c*.
256. Lateral view of specimen CIIC 1*d*.
258. Lateral view of specimen CIIB 6*c*.
259. Lateral view of specimen showing bone-like material attached to its aboral margin CIIB 6*d*.

FIGURE 244. *Ozarkodina* sp. Lateral view of specimen CIID 5*d*.

FIGURES 245, 257, 260. *Ligonodina salopia* n.sp.

245. Outer lateral view of paratype CIIB 5*b*.
257. Inner lateral view of paratype CIIB 5*b*.
260. Inner lateral view of holotype CIIB 5*a*.

FIGURES 248, 252 to 254. *Hindeodella equidentata* n.sp.

248. Outer lateral view of holotype CIIB 3*a*.
252. Inner lateral view of paratype CIIB 4*b*.
253. Inner lateral view of holotype CIIB 3*a*.
254. Superior view of holotype CIIB 3*a*.

FIGURES 251, 261, 262. *Ozarkodina typica* Branson & Mehl.

251. Lateral view of specimen CIIA 1*b*.
261. Lateral view of specimen CIIA 1*a*.
262. Lateral view of specimen CIIA 1*c*.

FIGURES 255, 263, 264. *Plectospathodus elegans* n.sp.

255. Posterior view of paratype CIIA 4*c*.
263. Anterior view of holotype CIIA 2*c*.
264. Posterior view of holotype CIIA 2*c*.