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CONODONT STRATIGRAPHY AND PALAEONTOLOGY OF THE NAMURIAN OF BELGIUM

BY

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SUMMARY

The sequence of conodont faunas in the Namurian of Belgium is described and compared with faunas of the same age in North America, western Europe and Japan.

The faunas exhibit major changes within the Namurian in the Chokerian (*H1*), Alportian (*H2*) and Kinderscoutian (*R1*) sub-stages involving the appearance of new species and genera and the disappearance of many pre-existing ones.

These changes take place at approximately the position of the Mississippian-Pennsylvanian boundary in North America. The palaeontology of these faunas is dealt with in detail and 47 species and sub-species have been recognised amongst which *Angulodus simplex*, *Lonchodina bischoffi*, *Idiognathoides sulcata sulcata*, *Idiognathoides sulcata parva*, *Idiognathoides minuta*, *Streptognathodus lateralis* and *Gnathodus bilineatus bollandensis* are considered new.

RÉSUMÉ

Ce mémoire décrit les faunes à conodontes du Namurien belge et les compare aux faunes du même âge provenant de l'Amérique du Nord, de l'Europe occidentale et du Japon.

Des variations majeures ont pu être observées dans le Chokierien (*H1*), Alportien (*H2*) et Kinderscoutien (*R1*) marqués par l'apparition et la disparition de certaines espèces.

Ces changements faunistiques se situent approximativement à la limite Mississipien-Pennsylvanien de l'Amérique du Nord. Les auteurs ont pu reconnaître 47 espèces et sous-espèces dont *Angulodus simplex*, *Lonchodina bischoffi*, *Idiognathoides sulcata sulcata*, *Idiognathoides sulcata parva*, *Idiognathoides minuta*, *Streptognathodus lateralis* et *Gnathodus bilineatus bollandensis* sont décrites pour la première fois.

CONODONT STRATIGRAPHY AND PALAEONTOLOGY OF THE NAMURIAN OF BELGIUM

INTRODUCTION

The lack of information concerning the distribution of Namurian conodont faunas in Europe led one of us (A.C.H.) to study the sequence of species in the Pennine area of England (HIGGINS, 1961, 1962).

Subsequently this work was extended to include the Namurian of Belgium in collaboration with J. BOUCKAERT. The considerable knowledge of the sequence of goniatite faunas in both these areas provided very close stratigraphic control for such a study and has meant that each sample could be accurately dated and therefore placed in the standard north west European Namurian sequence, much of which was first described in the areas which have been studied.

In the following work on the Belgium conodont sequence the conodonts have been studied by HIGGINS and the stratigraphic control has been provided by BOUCKAERT. During the course of the work it was discovered that the earliest Namurian beds, previously designated *E1*, were of earliest *E2* age (BOUCKAERT and HIGGINS, 1963) and therefore an incomplete Namurian sequence has been studied. However, this part of the sequence has been studied in England and the conodont faunas of this age will be described at a later date.

ACKNOWLEDGEMENTS.

The receipt of a N.A.T.O. post-doctoral Research Fellowship allowed A. C. HIGGINS to study the Belgian conodont faunas and this is gratefully acknowledged. Facilities were kindly provided at the offices of the « Service Géologique de Belgique » by M. DELMER. The help and encouragement of Professor L. R. MOORE and Professor W. P. VAN LECKWIJCK are also gratefully acknowledged.

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HISTORY OF PREVIOUS WORK ON NAMURIAN CONODONTS.

Conodonts of Namurian age have been described from many countries but, with the exception of the Japanese faunas (KOIKE, 1967), the complete succession of faunas is unknown. The majority of the faunas of this age have been described from North America where there is often an unconformity between the Mississippian and Pennsylvanian rocks and much of the sediment of Namurian age is missing.

Upper Mississippian, Chester Series, conodont faunas have been described in great detail in recent years in a series of papers by REXROAD (1957, 1958), REXROAD and COLLINSON (1961), REXROAD and BURTON 1961) and COLLINSON, SCOTT and REXROAD (1962). These papers described the sequence of Chester Conodonts in the Upper Mississippi Valley. Prior to these papers faunas of Chester age were described from Oklahoma by BRANSON and MEHL (1941) and ELIAS (1956), from Texas by HASS (1953), from Iowa by YOUNGQUIST and MILLER (1949) and REXROAD and FURNISH (1964) from Nevada by DUNN (1965) and recently from Arkansas by LANE (1967).

Lower Pennsylvanian conodonts are rather less well known. They include faunas described by HARRIS and HOLLINGSWORTH (1953) from Oklahoma, by HARLTON (1953) from Oklahoma, by ELLISON and GRAVES (1941) from Texas, by DUNN (1966) from Nevada, Texas and Oklahoma and by LANE (1967) from Arkansas.

Faunas from Europe are less comprehensive. HINDE (1900), described conodonts of Lower Namurian age from the Upper Limestone Group of Scotland and more recently CLARKE (1961), revised and extended this work, incorporating conodonts from later Namurian rocks in his paper. In England early Namurian conodonts were described by HIGGINS (1961) and a complete sequence of Namurian conodont faunas was described in an unpublished work by HIGGINS (1962). In Belgium, DEMANET (1938, 1941) referred to conodonts from early Namurian shales and figured several specimens. The faunas, however, were treated as natural assemblages. SCHMIDT (1934), also described natural assemblages from Lower Namurian shales in Germany. Lower Namurian faunas have been described from Spain by HIGGINS (1962) and BOOGAERT (1967) and from North Africa by REMACK-PETITOT (1960). Conodonts from the Namurian of France were identified by LYS, MAUVIER and SERRE (1962) from Northern France.

Until recently Asian conodonts of Namurian age were unknown but two papers by IGO and KOIKE described faunas of Lower Namurian (1965) and Upper Namurian (1966) age, and in 1967 KOIKE described faunas from the Atetsu Limestone which is of Lower and Upper Carboniferous age.

STRATIGRAPHY OF THE NAMURIAN OF BELGIUM.

The Namurian rocks of Belgium have been studied in considerable detail in recent years by a number of workers, notably BOUCKAERT (1959, 1960, 1961, 1962, 1963, 1966-1967) and VAN LECKWIJCK (1964). As a result of these studies it has become clear that, with the exception of the Pendleian (*E1*) sub-stage, the faunal succession in Belgium is essentially similar to that in the Pennine District of England. The subdivision of the Namurian in Belgium has recently been summarised by VAN LECKWIJK (1964) and is as follows :

	Sub-Stages.
Namurian C	Yeadonian (*G1*) Lower *Gastrioceras.*
Namurian B	Marsdenian (*R2*) Upper *Reticuloceras.* Kinderscoutian (*R1*) Lower *Reticuloceras.*
Namurian A	Alportian (*H2*) Upper *Homoceras.* Chokerian (*H1*) Lower *Homoceras.* Arnsbergian (*E2*) Upper *Eumorphoceras.*

The earliest beds of the Namurian as compared with Britain are absent (BOUCKAERT and HIGGINS, 1963) and over most of Belgium the relationship of the Namurian to the Visean is one of disconformity with the higher zones overlapping the lower ones around the Brabant Massif (BOUCKAERT, 1967). The upper beds of the Namurian pass into the Westphalian without a break.

The Namurian sequence in Belgium and the neighbouring areas consists of 330-800 m. of sediment which is thickest in the east in Western Germany (see VAN LECKWIJCK, 1964) thinning westwards to 330 m. in the Charleroi Basin and then thickening to 600 m. in the Bassin du Nord in Northern France. The sediments of the Arnsbergian and lower part of the Chokerian are predominantly marine shales, in places calcareous, with paralic sequences appearing in the extreme east of Belgium during *E2b* times. The paralic sequences spread westwards along the southern margin of the Brabant Massif during the upper part of the Chokerian and into the Campine during the Alportian. Paralic conditions of sedimentation were normal everywhere during the succeeding sub-stages of the Namurian.

The detailed descriptions of the sampled sections are given below :

LOCALITIES.

I. — BOLLAND BOREHOLE. Planchette 122 W, No. 260.

Bolland is 9 km. SE of Visé.

Samples were taken at the following depths :

Meters.		
314.75	Grey-black shales	*Reticuloceras coreticulatum.*
314.95		
316.30		
316.40		
316.00	Bullion limestone	
321.00	Grey-black shales	*Reticuloceras reticulatum.*
322.00		
328.00		*Reticuloceras nodosum.*
349.00	Bullion limestone	*Homoceratoides prereticulatus.*
449.00	Bullion limestone	*Homoceras beyrichianum.*
456.00	Bullion limestone	*Cravenoceratoides fragilis.*

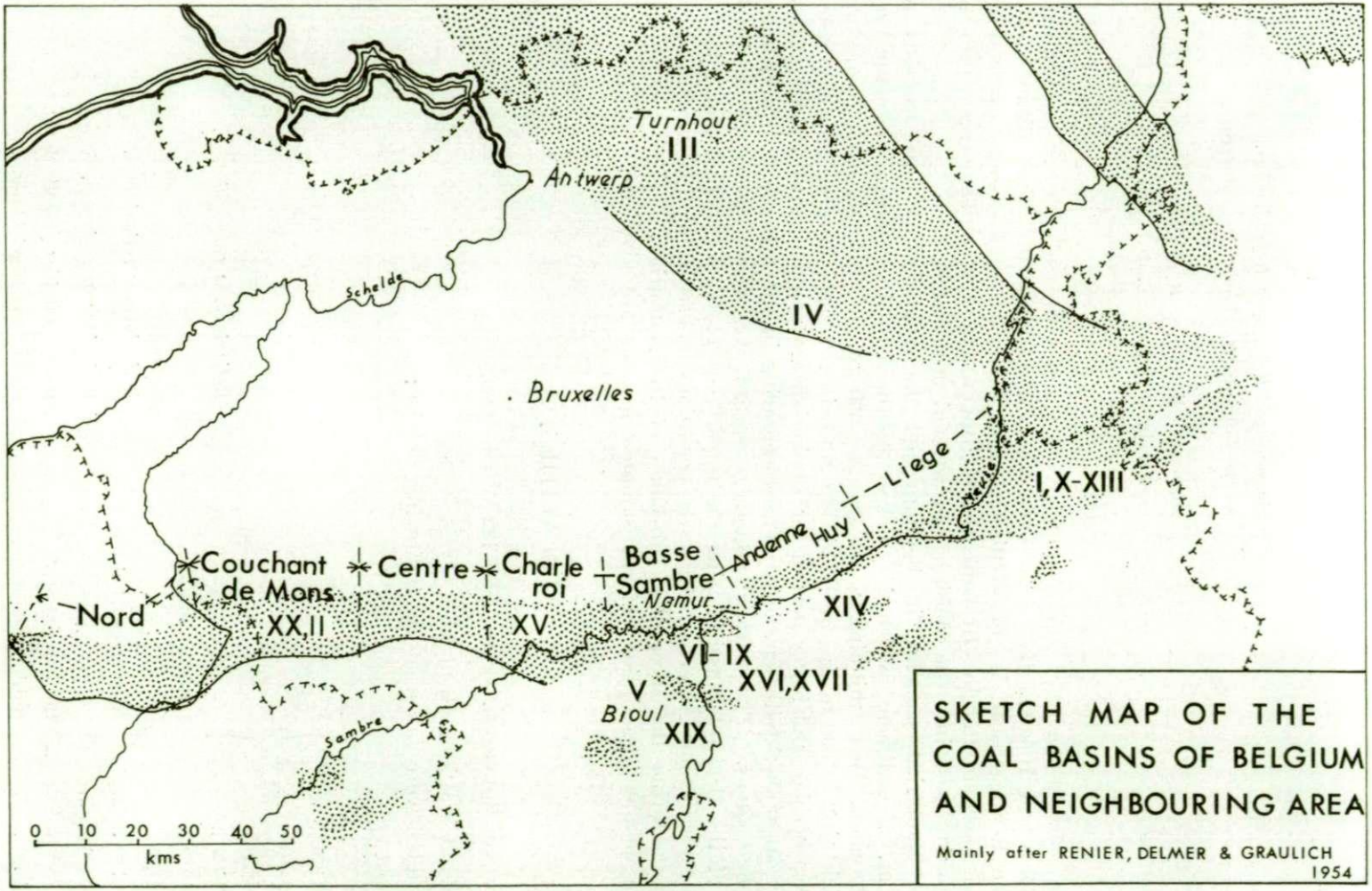

FIG. 1. — Sketch map of the main Coal Basins of Belgium and the neighbouring area showing the location of the sampled sections.

II. — HAUTRAGE COLLIERY.

The sample consisted of a dark grey shaly limestone with abundant brachiopods. It was taken from the *Reticuloceras nodosum* marine band (see STAINIER, 1938) in a gallery at 752 m.

III. — TURNHOUT BOREHOLE. Planchette Turnhout, 17 E, No. 120.

This borehole was located in the premises adjoining the municipal swimming pool. A full description of the core is given in DELMER, 1962. Samples were taken from the following horizons :

Marine bed No. 6.

1,847.40 m. limestone bullion ... ... } ... ... { *Reticuloceras gracile.*
1,847.85 m. black shales . ... } { *Reticuloceras bilingue, R2b.*

Marine bed No. 12.

2,144.00 m. limestone ... ...*Homoceratoides prereticulatus.*

Marine bed No. 13.

2,148.10 m. limestone ... ... { *Homoceras subglosum.*
{ *Homoceras beyrichianum.*
2,152.10 m. siliceous limestone .. ..occurs below.

IV. — WEBBEKOM BOREHOLE. Planchette Diest, 76 W, No. 264.

Webbekom is 1 ½ km. SSE of Diest. A full description of the core is given in DELMER, 1955. Samples were taken at the following depths :

Meters.		
465.20 .. .. }		
467.00 .. .. }	Dark-grey shales	*Reticuloceras gracile.*
468.00 .. .. }		

V. — MERBES-SPRIMONT QUARRY at Bioul. Planchette Bioul, 166 W, No. 122. See fig. 4.

The following section is taken from BOUCKAERT and HIGGINS, 1963 :

	Meters.
1. Sandy micaceous shale.	—
2. Black shale with an *E2a1* fauna : *Eumorphoceras bisulcatum bisulcatum, Eumorphoceras bisulcatum ferrimontanum, Eumorphoceras bisulcatum grassingtonense, Cravenoceras cowlingense*	0.82
3. Sandy micaceous shale	6.00
4. Calcareous shale with *Martinia* aff. *glabra*	1.30
5. Shales with bullion limestones containing conodonts	0.17
6. Brownish shales, sometimes nodular	1.80
7. Limestones	0.07
8. Shales with lenticular limestones containing conodonts	0.12
9. Black shales	1.80
10. Limestones with goniatites and conodonts	0.07

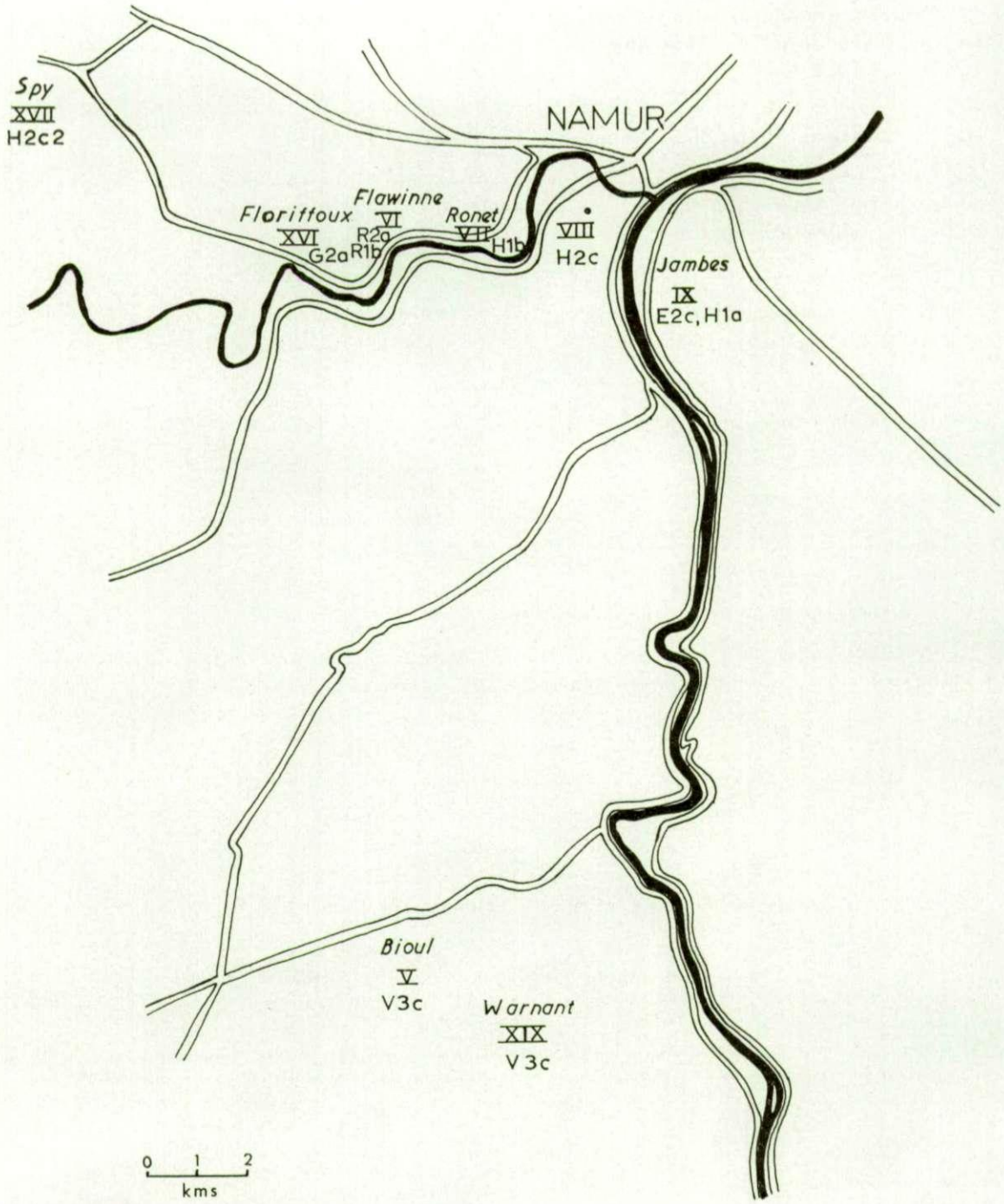

FIG. 2. — Sketch map of the area around Namur showing the location of the sampled sections.

VI. — Road section at FLAWINNE. Planchette Malonne, 155 W, No. 426.

Flawinne is 4 km. WSW of Namur on the road from Flawinne to Floriffoux, in the Sambre Valley.

The locality is at locality 13 (fig. 1) of BOUCKAERT, 1962 and was described in detail by BOUCKAERT and DELMER, 1960, p. 407.

The following samples were taken from this section : Meters.

bed *e*) Soft shales. *Homoceras moorei*, *Homoceras striolatum*, *Reticuloceras* aff. *stubblefieldi*, *Reticuloceras nodosum*, *Anthracoceras* sp., crinoid fragments 2.00
This bed was sampled at the base, middle and top.

bed *k*) Dirty, brownish shales, *Pterinopecten* sp., *Reticuloceras paucicrenulatum*, *R. todmordenense*, *Reticuloceras* sp. 0.50
This bed was sampled at the base, middle and top.

bed *n*) Soft shale with very abundant *Productus carbonarius* 1.00
This bed was sampled in the middle.

VII. — Cutting on a railway at RONET. Planchette Malonne, 155 W, No. 711.

The locality is 1 km. SW of Namur on the left bank of the River Sambre (locality 1 of BOUCKAERT, 1962). The full section is described in BOUCKAERT, 1962.

Samples were taken at the following horizons : Meters.

bed *d*) Shales and bullions with *Homoceras beyrichianum* 4.00
Two bullion horizons were sampled.

VIII. — CITADEL OF NAMUR. Planchette Malonne, 155 W, No. 688.

This is locality 3 of BOUCKAERT, 1962, 18 m. SW of the corner of a retaining wall below the Citadel. The full section was described by BOUCKAERT, 1962. The only bed sampled was a limestone 0.10 m. thick containing *Crurithyris urei*, *Productus carbonarius*, *Ctenodonta*, *Homoceratoides prereticulatus*, *Homoceras henkei* and crinoids.

IX. — Roadside exposure at JAMBES. Planchette Naninne, 155 E, No. 380.

This section was described by BOUCKAERT, 1959. Samples were taken from two horizons; the lower one was taken from dark brown shales containing, amongst others, *Nuculoceras nuculum* at locality *x* (fig. 1 of BOUCKAERT, 1959). The upper one was taken from bluish mudstones 44 m. south of point *x* which contain amongst others *Homoceras subglobosum*.

X. — MORTROUX. Planchette Dalhem, 122 W, No. 257.

On the right bank of the River Berwinne 600 m. WNW of Mortroux (see LAMBRECHT, 1958).

a) *Reticuloceras bilingue* marine band. Samples were taken at intervals of 0.50 m. above the base. Seven samples.

b) *Hudsonoceras proteum* marine band. One sample.

XI. — HOUYEUX. Planchette Herve, 122 E, No. 177.

See BOUCKAERT, 1960, shales with *R. reticulatum*.

XII. — Wadeleux. Planchette Herve, 122 E, No. 354.

The locality is situated 250 m. SW of the bridge crossing the Monty stream (see Bouckaert 1960, point 813).

Reticuloceras circumplicatile marine band. Two samples were taken from the band.

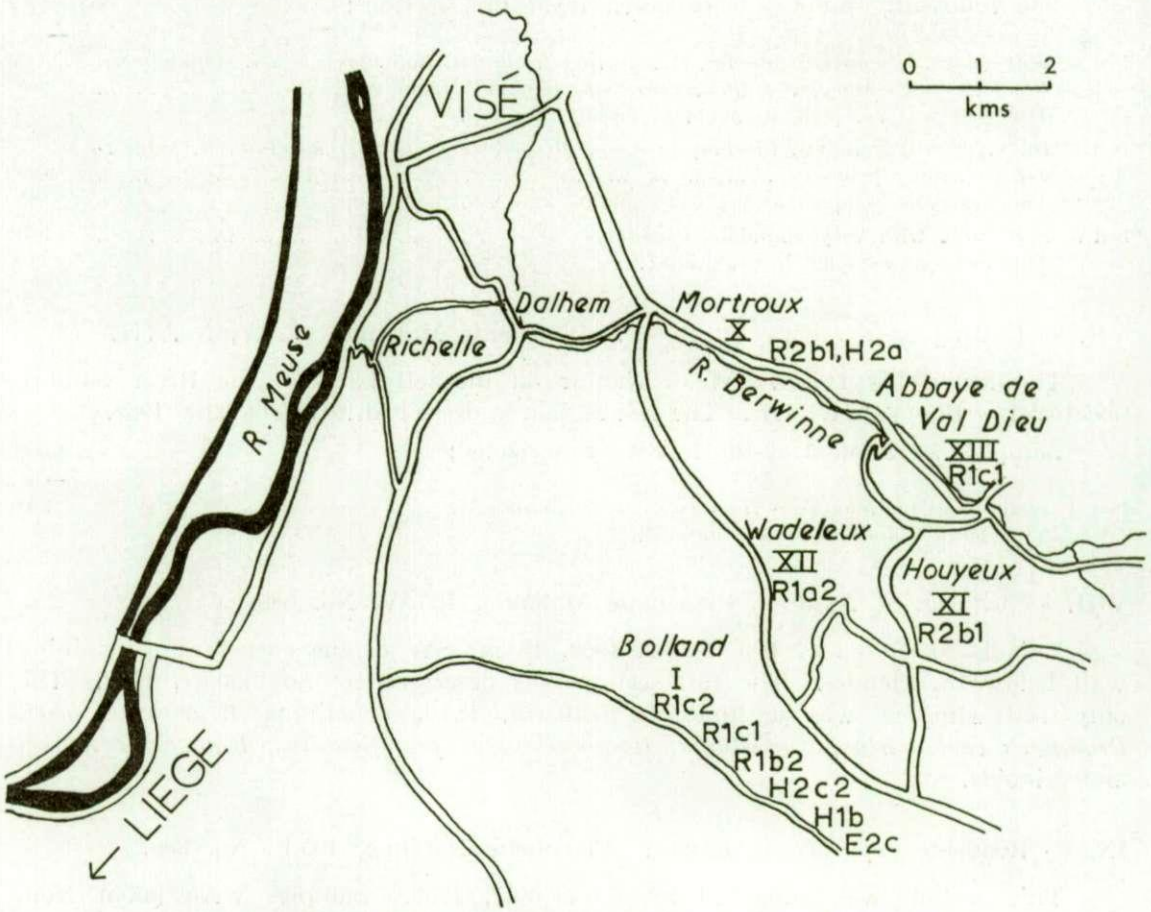

Fig. 3. — Sketch map of the area around Visé showing the location of the sampled sections.

XIII. — Abbaye de Val Dieu. Planchette Herve, 122 E, No. 356.

The locality is 1,200 m. NW of the abbaye de Val Dieu on the left bank of the River Berwinne (see Bouckaert, 1960, point 148). Four samples were taken from levels II and III of Bouckaert 1960. This is the *Reticuloceras reticulatum* marine band.

XIV. — Sections at the Colliery of Moha.

Two horizons were sampled.

a) *Gastrioceras listeri* marine band above Hayette Coal in the second southern drift at 170 m. depth (see Bouckaert and Molitor, 1963).

b) *Gastrioceras subcrenatum* marine band.

XV. — MONCEAU-SUR-SAMBRE. Planchette Font.-l'Évêque, 153 W, No. 310.

This is bed 5 of BOUCKAERT (1967). Bullion limestone with *Cravenoceratoides edalensis*.

XVI. — NOUVEAU BARRAGE ÉCLUSE, Floriffoux. Planchette Malonne, 155 W, No. 738.

A single sample from the *Gastrioceras subcrenatum* marine band.

XVII. — SPY. Planchette Spy, 143 E, No. 211.

This section is on a path ascending from Moustier to La Sauvenière about 400 m. from the entrance to the wood. The bed sampled was a crinoidal limestone with, amongst other fossils, *Homoceratoides prereticulatus*.

XVIII. — VERVIERS. Planchette Verviers, 135 E, No. 191.

The bed sampled was a bullion limestone with *Cravenoceras holmesi* (see GRAULICH and DELMER, 1959).

XIX. — Cutting in the JAIFFE À WARNANT QUARRY. Planchette Bioul, 166 W, No. 151.

This cutting was surveyed in detail by DEMANET in 1938. Below is a slightly revised version of the section given in BOUCKAERT and HIGGINS, 1963.

	Meters.
32. Brown carbonaceous shale with an *E2a1* fauna : *Eumorphoceras bisulcatum bisulcatum, Eumorphoceras bisulcatum ferrimontanum, Eumorphoceras bisulcatum grassingtonense, Cravenoceras cowlingense.*	
31. Sandy shale	5.00
30. Calcareous shale with *Martinia* aff. *glabra* and conodonts	1.50
30'. Limestone with abundant conodonts	0.10
29. Black silicified bed	0.10
28. Shales with phosphatic nodules	0.30
27. Brown shales with *Caneyella membranacea*	0.70
26. Silicified beds and black shales, nodules with numerous radiolaria	0.80
25. Limestone with abundant *Leiorhynchus carbonarius polypleurus*	0.10
24. Dark shales and lenticular limestones with conodonts	0.18
23. Partially silicified limestone with conodonts	0.20
22. Alternating black shales and silicified beds	0.30
21. Limestone with *Goniatites subcircularis, Goniatites newsomi* and conodonts	0.07

XX. — BLATON. Planchette Blaton, 139 W, No. 279.

Section along the cutoff of the Nimy (Mons)-Blaton Canal across the « Mont des Groseilliers » (see BOUCKAERT, DELMER and OVERLAU, 1961). The general section is as follows :

	Meters.
1. Black shales with bullions with *Homoceras beyrichianum*. Three bullion horizons were sampled	60
2. Calcareous shales, black shales and phtanites with *Cravenocerat. fragilis, Cravenocerat.* cf. *nititoides, Eumorphoceras bisulcatum*	70

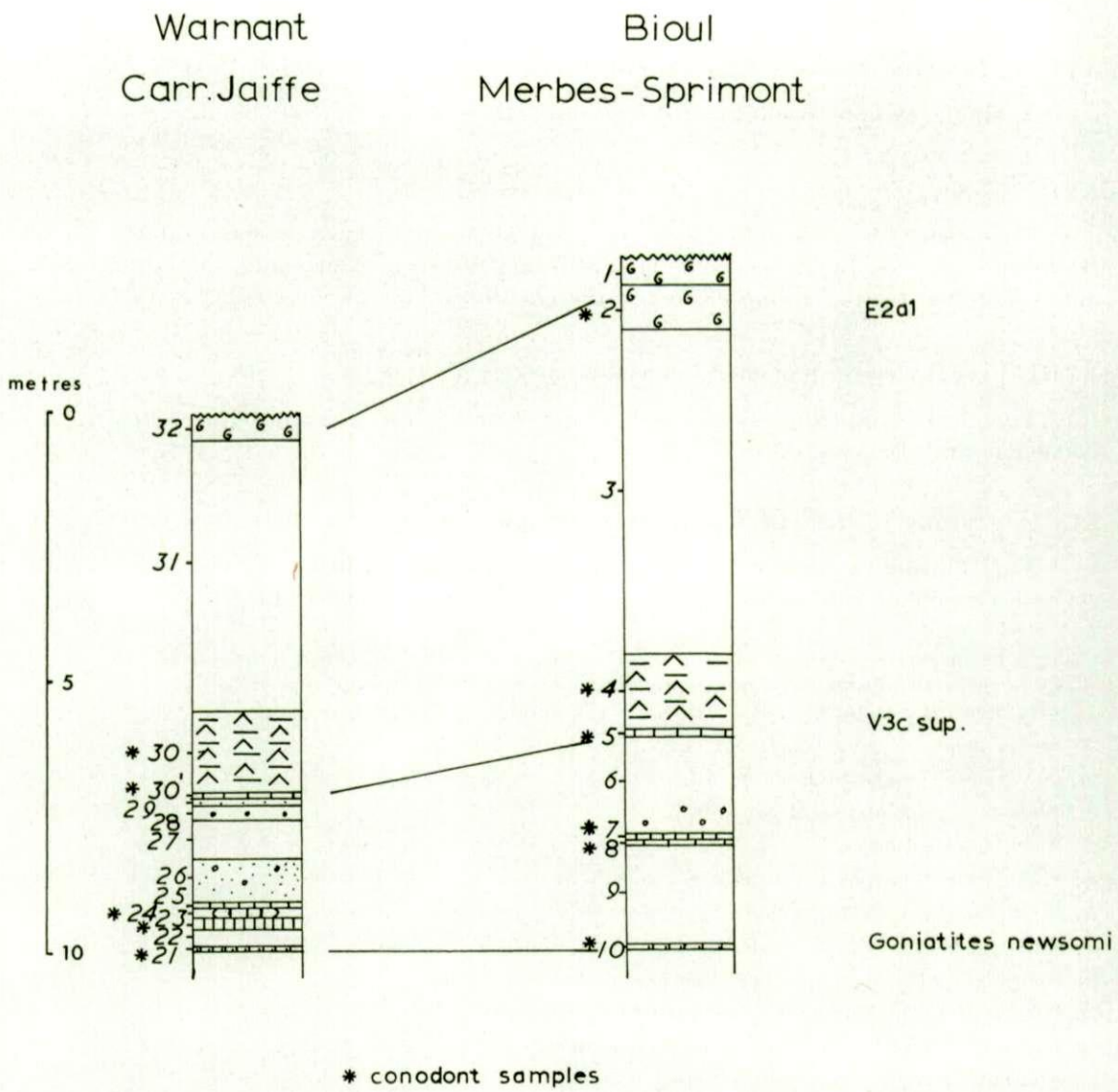

FIG. 4. — Sections through the Couches de Passage at Jaiffe à Warnant and Bioul showing the position of the sampled horizons and those which contain conodonts.

3. Phtanites with a radioactive bed at the base. These beds do not contain goniatites and their age is unknown. Beds sampled (see BOUCKAERT, DELMER and OVERLAU for locality numbers) 280, 271, 270, 267, 256 70
4. Mottled phtanites with calcareous shales at the base. These beds contain *Neoglyphioceras spirale* (*V3c*). Beds sampled at levels 236, 158 63
5. Calcareous shales, argillaceous limestones and alternating limestones and black shales with *Goniatites elegans* (*V3b*). Beds sampled at levels 112, 108, 98 44

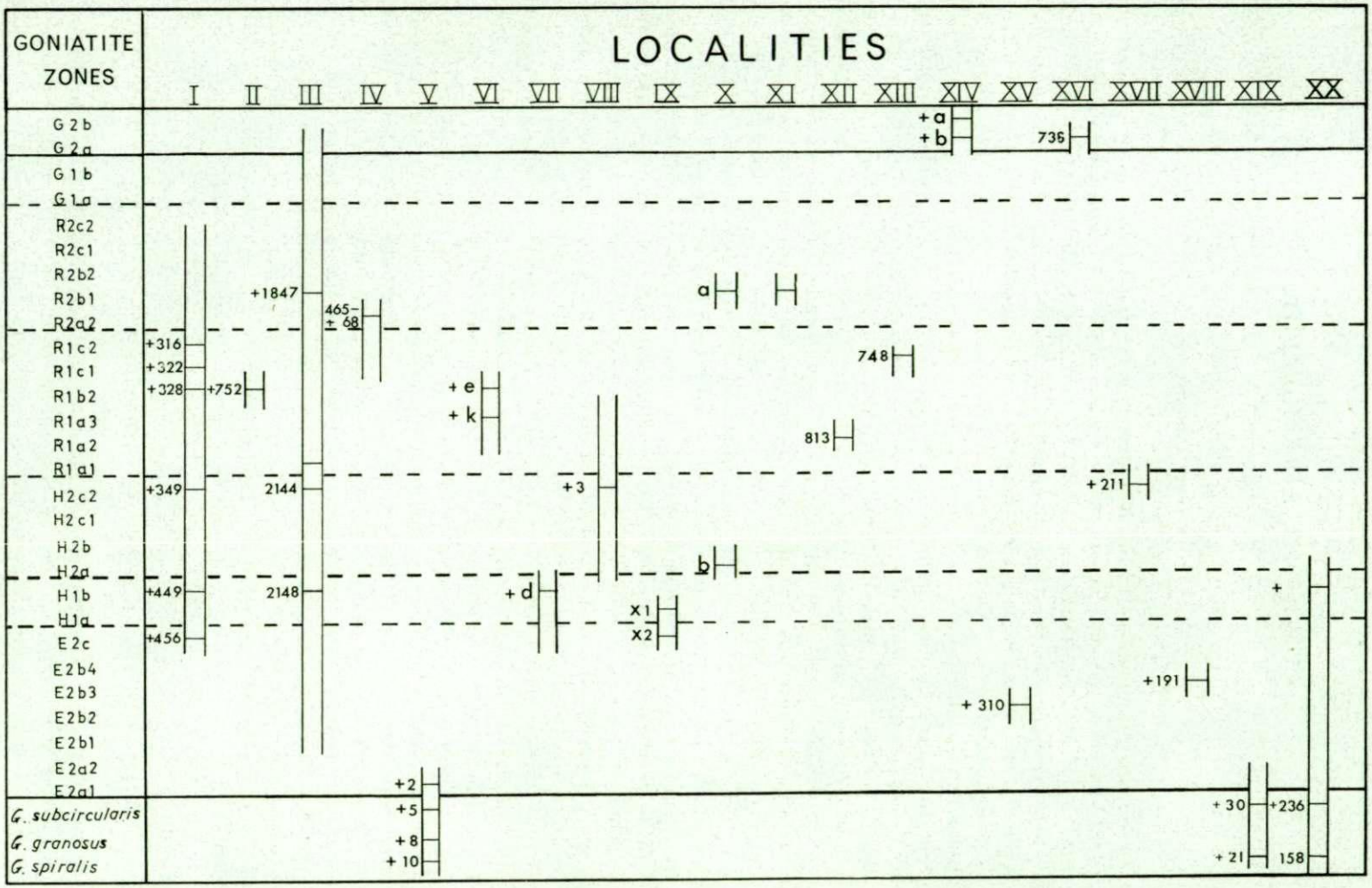

FIG. 5. — Sections of each sampled locality showing the sampled horizons and those which yielded conodont faunas (+). The locality numbers are those given in the text.

CONODONT STRATIGRAPHY.

A. — Conodont Abundance.

The abundance of conodonts in the Namurian, Westphalian, and in all probability in the Upper Visean, is dependant on many factors both pre- and post-depositional. The importance of the post-depositional factors, particularly the breakage of fragile specimens due to compaction, can be appreciated from the large numbers of incomplete specimens which are variously called *Hindeodella* sp. or *Lonchodus* sp. in most Upper Palaeozoic conodont papers. Normally it is not possible to assess the amount of breakage which has taken place and in any case it is probably not a very high percentage of the fauna in most samples. However, in the Upper Carboniferous and the Upper Visean it may well be a large proportion of the fauna. The work of Rhodes (1952), Scott (1934, 1941) and Schmidt (1934) on conodont assemblages from the Upper Carboniferous in Europe and N. America clearly indicated that the most abundant members of the assemblages were the most fragile ones, the hindeodellids, synpriodinids and ozarkodinids. In the best preserved Namurian faunas these are the most abundant members although they are never as abundant as they are in the assemblages. The great abundance of very fragile specimens, however, is only found in the very hard, calcareous bullions which were presumably more resistant to compaction than most other sediments and in fact only in the very hardest bullions are really well preserved faunas found. In softer bullions and in most limestones the fragile elements are a minor part of the fauna and only the more massive specimens are preserved. In shales and soft mudstones the entire fauna often consists only of massive specimens, particularly the polygnathids which probably represent only about one-quarter of the original fauna. This occurs only in heavily indurated shales where many of the specimens are strongly fractured. In many shales some proportion of the fragile non-polygnathid elements may be preserved, the actual figures varying according to the tectonic history of the area.

This loss of a large proportion of the fauna is not very important stratigraphically because the most sensitive zonal indices are the polygnathids, but it means that abundance figures in the Namurian are for the most part meaningless.

This factor of post-depositional breakage appears to be the main factor controlling the abundance of conodonts in the Namurian, for they occur in all types of marine sediments and with a variety of other fossil types. They occur in shales, limestones and mudstones and with goniatites, lamellibranchs and calcareous brachiopods. Though their abundance does vary it does not vary with either fossil or rock type.

B. — Conodont Distribution.

The distribution chart (Chart 1) clearly indicates that few species range throughout the Namurian and that many species have a range which is sufficiently limited to allow their use as stratigraphic indices. It also indicates that there are gaps in the conodont sequence, this being due on the one hand to the absence in Belgium of the

Chart No. 1.

	V3c	*E2*				*H1*	*H2*	*R1*				*R2*		*G2*	
		E2a	*E2b2*	*E2b3*	*E2c*		*H2c2*	*R1a3*	*R12b*	*R1c1*	*R1c2*	*R2a2*	*R2b1*	*G2a*	*G2b*
Cavusgnathus navicula	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gnathodus girtyi sub. sp. nov.	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hibbardella milleri	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hindeodella undata	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lambdagnathus macrodentata	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lonchodina bischoffi	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lonchodina furnishi	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Magnilateralla robusta	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Neoprioniodus scitulus	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Neoprioniodus spathatus	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Spathognathodus campbelli	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Subbryantodus subaequalis	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gnathodus commutatus	×	—	×	×	—	—	—	—	—	—	—	—	—	—	—
Gnathodus cruciformis	×	—	—	×	—	—	—	—	—	—	—	—	—	—	—
Gnathodus girtyi girtyi	×	×	—	×	—	—	—	—	—	—	—	—	—	—	—
Gnathodus girtyi intermedius	×	—	—	×	—	—	—	—	—	—	—	—	—	—	—
Metalonchodina sp.	×	—	—	×	—	—	—	—	—	—	—	—	—	—	—
Gnathodus nodosus	×	—	—	×	×	—	—	—	—	—	—	—	—	—	—
Gnathodus bilineatus bilineatus	×	×	—	×	×	×	—	—	—	—	—	—	—	—	—
Hindeodella germana	×	—	—	×	—	×	—	—	—	—	—	—	—	—	—
Neoprioniodus singularis	×	—	×	×	×	×	—	—	—	—	—	—	—	—	—
Hibbardella acuta	×	—	—	×	×	×	×	—	—	—	—	—	—	—	—
Hindeodella uncata	×	—	×	×	—	×	×	—	—	—	—	—	—	—	—

Chart No. 1 (continued).

	V3c	*E2*				*H1*	*H2*	*R1*				*R2*		*G2*	
		E2a	*E2b2*	*E2b3*	*E2c*		*H2c2*	*R1a3*	*R12b*	*R1c1*	*R1c2*	*R2a2*	*R2b1*	*G2a*	*G2b*
Roundya barnettana	×	—	—	×	—	—	×	×	—	—	—	×	×	—	—
Hindeodella ibergensis	×	×	—	×	×	×	×	—	—	—	×	×	×	—	×
Ligonodina typa	×	—	—	×	—	×	—	×	—	—	—	×	—	×	×
Neoprioniodus conjunctus	×	—	—	—	—	—	—	—	—	—	—	—	—	—	×
Ozarkodina delicatula	×	—	—	×	—	×	×	—	—	—	×	×	—	—	×
Synprioniodina microdenta	×	—	—	×	—	×	×	—	—	—	—	—	—	—	×
Gnathodus noduliferus	—	×?	—	—	—	×	×	—	×	—	—	—	—	—	—
Angulodus simplex	—	—	×	×	×	×	×	—	—	—	—	×	—	—	—
Gnathodus bilineatus bollandensis	—	—	×	×	×	×	—	—	—	—	—	—	—	—	—
Hibbardella pennata	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—
Ligonodina fragilis	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—
Lonchodina sp.	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—
Gnathodus cf. *girtyi*	—	—	—	—	—	×	×	—	—	—	—	—	—	—	—
Gnathodus japonicus	—	—	—	—	—	×	×	×	—	—	—	×	—	—	—
Idiognathoides minuta	—	—	—	—	—	×	—	—	—	—	—	—	—	—	—
Streptognathodus elegantulus	—	—	—	—	—	—	×	×	—	—	—	—	×	×	×
Streptognathodus lateralis	—	—	—	—	—	—	×	×	×	×	—	×	×	×	×
Idiognathoides corrugata	—	—	—	—	—	—	—	×	—	—	—	×	—	×	×
Idiognathoides sinuata sinuata	—	—	—	—	—	—	—	×	—	—	×	×	×	×	×
Idiognathoides sulcata sulcata	—	—	—	—	—	—	—	×	×	—	×	×	—	×	×
Idiognathoides attenuata	—	—	—	—	—	—	—	—	—	—	—	×	×	×	×
Idiognathoides convexa	—	—	—	—	—	—	—	—	—	—	—	—	—	×	×
Idiognathoides sulcata parva	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×
Lonchodina clarki	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×

Chart No. 2.

	Bioul				Jaiffe					
	10	8	7	5	21	23	24	28	30′	30
Cavusgnathus navicula	—	×	—	—	—	×	—	—	—	—
Gnathodus girtyi sub. sp. nov.	—	×	×	—	—	×	—	—	—	—
Hibbardella milleri	—	—	×	—	—	—	—	—	—	—
Hindeodella undata	—	—	×	×	—	×	—	—	—	—
Lambdagnathus macrodentata	—	—	×	—	—	×	—	—	—	—
Lonchodina bischoffi	—	—	×	—	×	—	—	—	—	—
Magnilaterella robusta	—	—	×	—	—	—	—	—	—	—
Metalonchodina sp.	—	—	×	×	×	×	—	×	×	—
Neoprioniodus scitulus	—	—	—	—	—	×	×	—	—	—
Neoprioniodus spathatus	—	—	—	×	×	×	—	—	—	—
Subbryantodus subaequalis	—	—	—	×	—	—	—	×	×	—
Spathognathodus campbelli	—	—	—	×	—	—	—	—	—	—
Gnathodus commutatus	×	×	×	×	×	×	×	×	×	—
Gnathodus cruciformis	×	—	—	—	×	—	—	×	—	—
Gnathodus nodosus	×	—	—	—	×	—	×	×	×	—
Gnathodus bilineatus bilineatus	×	—	×	×	×	—	×	×	×	—
Hindeodella germana	—	—	—	—	×	—	×	×	×	—
Hindeodella uncata	—	—	×	—	×	—	—	—	—	—
Neoprioniodus singularis	×	—	×	×	×	—	×	×	×	—
Gnathodus girtyi girtyi	×	×	×	×	×	×	—	×	×	×
Gnathodus girtyi intermedius	—	×	—	—	—	—	—	×	×	×
Hibbardella acuta	—	—	—	×	—	—	—	—	—	—
Roundya barnettana	—	—	—	—	×	×	—	×	×	—
Hindeodella ibergensis	×	—	—	—	×	—	—	×	×	—
Neoprioniodus conjunctus	—	—	—	×	—	—	—	—	—	—
Ozarkodina delicatula	—	—	—	—	—	×	—	—	—	—
Synprioniodina microdenta	×	—	—	—	—	—	—	—	—	—
Ligonodina typa	—	×	—	×	×	—	—	×	×	—
Lonchodina furnishi	—	—	—	—	×	—	—	—	—	—

Pendleian (*E1*), sub-stage and the difficulty of obtaining in Belgium suitable samples of Yeadonian (*G1*) age on the other. Conodonts from both sub stages are however, known from Britain (HIGGINS, 1961, 1962).

1. *V3c.* — **Couches de Passage.**

These beds were described in detail by DEMANET (1938) and BOUCKAERT and HIGGINS (1963) who showed them to consist of alternations of limestone and shale with brachiopods, crinoids and goniatites. The latter include *Goniatites subcircularis* and *Goniatites newsomi.*

Two sections have been examined in detail, the quarry at Jaiffe à Warnant (loc. XIX), and the Merbes-Sprimont Quarry at Bioul (loc. V). From the former some six horizons yielded conodonts and from the latter four (see Chart 2).

The fauna is varied but there is a preponderance of one genus in most samples this being the genus *Gnathodus* which usually comprises some 70 % of the total fauna. Particularly common are the species *Gnathodus bilineatus* and *Gnathodus girtyi* and at some horizons *Gnathodus nodosus.* Other abundant species include *Gnathodus commutatus* and *Neoprioniodus singularis.* Stratigraphically the important species are *Gnathodus nodosus*, *Lambdagnathus macrodentata* and *Neoprioniodus spathatus* which have not been recorded below this horizon. *Cavusgnathus* may be locally useful because it has not been recorded below *V3b* or above *V3c* in Belgium. Similarly *Gnathodus girtyi* subsp. nov. has not been recorded in the Namurian.

This fauna belongs to the *bilineatus-nodosus* zone.

2. **Sub-stage Arnsbergian** *(E2).*

The Arnsbergian was sampled at four main horizons, *E2a1* at Bioul (loc. V), *E2b2* at Monceau-sur-Sambre (loc. XV), *E2b3* at Verviers (loc. XVIII), and *E2c* at Bolland (loc. I). The upper three horizons were limestones or limestone bullions and the first was a shale. The following species were recorded :

Metalonchodina sp.
Gnathodus commutatus (BRANSON and MEHL).
Gnathodus nodosus BISCHOFF.
Gnathodus bilineatus bilineatus (ROUNDY).
Gnathodus cruciformis CLARKE.
Hindeodella germana HOLMES.
Hindeodella uncata (HASS).
Neoprioniodus singularis (HASS).
Gnathodus girtyi girtyi HASS.
Hibbardella acuta MURRAY and CHRONIC.
Roundya subacoda (GUNNELL).
Hindeodella ibergensis BISCHOFF.
Ozarkodina delicatula (STAUFFER and PLUMMER).
Synprioniodina microdenta ELLISON.
Hibbardella pennata HIGGINS.
Ligonodina fragilis HASS.
Gnathodus bilineatus (ROUNDY) subsp. *bollandensis* nov.
Angulodus simplex sp. nov.
Ligonodina typa (GUNNELL).
Gnathodus noduliferus ? (ELLISON and GRAVES).
Gnathodus girtyi intermedius GLOBENSKY.
Lonchodina sp.

The conodont faunas of the Arnsbergian are basically very similar to those of *V3c*. The abundant species are *Gnathodus bilineatus*, *Gnathodus nodosus* and *Neoprioniodus singularis*. In bullion faunas species of *Hindeodella* such as *H. ibergensis* and *H. germana* are very common. There are, however, several differences from any earlier faunas. In the first place the faunas are less varied and species such as *Spathognathodus cambelli*, *Lambdagnathus macrodentata*, *Subbryantodus subaequalis* and *Gnathodus girtyi* subsp. nov. have not been recorded from the Arnsbergian. In the second place new forms appear in the Arnsbergian which have not been recorded below this horizon. These include *Gnathodus noduliferus* which is doubtfully recorded from the *E2a1* sub-zone and which is comparable to *Cavusgnathus nodulifera* recorded from basal *E2* beds in northern Spain (HIGGINS, 1962). This species is rare in the Arnsbergian. They also include *Gnathodus bilineatus bollandensis* a new subspecies which makes its first appearance in the *E2b2* subzone at Monceau-sur-Sambre and is a common element of middle and upper Arnsbergian faunas. Also appearing for the first time are *Hibbardella pennata*, *Ligonodina fragilis* and *Angulodus simplex* but only the first named species has not been recorded from below the Arnsbergian elsewhere.

3. **Sub-stage Chokerian** *(H1)*.

The lowest zone of this sub-stage, that of *Homoceras subglobosum* is not well known in Belgium and the one locality at which it was sampled (loc. IX) did not yield a fauna.

The upper zone, that of *Homoceras beyrichianum* however, yielded good faunas from several localities. These were Ronet (loc. VIII), Blaton (loc. XX) and Bolland (loc. I). The fauna includes the following species :

Gnathodus bilineatus bilineatus (ROUNDY)	L
Hindeodella germana HOLMES	L
Hindeodella uncata (HASS).	
Neoprioniodus singularis (HASS)	L
Gnathodus cf. *girtyi* HASS	L, U
Hibbardella acuta MURRAY and CHRONIC	L
Ozarkodina delicatula (STAUFFER and PLUMMER)	L
Synprioniodina microdenta ELLISON	L
Gnathodus bilineatus bollandensis subsp. nov.	L
Angulodus simplex sp. nov.	L
Idiognathoides minuta sp. nov.	U
Gnathodus noduliferus (ELLISON and GRAVES)	U
Gnathodus japonicus (IGO and KOIKE)	U
Ligonodina typa (GUNNELL)	L
Hindeodella ibergensis BISCHOFF	L

L = Lower Fauna; U = Upper Fauna.

The faunas of this goniatite zone fall into two parts, an upper and a lower, which are very different in character. The lower part has a fauna which is a continuation of the late Arnsbergian faunas with *Gnathodus bilineatus bilineatus* and *G. bilineatus bollandensis*, *Neoprioniodus singularis* and *Hindeodella germana* in abundance. The upper part has a fauna in which the above species are absent and their place is taken by *Gnathodus noduliferus*, *Gnathodus japonicus* and *Idiognathoides minuta*. The latter species appears to be restricted to this horizon; it has been recorded from the same zone in England.

4. Sub-stage Alportian *(H2)*.

Only two of the three zones of this sub-stage are known in Belgium and only one, the *Homoceratoides prereticulatus* is widespread. This latter zone has yielded very abundant and distinctive faunas at three localities. These are Spy (loc. XVII), the Citadel of Namur (loc. VIII), and Bolland (loc. I).

The following species were recorded :

Hindeodella uncata (HASS).
Gnathodus cf. *girtyi* HASS.
Hibbardella acuta MURRAY and CHRONIC.
Hindeodella ibergensis BISCHOFF.
Ozarkodina delicatula (STAUFFER and PLUMMER).
Angulodus simplex sp. nov.
Roundya barnettana HASS.
Synprioniodina microdenta ELLISON.
Gnathodus noduliferus (ELLISON and GRAVES).
Gnathodus japonicus (IGO and KOIKE).
Streptognathodus elegantulus STAUFFER and PLUMMER.
Streptognathodus lateralis sp. nov.

This fauna is a continuation of that found in the upper part of the *Homoceras beyrichianum* zone. The most abundant species are *Gnathodus noduliferus* and *Streptognathodus lateralis* and in the bullions *Hindeodella ibergensis*. The most important new feature is the appearance of the genus *Streptognathodus*. This is unlikely to be its earliest occurrence since it is known from lower zones in the Alportian and Chokerian in England and has been recorded from the *Hudsonceras proteum* zone in Northern France (LYS, MAUVIER and SERRE, 1962). However, it does not occur in abundance below the Alportian and appears to be characteristic of the sub-stage.

5. Sub-stage Kinderscoutian *(R1)*.

The Kinderscoutian has been described in great detail by BOUCKAERT (1960) and is well known in Belgium. Consequently it has been sampled at several localities. *Reticuloceras nodosum* (*R1b*) and *R. reticulatum* (*R1c*) were sampled from Bolland (loc. I). *R. nodosum* was also sampled from Hautrage (loc. II). *R. circumplicatile* (*R1a*) and *R. nodosum* were sampled at Flawinne (loc. VI). *R. reticulatum* was sampled at Abbaye de Val-Dieu (loc. XIII). All of these samples yielded conodonts, but the majority were from shale horizons and the fauna largely consisted therefore of polygnathids.

The following species were recorded :

Roundya barnettana HASS.
Hindeodella ibergensis BISCHOFF.
Ozarkodina delicatula (STAUFFER and PLUMMER).
Gnathodus noduliferus (ELLISON and GRAVES).
Gnathodus japonicus (IGO and KOIKE).
Streptognathodus elegantulus STAUFFER and PLUMMER.
Streptognathodus lateralis sp. nov.

Idiognathoides corrugata (HARRIS and HOLLINGSWORTH).
Idiognathoides sinuata sinuata HARRIS and HOLLINSWORTH.
Ligonodina typa (GUNNELL).
Idiognathoides sulcata sp. nov.

The appearance, for the first time, of the genus *Idiognathoides* at the base of the Kinderscoutian is of considerable importance because it is one of the most abundant genera in the succeeding stages. It is known to occur at earlier horizons in England but it has not been recorded in abundance below this sub-stage. It is represented by three species, *Idiognathoides corrugata*, *Idiognathoides sinuata sinuata* and *Idiognathoides sulcata* of which *I. corrugata* has not been recorded below this sub-stage. *Gnathodus noduliferus* and *Streptognathodus lateralis* are still abundant species

6. **Marsdenian** *(R2).*

The Marsdenian has been sampled at two localities. The lower one, *Reticuloceras gracile* (*R2a*) horizon, was sampled at Webbekom (loc. IV), and the upper one *R. bilingue* (*R2b*) at Turnhout (loc. III). One sample from the latter horizon was a limestone but it did not yield a large fauna. The remainder were shales and therefore yielded mainly polygnathids.

The following species were recorded :

Roundya barnettana HASS.
Hindeodella ibergensis BISCHOFF.
Ozarkodina delicatula (STAUFFER and PLUMMER).
Angulodus simplex sp. nov.
Streptognathodus elegantulus STAUFFER and PLUMMER.
Streptognathodus lateralis sp. nov.
Idiognathoides corrugata (HARRIS and HOLLINGSWORTH).
Idiognathoides sinuata sinuata HARRIS and HOLLINSWORTH.
Idiognathoides attenuata (HARRIS and HOLLINSWORTH).
Gnathodus japonicus (IGO and KOIKE).
Ligonodina typa (GUNNELL).
Idiognathoides sulcata sp. nov.

The composition of the faunas changes at this horizon and *Gnathodus noduliferus* disappears although a few specimens have been recorded from England. The important forms at this stage are *Idiognathoides* and *Streptognathodus*. *Idiognathoides* is represented by *Idiognathoides sinuata*, *Idiognatoides sulcata* and *I. corrugata*, which were present in the Kinderscoutian, and *Idiognathoides attenuata* which appears at this horizon. *Gnathodus japonicus* is uncommon. LYS, MAUVIER and SERRE recorded the occurrence of *Idiognathodus* in the *R2b* zone in Northern France, and it is known to occur in *R2a* in Britain (HIGGINS, 1962).

7. *G2.*

The Lower Westphalian marine bands of *Gastrioceras subcrenatum* and *Gastrioceras listeri* were sampled at the colliery of Moha (XIV). The lower bed of the two was preserved in shales and so yielded only polygnathids, but the upper one was sampled from both bullions and shales.

The following species were recorded :

Idiognathoides sulcata sp. nov.
Neoprioniodus conjunctus (GUNNELL).
Ozarkodina delicatula (STAUFFER and PLUMMER).
Synprioniodina microdenta ELLISON.
Streptognathodus elegantulus STAUFFER and PLUMMER.
Streptognathodus lateralis sp. nov.
Idiognathoides corrugata (HARRIS and HOLLINSWORTH).
Idiognathoides sinuata sinuata HARRIS and HOLLINGSWORTH.
Idiognathoides attenuata (HARRIS and HOLLINGSWORTH).
Idiognathoides convexa (ELLISON and GRAVES).
Idiognathoides sulcata parva sp. and sub. sp. nov.
Lonchodina clarki (GUNNELL).
Ligonodina typa (GUNNELL).
Hindeodella ibergensis BISCHOFF.

Fundamentally these faunas are similar to those of the Marsdenian. They are dominated by *Idiognathoides* and *Streptognathodus* with additional species such as *Idiognathoides convexa* and *Idiognathoides sinuata parva*. The former appears at the base of the Westphalian and the latter at the *G. listeri* marine band.

STRATIGRAPHIC CONCLUSIONS.

The succession of conodont faunas may be summarised as follows :

1. *V3c* ..... Faunas characterised by *Gnathodus bilineatus, G. girtyi girtyi, G. girtyi intermedius, G. girtyi* sub. sp. nov. *Gnathodus commutatus, G. nodosus, Lambdagnathus macrodentata* and species of *Neoprioniodus*.

2. *E2a* ..... These faunas are poorly known in Belgium, but may include the first occurrence of the important species *Gnathodus noduliferus*. They also include *Gnathodus bilineatus* and *G. girtyi*.

3. *E2b2-E2c* ..... These faunas are characterised by *Gnathodus bilineatus, Gnathodus girtyi* and *Gnathodus nodosus*. *Gnathodus bilineatus bollandensis* appears in the *E2b3* subzone. *Gnathodus nodosus, Gnathodus commutatus, Gnathodus cruciformis* and *Hibbardella pennata* have not been recorded above *E2c*.

4. *H1*-Lower ..... *Gnathodus bilineatus bollandensis* and *Neoprioniodus singularis* characterise the early part of the Chokerian but no new species appear.

5. *H1*-Upper ..... *Idiognathoides minuta, Gnathodus* cf. *girtyi, Gnathodus noduliferus* and rare specimens of *Gnathodus japonicus* characterize the upper part of the Chokerian.

6. *H2* ..... The appearance of *Streptognathodus* in the Alportian and its association with *Gnathodus* cf. *girtyi, Gnathodus noduliferus* and *G. japonicus* characterise this sub-stage. The abundance of *Hindeodella ibergensis, Ozarkodina delicatula* and *Synprioniodina microdenta* is characteristic of this and the succeeding sub-stages.

R1 ..... The Kinderscoutian faunas have an abundance of *Idiognathoides* species, such as *Idiognathoides sinuata* and *I. sulcata* together with *Gnathodus noduliferus*.

R2 ..... Marsdenian faunas are very similar to those of the preceeding sub-stage differing mainly in the rarity of species of *Gnathodus*, particularly *Gnathodus noduliferus*. *Idiognathoides attenuata* appears at this horizon for the first time.

G2 ..... *Idiognathoides* species, particularly *I. corrugata* and *I. attenuata* dominate early Westphalian faunas. *Gnathodus* is absent. Species appearing for the first time include *Idiognathoides sinuata parva* and *Idiognathoides convexa*.

CORRELATION OF NAMURIAN CONODONT FAUNAS.

The major changes in the succession of Namurian conodont faunas occur not at the base and top but approximately in the middle, in the Chokerian and Alportian sub-stages. It is a gradual change involving the disappearance of many earlier species and the appearance of new ones over a considerable span of time. It involves a change from faunas dominated by *Gnathodus*, which existed from the early Visean to the beginning of the Chokerian, to faunas dominated by *Idiognathoides* and *Streptognathodus*. It also involves a gradual reduction in the number of species from a maximum of about 35 species in the early Namurian to about 21 species in the late Namurian.

Similar changes can be seen to a greater or lesser extent in successions of similar age in various parts of the Northern Hemisphere.

Conodonts of Namurian age have been described from North America, several countries in Europe, North Africa and Asia and most of them show considerable similarity.

In North America intensive studies in the Upper Mississippian Valley by COLLINSON, SCOTT and REXROAD and others resulted in the publication of six charts showing the distribution of conodonts in the type area of the Upper Mississippian Chester Series and of the Devonian and the Lower and Middle Mississippian of the same area (COLLINSON, SCOTT and REXROAD, 1962). The faunas from the Upper Chester Series show some similarity with those of the Pendleian and Arnsbergian of western Europe although the differences are significant. All of the genera found in the Upper Chester Series, with the exception of *Cladognathodus* and *Hindeodus*, have been recorded in the two lowest sub-stages of the Namurian and eleven species including *Gnathodus bilineatus* and *Gnathodus girtyi* are common to the two areas. A general correspondence between the Glen Dean Formation conodonts and early Namurian faunas was noted by HIGGINS (1961) and a general correlation between the highest Chester Grove Church Formation (called Kincaid by REXROAD and BURTON, 1961) and the base of the Homoceras (Chokerian) sub-stage was suggested by COLLINSON, SCOTT and REXROAD (1962) on the basis of the mutual first appearance of *Streptognathodus*. LANE (1967) has shown that the Grove Church specimens do not belong to the genus *Streptognathodus* but the general composition of the Grove Church faunas suggests a probable correlation with the late Arnsbergian and early Chokerian.

REXROAD (1958) first noted the presence of a southern faunal province in North America, including Oklahoma and Texas, with rather different conodont faunas. These latter are dominated by species of the genus *Gnathodus* rather than species of *Cavusgnathus* which is the dominant genus in most of the northern province faunas. These faunas from the southern province, notably from Texas (HASS, 1954) and from Oklahoma (ELIAS, 1956), are closely comparable to early Namurian faunas from Europe. Most of the common species in the two areas are similar including *Gnathodus bilineatus*, *Gnathodus girtyi*, *Gnathodus commutatus* and *Neoprioniodus singularis* and there seems to be a close correspondence in age between the upper faunal zone of the Barnett Formation of Texas, the Delaware Creek Formation of Oklahoma and the early Namurian (*E1* and *E2*) of western Europe.

A fauna recently described from Nevada (DUNN, 1965) shows elements of both faunal provinces including *Gnathodus bilineatus*, *Gnathodus girtyi* and *Adetognathus unicornis*. The figured specimens of *Gnathodus bilineatus* appear to be very similar

to *Gnathodus bilineatus bollandensis* and those of *Gnathodus girtyi simplex* are closely similar to *Gnathodus noduliferus* which would place this fauna in the Chokerian or late Arnsbergian.

Conodonts of Lower Pennsylvanian age are poorly known. The most extensive fauna is from the Dimple Limestone of Texas (ELLISON and GRAVES, 1941). The conodonts of the lower Pennsylvanian are less varied than those of the Upper Mississippian and are characterised by three genera, *Idiognathoides*, *Idiognathodus* and *Streptognathodus*. All of the species of *Idiognathoides* found in the Dimple Limestone are also found in the Namurian of western Europe, and comparison of the faunas suggests a correlation of at least the lower part of the Dimple Limestone with the highest part of the Namurian. All three genera first occur together in the Marsdenian (*R2*) sub-stage although the species of *Idiognathodus* and *Streptognathodus* are rather simple forms at this horizon. A general correlation of the Dimple Limestone with the later Namurian-Westphalian is suggested. The same general correlation applies to the early Pennsylvanian conodonts described by DUNN (1966).

There is, therefore, a correspondence between late Mississippian and late Arnsbergian-early Chokerian conodont faunas and between later Namurian and early Pennsylvanian conodont faunas, but there is little evidence of faunas of Alportian and Kinderscoutian age having been described from North America.

In Europe too, no-one has described a complete sequence of Namurian conodont faunas. CLARKE (1960) described faunas from the Upper Limestone Group (*E2*) of Scotland, which are very comparable to Arnsbergian faunas in Belgium, with an abundance of species of *Gnathodus* such as *Gnathodus bilineatus*, *Gnathodus commutatus*, *Gnathodus girtyi* and including *Gnathodus nodosus*. The main differences are the presence in Scotland of *Apatognathus* and several species of *Spathognathodus* such as *S. scitulus*, *S. exodentatus* and *S. pusilus*. A few specimens from the Millstone Grit of Scotland include *Gnathodus noduliferus* and *Idiognathodus* sp. which suggest a Marsdenian age for these beds by comparison with the Namurian successions in England and Belgium. Faunas described from the Namurian of the English Pennines (HIGGINS, 1961, 1962) show an identical sequence to that of Belgium except that they are more complete, including faunas of Pendleian and Yeadonian age, and are richer in variety because of their greater abundance.

In a recent note by LYS, MAUVIER and SERRE (1962) several species from the Namurian of northern France were identified. The important point of comparison between the French and the Belgian faunas is the presence of *Streptognathodus* in the Alportian.

Conodont faunas of Pendleian and Arnsbergian age, described by HIGGINS (1962), BUDINGER (1965) and BOOGAERT (1967) from Spain, follow the normal pattern for faunas of this age in western Europe. The dominant species are *Gnathodus bilineatus*, *Gnathodus commutatus* and *Gnathodus nodosus*. A few specimens of *Gnathodus noduliferus* were recorded from the early Arnsbergian by HIGGINS.

Namurian faunas from Asia have been described recently by IGO and KOIKE (1954, 1965) and by KOIKE (1967). These faunas from Japan show many points of similarity with the European ones. Faunas of probable Namurian age have been divided into four zones (KOIKE, 1967). At the base is the *Gnathodus bilineatus-G. commutatus nodosus* zone which compares broadly with late Visean (*V3c*) to mid-Arnsbergian faunas in Europe. Above this is the *Gnathodus bilineatus-G. nodulifera* zone which compares with late Arnsbergian to Chokerian faunas in Europe. Following this zone is the *Gnathodus wapanuckensis* zone of probable Alportian and Kinderscoutian

age and at the top is the *Idiognathodus parvus-Gnathodus nodulifera* zone of probable Marsdenian and Yeadonian age.

An incomplete Namurian conodont sequence has recently been described from North America by LANE (1967). The earliest faunas, referred to the *Adetognathus unicornis* zone show little similarity to any described faunas in Europe but the presence of species such as *Cavusgnathus navicula*, *Hibbardella milleri*, *Neoprioniodus varians* and *Neoprioniodus scitulus* suggest a late Visean-early Namurian age. Lane is uncertain of the correlation of this zone with the standard Namurian succession but broadly suggests an Arnsbergian age. Above this zone, but separated from it by a considerable gap, is the *Idiognathoides* aff. *I. nodulifera* zone. Only a few specimens have been described from this zone and of these only *Idiognathoides* aff. *I. nodulifera* bears any resemblance to European species. This species is comparable to *Gnathodus japonicus* and possibly *Streptognathodus lateralis* and therefore the zone correlates broadly with Alportian and Kinderscoutian beds. The succeeding zone, that of *Gnathodus bassleri symmetricus*, contains *Idiognathoides corrugata*, *I. sinuata* and *I. attenuata* and therefore correlates broadly with Marsdenian and Yeadonian beds in Europe.

SYSTEMATIC DESCRIPTION

All type and figured material included in this study has been deposited in the collections of the « Service Géologique de Belgique, Bruxelles ».

The heading distribution refers to the known stratigraphic ranges of conodonts in Belgium.

Where species are well known only the original references to the species has been given. Elsewhere, synonymies are complete.

Genus **ANGULODUS** HUDDLE, 1934.

Type species : *Angulodus demissus* HUDDLE, 1934.

Angulodus simplex sp. nov.

(Pl. 1, fig. 7.)

Angulodus walrathi (HIBBARD) HIGGINS, 1961, pl. X, fig. 16.

Holotype : Pl. 1, fig. 7.

Diagnosis. — A species of *Angulodus* with a long, low posterior bar which bears incurved denticles, and a shorter, low, aborally curved and bent anterior bar whose distal extremity is pointed.

Description. — The posterior bar is long and low but increases in height towards the mid-point. The bar is straight or slightly arched and slightly curved in oral view. It runs to a point at the posterior end, but the posterior end is often broken. On its oral surface are numerous alternating, rounded, slender denticles usually with a greater number in the middle of the bar. All the denticles are incurved but the large ones show a greater degree of incurvature than the small ones. The alternation is regular in small and average sized specimens but becomes irregular in large ones where the denticles originate from the outer side of a laterally thickened bar.

The main cusp is smaller than the largest posterior bar denticle but in a few specimens it has greater incurvature than the denticles of the posterior bar. There is often a small lip on the inner side of the unit, below the cusp, which may extend a little way down the anterior bar.

The anterior bar is thinner than the posterior and is bent and incurved about 30° and aborally bent about 45°. It is about one-fifth the length of the posterior bar in an average specimen but in small ones may be almost half the length. Its aboral edge is curved and may be sharply bent downwards at the distal end. The whole bar is slightly folded along its length so that the inner side is concave and the outer convex. The oral surface bears numerous rounded denticles of two main sizes but they are not always alternating.

The aboral cavity is small and may be continued along the unit as a groove.

Comparisons. — This species differs from *Angulodus walrathi* (HIBBARD) in possessing a longer posterior bar, smaller cusp and a shorter anterior bar.

Discussion. — This species almost certainly includes some of the specimens which BISCHOFF (1957) referred to *Angulodus walrathi*. He noted (pp. 17 and 18) that in the upper part of the Lower Carboniferous of Germany were specimens with a small cusp and bar denticles which were incurved. These specimens probably belong to *Angulodus simplex* sp. nov. Typical specimens of *Angulodus walrathi* have not been recorded from the Namurian.

Distribution. — *E2b2-R2.*

Genus **CAVUSGNATHUS** HARRIS and HOLLINGSWORTH, 1933.

Type species : *Cavusgnathus alta* HARRIS and HOLLINGSWORTH, 1933.

Cavusgnathus navicula (HINDE).

(Pl. 2, figs. 7, 8.)

Cavusgnathus unicornis ? BOUCKAERT and HIGGINS, 1963, fig. 3.

Distribution. — *V3c* supérieur.

Genus **GNATHODUS** PANDER, 1856.

Type species : *Gnathodus mosquensis* PANDER, 1856.

Gnathodus bilineatus (ROUNDY) sub sp. **bilineatus.**

(Pl. 3, fig. 9.)

Polygnathus (*Gnathodus*) *Mosquensis* PANDER (sic), HINDE, 1900, pl. IX, figs. 2-4.

Distribution. — *V3c-H1.*

Gnathodus bilineatus (ROUNDY) sub. sp. **bollandensis** nov.

(Pl. 2, figs. 10, 13; Pl. 3, figs. 4-8, 10.)

Holotype : Pl. 2, fig. 10.

Diagnosis. — A subspecies of *Gnathodus bilineatus* whose platform has a narrow outer side which is weakly ornamented.

Description :

Oral View. — The blade is narrow, straight or slightly curved and bears numerous laterally compressed denticles on its oral edge. Posteriorly, it is continued as a carina composed of fused and laterally thickened nodes which narrow towards the posterior end of the platform. The carina is approximately the same length as the blade. The inner side of the platform parallels the carina but is for the most part separated from it by a trough. At the posterior end, however, the platform may consist of isolated nodes which may be fused to the nodes of the carina, forming

transverse ridges. Anterior to these the platform consists of an elevated, transversely ridged parapet which is widest at a point about one-third from the anterior end, from which point it tapers gradually posteriorly but sharply anteriorly. The outer side of the cup is wider but shorter than the inner side and is sub-ovate to sub-rectangular in outline. Its width is about one-third of its length. The angle between the carina and the anterior edge of the cup is approximately a right angle. On the surface of the outer half of the platform is a small area ornamented with nodes or ridges which is separated from the edge of the cup by a wide, smooth marginal band. Typically, the ornamentation is concentrated in the anterior half. In a few extreme variants the cup may be smooth except for a few anterior nodes. Adjacent to, and often fused with the carina, may be found a row of nodes at the posterior end of the platform.

Lateral View. — The carina and the oral surface of the platform are downcurved posteriorly. The oral edge of the blade is irregular but usually rises slightly to a point about one-third from the anterior end. The aboral edge of the unit is straight to slightly concave.

Aboral View. — The aboral side of the cup is strongly excavated and is crossed by a longitudinal groove which is continued beneath the blade.

Comparisons. — *Gnathodus bilineatus bollandensis* differs from *Gnathodus bilineatus bilineatus* and *Gnathodus bilineatus modocensis* REXROAD in possessing a narrow outer half of the cup which is weakly ornamented.

Discussion. — The change from faunas dominated by *Gnathodus bilineatus bilineatus* to those dominated by *Gnathodus bilineatus bollandensis* consistently takes place in mid-late Arnsbergian (*E2*) times and by Chokerian (*H1*) times typical *G. bilineatus bilineatus* is a rare form.

Distribution. — *E2b2-H1.*

Gnathodus commutatus (BRANSON and MEHL).

(Pl. 2, fig. 5.)

Spathognathodus commutatus BRANSON and MEHL, 1941, pl. 19, figs. 1-4.

Discussion. — This species formerly included several subspecies or varieties which are here regarded as separate species. These include the following species :

Gnathodus commutatus (BRANSON and MEHL).
Gnathodus cruciformis CLARKE.
Gnathodus homopunctatus ZEIGLER.
Gnathodus multinodosus HIGGINS.
Gnathodus nodosus BISCHOFF.

The range of these species are now known in western Europe and have been shown to differ from each other.

Distribution. — *Tn3a-E2b3.*

Gnathodus cruciformis CLARKE.

Gnathodus cruciformis CLARKE, 1960, p. IV, figs. 10-12.

Discussion. — This species was included in *Gnathodus commutatus nodosus* by HIGGINS 1961 as an extreme variant of that variety and more recently REXROAD and FURNISH, 1964 formally considered the two as synonyms.

However, the ranges of the two are now known to differ and they are therefore considered to be separate species.

Distribution. — *V3c* supérieur-*E2b3*.

Gnathodus homopunctatus ZIEGLER.

Gnathodus homopunctatus ZIEGLER, 1959, pl. 4, fig. 3.

Discussion. — This species has not been recorded from the Namurian of Belgium but it is known from the Lower Carboniferous (CONIL, LYS and MAUVIER, 1964). A few specimens have been recorded from the early Namurian of England (HIGGINS, 1961) but it is a very rare species above the Lower Carboniferous.

Distribution. — *Tn3b-V3b*.

Gnathodus nodosus BISCHOFF.

(Pl. 2, figs. 2, 3.)

Gnathodus nodosus BISCHOFF, 1957, pl. 4, figs. 12, 13.

Discussion. — This stratigraphically useful species is common in many of the late Visean and early Namurian conodont faunas of western Europe.

Distribution. — *V3c-E2c*.

Gnathodus girtyi HASS.

Gnathodus girtyi HASS, 1953, pl. 14, figs. 22, 24.
Gnathodus girtyi HASS, FLUGEL and ZIEGLER, 1957, pl. 3, figs. 9-13, 20.
Gnathodus girtyi HASS, BISCHOFF, 1957, pl. 4, figs. 16-23.
Gnathodus clavatus CLARKE, 1961, pl. 1, figs. 4-6.
Gnathodus girtyi HASS, HIGGINS, 1961, pl. X, fig. 4.
Gnathodus girtyi HASS, HIGGINS, 1962, pl. 3, fig. 31.
Gnathodus girtyi HASS, GLOBENSKY, 1967, pl. 58, figs. 11, 15-20.

Gnathodus girtyi girtyi HASS.

Gnathodus girtyi HASS, A, BOUCKAERT and HIGGINS, 1963, pp. 13, 17.

Distribution. — The complete range in Belgium is unknown but is at least from *V3c* to *E2b3*.

Gnathodus girtyi HASS subsp. **intermedius** GLOBENSKY.

(Pl. 3, fig. 11.)

Gnathodus girtyi intermedius GLOBENSKY, 1967, pl. 58, figs. 11, 15-20.
Gnathodus girtyi HASS, B, BOUCKAERT and HIGGINS, 1963, pp. 13, 17.

Discussion. — The platform of this subspecies is better developed than that of *Gnathodus girtyi girtyi* whereas the carina tends to be less prominent, particularly at the posterior end where it consists of isolated nodes. In the posterior half of the platform the carina may not rise above the level of the platform margins.

Distribution. — *V3c-E2b3.*

Gnathodus girtyi subsp. nov.

(Pl. 5, fig. 12.)

Description :

Oral View. — The blade is 1 ½-2 the length of the platform and is slightly curved. It is continued posteriorly to the end of the unit as a prominent carina. The latter consists of nodes which are only partially fused. The platform is poorly developed and consists of two low parapets, on either side of the carina, which are approximately equal in length. The outer is narrow with a convex outer margin and is noded on its oral surface. The inner side is somewhat wider and is separated from the carina by a sulcus. It consists of a noded ridge which may be continued a short distance posteriorly as a row of nodes but it never extends to the posterior extremity. The cup is asymmetric, being wider but shorter on the outer than on the inner side.

Lateral View. — The oral edge of the carina is convex. The oral edges of the platform are approximately horizontal but differ in height since the outer is lower than the inner.

Aboral View. — The aboral side of the cup is excavated.

Discussion. — Only a few specimens of this subspecies have been recorded and none of them are sufficiently complete to justify the erection of a new category. However, the subspecies has not yet been recorded from Namurian rocks and may therefore be stratigraphically useful.

The subspecies is not directly comparable with *Gnathodus girtyi simplex* as suggested by DUNN, 1965 (p. 1148). The carina is virtually free throughout its length and there is no indication of the fusion with the outer side which characterises that subspecies.

Distribution. — *V3c.*

Gnathodus cf. **girtyi.**

(Pl. 1, fig. 9; Pl. 5, figs. 5, 6.)

Discussion. — Specimens from the Chokerian and Alportian stages which could be referred to *Gnathodus girtyi* differ from that species in a number of ways which may have some significance. The major difference is their consistently smaller

size, both length and breadth. Small size, relative to that of specimens from the preceding and in many instances from the succeeding stages, is a feature of all the platform species in the Chokerian and Alportian. In addition some specimens have a platform which has more rounded margins and is more symmetrical with respect to the length and width of the inner and outer sides than is usual in *Gnathodus girtyi*. Nevertheless, the majority of the specimens referred to *Gnathodus* cf. *girtyi* differ only in size from earlier specimens of the species and this may be a reflection of local environmental, rather than general evolutionary change.

Remarks. — The relationship of *Gnathodus* cf. *girtyi* to *Streptognathodus lateralis* is indicated in figure 6. These specimens were taken from a single sample of the *Homoceratoides prereticulatus* marine band and they indicate two of the main trends seen at this horizon. One trend is towards the reduction in size and length of the carina and the other is towards a fusion of the carina with the outer side of the platform. The latter appears to be a gradual fusion which starts at the posterior end.

Distribution. — *H1b-H2c.*

Gnathodus noduliferus (ELLISON and GRAVES, 1941).

(Pl. 2, figs. 6, 12.)

Cavusgnathus nodulifera ELLISON and GRAVES, 1941, pl. 3, fig. 4 only.
Streptognathodus parallelus CLARKE, 1961, pl. 5, figs. 6-8, 14, 15.
Cavusgnathus nodulifera ELLISON and GRAVES, 1941, HIGGINS, 1962, pl. 3, fig. 27.

Diagnosis. — A species of *Gnathodus* with the carina partially merged with the outer side of the platform.

Description :

Oral View. — The unit is lanceolate and consists of a thin blade and a platform which is an outgrowth from a flaring cup. The blade is typically about 1 ½ times the length of the platform and is either median or slightly offset to the outer side. It is continued on to the platform as a carina of variable length which merges with the outer side of the platform, often but not always bending towards the outer side. Posterior to the termination of the carina the outer side of the platform is about the same width as the inner side. The platform consists of two parapets ornamented with nodes which are separated by a groove at the posterior end and by the carina at the anterior.

Lateral View. — The platform is longitudinally flat or slightly convex and its outer side is often higher than its inner posterior to the point of its merging with the carina.

Aboral View. — The cup is concave and is widest near the anterior end; the inner side is narrower and longer than the outer. The cup is typically gnathodid in shape.

Comparisons. — *Gnathodus noduliferus* bears many similarities to *Gnathodus girtyi simplex* DUNN. However, the shape of the platform is somewhat different from that of the latter which is very narrow posteriorly and widens markedly

anteriorly, whereas that of the former subspecies is more uniform in width. In addition the inner platform margin is more markedly sinuous in *Gnathodus girtyi simplex*.

Discussion. — The specimen figured on plate 3, figure 6 of ELLISON and GRAVES as *Cavusgnathus nodulifera* is incomplete but does not appear to belong with *Gnathodus noduliferus*. The blade appears to be continued to the posterior end as a row of nodes which are partially fused to the outer side of the platform but which retain a median position throughout their length. Such specimens have been referred to *Streptognathodus lateralis* in this work.

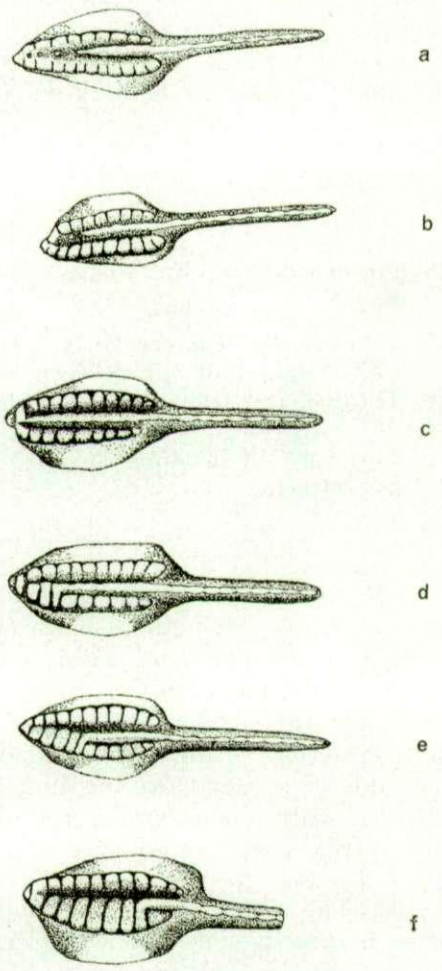

FIG. 6. — A diagram illustrating the suggested relationships between *Gnathodus* cf. *girtyi* HASS and *Streptognathodus lateralis* sp. nov. Specimens a-c : illustrate the gradual reduction of the carina in *Gnathodus* cf. *girtyi* suggesting a trend towards *Streptognathodus elegantulus*. Specimens d-f : illustrate the fusion of the carina with the outer side of the platform in *Streptognathodus lateralis*. All specimens came from the same sample which was collected from the *Homoceratoides prereticulatus* band at Spy (loc. XVII). All specimens are approximately ×45.

Remarks. — The fusion of the outer side of the platform with the carina appears to be a gradual process which starts at the posterior end and terminates with the complete fusion of the two, giving rise to specimens with a lateral blade such as *Idiognathoides sulcata*. Transitions such as this can be seen in the Alportian.

Distribution. — *E2a ?-R1a2.*

Gnathodus japonicus (Igo and Koike, 1964).

(Pl. 4, figs. 1, 2, 4.)

Streptognathodus japonicus Igo and Koike, 1964, pl. 28, figs. 5-10 (*non* 11-13).
Declinognathodus nevadensis Dunn, 1966, pl. 158, figs. 4, 8.
Idiognathoides aff. *nodulifera* (Ellison and Graves), Lane, 1967, pl. 123, fig. 17.

Diagnosis. — A species of *Gnathodus* with one or two nodes at the outer, anterior end of the platform which are usually separated from the outer parapet. The species includes both right and left specimens.

Description :

Oral View. — The unit is lanceolate with a blade which is usually slightly offset to the outer side of the platform but which may be median. It is continued posteriorly as a short carina which joins the outer parapet of the platform and is usually bent outwards round one or two nodes which remain anterior to the outer parapet. In extreme variants the blade and the carina join the outer parapet in a straight line. The outer anterior node or nodes may be partially fused to the outer parapet but typically they are free. The platform is pointed posteriorly, narrow, and consists of two noded parapets separated by a marked trough. There may be a tendency for the nodes to coalesce across the median trough, particularly at the posterior end.

Lateral View. — The oral surface of the platform is flat or longitudinally convex. The outer side may be higher than the inner.

Aboral View. — The aboral side of the cup is concave and is widest near the anterior end; the inner side is narrower and longer than the outer.

Comparisons. — This variety differs from *Idiognathoides sinuata* in the possession of nodes on the outer side of the carina. It differs from *Gnathodus noduliferus* in the possession of a short carina which has only one or two nodes anterior to it.

Discussion. — The distinction between *Gnathodus japonicus* and *Gnathodus noduliferus* is arbitrary since there are transitional specimens known which bridge the gap between the two. However, typical specimens of the former species have outer anterior nodes which are clearly separated from the outer parapet of the platform; therefore, the species is normally easily recognised. In addition their stratigraphic ranges differ.

Remarks. — The gradual reduction of the outer anterior nodes probably marks the change from *Gnathodus japonicus* to *Idiognathoides sulcata*. *Declinognathodus nevadensis*, with a single, clearly separate anterior node, is considered

a late form in this transition series. On the other hand *Streptognathodus japonicus* of IGO and KOIKE, 1964 (pl. 28, fig. 9) is considered an early form because two nodes are present and these appear to be partially fused to the outer parapet of the platform.

Distribution. — *H1-R2a.*

Genus **HIBBARDELLA** ULRICH and BASSLER, 1926.

Type species : *Prioniodus angulatus* HINDE, 1879.

Hibbardella acuta MURRAY and CHRONIC, 1965.

(Pl. 1, fig. 9.)

Hibbardella fragilis HIGGINS, 1961, pl. XII, fig. 4.
Hibbardella acuta MURRAY and CHRONIC, 1965, pl. 73, figs. 3-5.

Discussion. — This species, first described by HIGGINS from the Lower Namurian as *Hibbardella fragilis* became invalid when REXROAD and BURTON transferred *Trichonodella fragilis* REXROAD, 1957 to the genus *Hibbardella* in 1961. *Hibbardella acuta* MURRAY and CHRONIC is clearly synonymous with *Hibbardella fragilis* HIGGINS and therefore is the valid species.

Distribution. — *V3c-H2c.*

Hibbardella milleri REXROAD, 1958.

Hibbardella n. sp. ? REXROAD, 1957, pl. 1, fig. 19.
Hibbardella milleri REXROAD, 1958, pl. 2, figs. 13-16.

Distribution. — *V3c.*

Hibbardella pennata HIGGINS, 1961.

(Pl. 1, fig. 10.)

Hibbardella pennata HIGGINS, 1961, pl. XII, figs. 5, 6.

Distribution. — *E2b3.*

Genus **HINDEODELLA** ULRICH and BASSLER, 1926.

Type species : *Hindeodella subtilis* ULRICH and BASSLER, 1926.

Discussion. — This genus is usually represented by fragmentary specimens. In the Namurian, however, the hindeodellids are often complete and form a large part of the faunas particularly in rocks of post-Arnsbergian age.

Hindeodella germana HOLMES, 1928.

(Pl. 1, fig. 12.)

Hindeodella germana HOLMES, 1928, pl. 9, fig. 9.

Distribution. — *V3c-H1.*

Hindeodella ibergensis BISCHOFF, 1957.

(Pl. 1, figs. 1-3.)

Hindeodella ibergensis BISCHOFF, 1957, pl. 6, figs, 33, 37, 39.
Hindeodella delicatula STAUFFER and PLUMMER, 1932, MURRAY and CHRONIC, 1965, pl. 72, figs. 1, 2, 5.

Description. — The posterior bar is long, slightly arched and weakly incurved. In small specimens the bar is thin and elliptical in cross-section but during development lateral thickening takes place and very large specimens often have a subquadrate cross-section. The bar is usually highest in the middle third of its length. Its oral surface bears numerous rounded, pointed denticles which are inclined and curved posteriorly and slightly inwardly curved. The inclination tends to increase posteriorly. The denticles alternate in size, generally with three small ones between two large ones in small specimens but becoming irregular in large specimens due to the fusion of denticles. The main cusp is pointed, rounded or slightly laterally flattened and is inclined and curved posteriorly. The size of the cusp tends to increase more slowly than that of the posterior bar denticles. The anterior bar is approximately as long as the cusp. It is directed aborally at an angle of 45-90° and incurved 45-90°. Typically its postero-aboral edge is concave but in a few specimens the aboral half is convex. The incurvature starts a little way along the bar and at least one denticle is directly anterior to the cusp. The denticles on its oral surface are alternating in size, usually with one or more smaller denticles between each larger pair. On large specimens, however, the denticulation becomes irregular. The denticles are inclined and usually curved posteriorly. A few extreme specimens show posterior curvature of the oral half of the bar so that a sulcus is formed.

The aboral edge of the unit is grooved and has a small pit beneath the main cusp.

Discussion. — This species is undoubtedly the commonest in the Namurian but it is not often preserved well enough to allow identification. In bullion or hard limestone samples specimens of *Hindeodella ibergensis* may outnumber all other species by a 3 : 1 ratio and there is little doubt that the species formed the hindeodellid component of such natural assemblage genera as *Scottognathus* RHODES.

MURRAY and CHRONIC, 1965, identified several incomplete specimens of *Hindeodella ibergensis* as *Hindeodella delicatula* STAUFFER and PLUMMER, 1932, a species which was founded on fragments of posterior bars which belong to any of several possible species of *Hindeodella*. Only the anterior bar and main cusp are distinctive in most species of *Hindeodella*.

Distribution. — *V3c-G2.*

Hindeodella uncata (HASS, 1959).

(Pl. 1, fig. 5.)

Hindeodella brevis BRANSON and MEHL, 1934, BISCHOFF, 1957, pl. 6, fig. 24.
Hindeodina uncata HASS, 1959, pl. 47, fig. 6.

Description. — The posterior bar is long, usually with a straight aboral edge but sometimes sinuous, and in oral view convex except adjacent to the anterior bar. Bowing of the posterior bar is common and in a few extreme variants the

posterior extremity of it is at an angle of 90° to the anterior extremity. Its oral edge bears numerous needlelike, inwardly and posteriorly inclined, denticles whose inclination increases posteriorly. The denticles alternate : up to six small denticles situated between each adjacent large pair. There are generally fewer small denticles at the extremities of the bar. There is a distinct tendency towards sinuosity in the anterior half where the large denticles are more strongly inclined and curved than the small ones. This is very marked in massive specimens where the denticles originate from the outer side of the bar.

The main cusp is about the same size as the larger posterior bar denticles.

The anterior bar is about one-fifth the length of the posterior bar. Its posterior part is sharply outwardly curved at a point slightly anterior to the main cusp but its anterior part is abruptly bent inwards at 90° to the posterior bar. The denticles on the oral surface of the bar are typically curved posteriorly. The denticles on the distal surface are inclined and sometimes curved inwardly. The denticles are of varying sizes and number, the larger ones being as large as the major denticles of the posterior bar. The aboral edge of the bar is concave and in specimen of average and large size the distal part has a sharp aboral deflection.

The aboral cavity is small and is sometimes continued as a groove beneath the bars.

Discussion. — During the development of the species the unit becomes laterally thickened and massive. In such large specimens the anterior bar is often broken off and may well be identified as the posterior bar of another species. It is possible that *Hindeodella pulchra* Ellison, 1941 is an anterior bar of *Hindeodella uncata.*

This species was included with *Hindeodella brevis* Branson and Mehl by Bischoff, 1957 and by Higgins, 1961, 1962, but as Bischoff noted the cusp is relatively much smaller than that of *Hindeodella brevis* and this character seems to be consistent in all Carboniferous specimens. The author agrees with Scott and Collinson, 1961 that the size of the main cusp is not of generic importance in *Hindeodella* and the species *Hindeodella uncata* has therefore been transferred from the genus *Hindeodina* Hass, 1959.

Distribution. — *V3c-H2.*

Hindeodella undata Branson and Mehl, 1941.

(Pl. 1, fig. 4.)

Hindeodella undata Branson and Mehl, 1941, pl. V, fig. 3.

Distribution. — *V3c.*

Genus **IDIOGNATHOIDES** Harris and Hollingsworth, 1933.

Type species : *Idiognathoides sinuata* Harris and Hollingsworth, 1933.

Discussion. — The validity of this genus has recently been discussed by Merrill (1963), Huddle (1964) and Lane 1967). The author agrees with Lane that there is no direct relationship between *Idiognathoides* and *Cavusgnathus*, the basal cavities of species of these genera being quite distinct. It is also agreed that species

of the genus *Polygnathodella* should be included in the genus *Idiognathoides*. On the other hand the inclusion in the genus of species with a carina, such as *Idiognathoides* aff. *nodulifera* does not seem to be desirable.

Idiognathoides attenuata (HARRIS and HOLLINGSWORTH).

(Pl. 4, fig. 10.)

Idiognathoides attenuata HARRIS and HOLLINGSWORTH, 1933, pl. 1, figs. 9*a*, *b*.
Polygnathodella attenuata (HARRIS and HOLLINGSWORTH), BRANSON and MEHL, 1941, p. 104.
Polygnathodella attenuata (HARRIS and HOLLINGSWORTH), ELLISON and GRAVES, 1941, pl. 3, figs. 14, 15 (*non* figs. 11, 13).

Discussion. — The distinction between this species and *Idiognathoides corrugata* is slight but the latter appears before the former stratigraphically and so the two should be retained as separate species.

Distribution. — *R2a2-G2*.

Idiognathoides convexa (ELLISON and GRAVES).

(Pl. 4, fig. 3.)

Polygnathodella convexa ELLISON and GRAVES, 1941, pl. 3, figs. 10, 12, 16.

Distribution. — *G2a-G2b*.

Idiognathoides corrugata (HARRIS and HOLLINGSWORTH).

(Pl. 5, fig. 9.)

Idiognathodes corrugata HARRIS and HOLLINGSWORTH, 1933, pl. 1, figs. 8*a*, *b*.
Polygnathodella ouachitensis HARLTON, 1933, pl. 4, figs. 14*b*, *c*.
Idiognathoides corrugata (HARRIS and HOLLINGSWORTH, 1933), LANE, 1967, pl. 122, figs. 1, 2, 4-7, 9-11.

Discussion. — The range of variation in this species is considerable. It includes specimens with transverse ridges which are separated along the length of the platform by a median trough and specimens in which the median trough is partially filled by the fusion of the transverse ridges across the trough. Both variants appear at the same time and there seems little point in separating them by an arbitrary distinction such as the number of ridges which are complete across the trough. Those with a continuous median trough are quite distinct from *Idiognathoides sulcata* sp. nov. because the parapets are broader and are at the same height along the length of the platform.

Discussion. — A few specimens have been recorded which have a narrow and completely grooved platform (see plate 5, fig. 9). These are not typical specimens of *Idiognathoides corrugata* but are thought to fall within the range of that species.

Distribution. — *R1a-G2b*.

Idiognathoides minuta sp. nov.

(Pl. 6, figs. 7-12.)

Holotype : Pl. 6, figs. 7-9.

Diagnosis. — A small species of *Idiognathoides* with a coarsely noded platform which is pointed at the posterior end. The oral surface of the platform is crossed by a deep, median longitudinal trough. The species is left sided.

Description :

Oral View. — The lateral blade is narrow, straight or slightly curved and bears numerous laterally compressed denticles on its oral edge. It is approximately as long as the outer side of the platform. The latter is lanceolate, posteriorly pointed and has convex margins. Typically, as the platform becomes wider the posterior end becomes less pointed. The parapets are separated by a deep median trough which extends almost to the posterior extremity. A small number of coarse nodes ornament the oral surface of the platform but do not cross the median trough.

Lateral View. — The oral edge of the blade is denticulate and typically rises above the level of the oral surface of the platform. It is convexly arched, rising gradually from the platform to its highest point about one-third from the posterior end. However, the height of the blade varies considerably and in many specimens is only a little greater than that of the platform. Its aboral edge is either straight or slightly concave. The oral and aboral edges of the platform are straight and parallel to each other.

Aboral View. — The aboral surface of the cup is shallowly excavated and is crossed by a groove which is continued along the aboral edge of the blade. On its inner side the cup is widest near the anterior end whereas the outer side is widest at its midpoint. Both sides are of approximately equal width but the outer side is slightly the longer.

Comparisons. — *Idiognathoides minuta* differs from *Idiognathoides sulcata sulcata* in being smaller, approximately half the size of the latter, and in possessing an arched blade. It differs from *Idiognathoides sulcata parva* in having a short blade relative to the lenght of the platform.

Discussion. — The generic affinity of this species is a little doubtful. Affinity with *Idiognathoides* is inferred by the short narrow platform, lateral blade and by the gnathodid cup. However, the height of the blade of some specimens is abnormal for *Idiognathoides* and more typical of *Adetognathus* and if this character were more consistently present the species would be referred to that genus.

Distribution. — *H1.*

Idiognathoides sinuata Harris and Hollingsworth.

(Pl. 2, fig. 14; Pl. 5, fig. 11; Pl. 4, figs. 5, 8, 9.)

Idiognathoides sinuata Harris and Hollingsworth, 1933, pl. 1, fig. 14.
Idiognathoides sinuata Harris and Hollingsworth, Lane 1967, pl. 119, figs. 1-9, 12-15; pl. 123, figs. 7, 8, 12.

Distribution. — *R1a3-G2.*

Idiognathoides sulcata sp. nov.

(Pl. 4, figs. 6, 7.)

Idiognathoides sp. A, LANE, 1967, pl. 123, figs. 14, 15, 18, 19.

Holotype : Pl. 4, fig. 6.

Diagnosis. — A species of *Idiognathoides* with a platform consisting of two noded parapets separated by a deep median trough. It includes both right and left sided specimens.

Description :

Oral View. — The unit is lanceolate and consists of a platform and a thin blade. The latter arises from the outer side of the platform and is of variable length but typically is 1-1½ times the length of the platform. The narrow platform is pointed at the posterior end and consists of two parapets separated by a deep median trough. Typically the oral surface of the platform is ornamented by coarse nodes. At the base of the platform is a flaring cup whose outer side is subrectangular and is shorter and wider than the inner. The cup is smooth and usually flares abruptly from the almost vertical sides of the platform.

Lateral View. — The platform is flat or convex longitudinally. Its outer side is often higher than its inner. The oral edge of the blade is often slightly higher than that of the platform but always rises gently from it.

Aboral View. — The aboral side of the cup is excavated and is traversed by a longitudinal groove which is continued along the blade.

Comparisons. — *Idiognathoides sulcata* differs from *Idiognathoides sinuata* in possessing a noded platform with a long median trough.

Discussion. — LANE (1967) described *Idiognathoides* sp. A as a right sided species but in large collections both right and left sided specimens are found.

Remarks. — The distinction between some left sided specimens of *Idiognathoides sulcata* and specimens of *Idiognathoides sinuata* with a marked median trough is slight and there seems little doubt that the two species are closely related. However, there is less evidence of a connection between *Idiognathoides sulcata* and *Idiognathoides corrugata.*

Distribution. — *R1a3-G2.*

Idiognathoides sulcata parva subsp. nov.

(Pl. 6, figs. 1-6.)

Holotype : Pl. 6, fig. 6.

Diagnosis. — A small variety of *Idiognathoides sulcata* with a blade which is 1½ or more times longer than the inner side of the platform. It includes both right and left sided specimens.

Description :

Oral View. — The unit is small and lanceolate. The platform consists of two noded ridges separated by a deep median trough of which the outer one is the broader. The inner side of the platform is broad at the anterior end but narrows posteriorly and in immature specimens the posterior inner half may consist of isolated nodes. The blade is thin and is more than 1½ times the length of the platform. The outer side of the cup is wider and shorter than the inner.

Lateral View. — The outer side of the platform is typically higher than the inner and is longitudinally convex.

Aboral View. — The aboral side of the cup is concave and is crossed by a groove which is continued beneath the blade.

Comparisons. — This variety differs from *Idiognathoides sulcata sulcata* in possessing a blade which is longer relative to the length of the platform.

Discussions. — Apart from the difference in size and the length of the blade this subspecies is identical to *Idiognathoides sulcata sulcata*, to which it is closely related.

Distribution. — *G2b.*

Genus **LAMBDAGNATHUS** Rexroad, 1958.

Type species : *Lambdagnathus fragilidens* Rexroad, 1958.

Lambdagnathus macrodentata Higgins.

Lambdagnatus macrodentata Higgins, 1961, pl. XII, figs. 1-3.

Distribution. — *V3c.*

Genus **LIGONODINA** Ulrich and Bassler, 1926.

Type species : *Ligonodina pectinata* Ulrich and Bassler, 1926.

Ligonodina fragilis Hass.

Ligonodina fragilis Hass, 1953, pl. 15, fig. 1.

Distribution. — *E2b3.*

Ligonodina typa (Gunnell).

(Pl. 2, fig. 11.)

Idioprioniodus typus Gunnell, 1933, pl. 31, fig. 47.
Prioniodus galesburgensis Gunnell, 1933, pl. 31, fig. 12.
Ligonodina typa (Gunnell), Ellison, 1941, pl. 20, figs. 8-11.

Distribution. — *V3c-G2b.*

Genus **LONCHODINA** ULRICH and BASSLER, 1926.

Type species : *Lonchodina typicalis* ULRICH and BASSLER, 1926.

Lonchodina bischoffi sp. nov.

Lonchodina cf. *projecta* ULRICH and BASSLER, BISCHOFF, 1957, pl. 1, fig. 20.
Lonchodina cf. *projecta* ULRICH and BASSLER, HIGGINS, 1961, pl. XI, fig. 10.

Holotype : Fig. 10 of plate XI (HIGGINS, 1961), is designated as the holotype.

Diagnosis. — A species of *Lonchodina* with a long posterior bar and a shorter anterior bar which is bent inwards at 45° and aborally at approximately 110° to the posterior bar.

Description. — The posterior bar is of variable length, and is narrow, low, slightly arched and curved outwards. On its oral edge are three or more small, slender, discrete and rounded denticles which are also curved slightly outwards. The inclination of the denticles increases towards the posterior.

The main cusp is three to four times larger than the posterior bar denticles and is recurved posteriorly and outwards. It is rounded on the outer side but flattened on the inner and its base is expanded into a rounded apron on the outer side. The anterior bar is higher than the posterior but is often shorter. Its oral surface bears six or more long, slender, discrete and outwardly curved denticles whose curvature increases posteriorly. All the denticles are rounded but the anterior most ones are often slightly flattened in their lower half. The bar is bent inwards at approximately 45° and at approximately 110° to the posterior bar.

The aboral side is grooved and is expanded into a rounded aboral cavity.

Comparisons. — This species is distinguished from *Lonchodina projecta* by the long recurved anterior bar denticles, the curvature of the posterior bar and the angle of the anterior to the posterior bars.

Discussion. — *Lonchodina projecta* ranges throughout the Lower Carboniferous according to BISCHOFF, 1957 but it has not been recorded from the Namurian. *Lonchodina bischoffi* is known from the late Visean and early Namurian (HIGGINS, 1961).

Distribution. — *V3c.*

Lonchodina clarki (GUNNELL).

(Pl. 2, fig. 1.)

Prioniodus clarki GUNNELL, 1931, pl. 29, fig. 8.

Distribution. — *G2b.*

Lonchodina furnishi REXROAD.

Lonchodina furnishi REXROAD, 1958, pl. 4, figs. 11-13.

Distribution. — *V3c.*

Lonchodina ? sp.

(Pl. 1, fig. 13.)

Description. — A single specimen which is probably referable to *Lonchodina* has the following characteristics : the unit is large and massive and consists of a long anterior bar, main cusp and an incomplete posterior bar. The anterior bar is long, wide at the posterior but tapering anteriorly. Its margins are rounded but more markedly so on the outer side than the inner. Its oral surface bears nine denticles which originale from the inner side of the bar and which are elliptical in cross-section. They are slightly curved posteriorly and are of variable size. The main cusp is twice the width of the largest anterior bar denticles, is flattened on its inner surface but curved on its outer and is curved outwards. At its base is a flaring lip on the outer side. The posterior bar is incomplete but appears to be in a different plane to the anterior bar. The latter is narrower than the posterior bar and it bears at least two denticles on its oral surface. The aboral surfaces of both bars are flattened, except for a narrow groove running along their length which expands to a subtriangular pit beneath the main cusp.

Distribution. — *E2b3.*

Genus **MAGNILATERELLA** Rexroad and Collinson, 1963.

Type species : *Magnilaterella robusta* Rexroad and Collinson, 1963.

Magnilaterella robusta Rexroad and Collinson.

Magnilaterella robusta Rexroad and Collinson, 1963, pl. 2, figs. 4, 5, 9.

Distribution. — *V3c.*

Genus **METALONCHODINA** Branson and Mehl, 1941.

Type species : *Prioniodus bidentatus* Gunnell, 1931.

Metalonchodina sp.

(Pl. 2, fig. 4.)

Metalonchodina bidentata (Gunnell) Higgins, 1961, pl. XII, fig. 9.

Description. — A few specimens of this genus have been recorded which are incomplete but are distinctive. The main cusp is flattened on the outer side but rounded on the inner and it curves slightly anteriorly and inwards. The base of the cusp is extended inwards as a marked apron. The posterior bar is incomplete. Its width is about the same as the height and its oral surface bears small elliptical denticles. The anterior bar is narrow and is higher than the posterior bar and is markedly bevelled on its inner side. It bears two or three denticles on its oral surface which are elliptical in cross-section but somewhat flattened on the outer side. The denticles increase in size posteriorly and the denticle adjacent to the main

cusp is slightly longer but is about as wide as the main cusp. The aboral side of the main cusp bears a circular aboral cavity which is continued beneath the bars as a groove.

Discussion. — It was originally considered that this species was within the range of variation of *Metalonchodina bidentata*, but the stratigraphic ranges of the two species have been found to differ.

Distribution. — *V3c-E2b3.*

Neoprioniodus scitulus (Branson and Mehl).

(Pl. 1, fig. 11.)

Prioniodus scitulus Branson and Mehl, 1941, pl. V, figs. 5, 6.

Distribution. — *V3c.*

Neoprioniodus conjunctus (Gunnell).

Prioniodus conjunctus Gunnell, 1931, pl. 29, fig. 7.

Distribution. — *V3c-G2a.*

Neoprioniodus singularis (Hass).

(Pl. 1, fig. 8.)

Prioniodus singularis Hass, 1953, pl. 16, fig. 4.

Distribution. — *V3c-H1.*

Neoprioniodus spathatus Higgins.

Neoprioniodus spathatus Higgins, 1961, pl. XI, figs. 2, 4.

Distribution. — *V3c.*

Ozarkodina delicatula (Stauffer and Plummer).

(Pl. 3, fig. 3.)

Bryantodus delicatulus Stauffer and Plummer 1932, pl. 2, fig. 27.

Distribution. — *V3c-G2a.*

STREPTOGNATHODUS Stauffer and Plummer, 1932.

Type species : *Streptognathodus excelsus* Stauffer and Plummer, 1932.

Streptognathodus lateralis sp. nov.

(Pl. 5, figs. 1-4, 7.)

Diagnosis. — A species of *Streptognathodus* with a short carina which terminates against the transverse ridges of the outer side of the platform. The oral trough is on the inner side of the platform.

Description :

Oral View. — The blade is as long or slightly longer than the platform and is approximately median. The platform is long, posteriorly pointed, approximately symmetrical and typically is wide. The blade is continued on to the platform as a short carina which terminates against an outer transverse ridge but which may continue as a row of nodes partially fused to the transverse ridges of the posterior half of the platform. The oral groove extends to the posterior end on the inner side of the platform. The platform ornamentation consists of transverse ridges which extend for more than half its length without interruption by the carina. Nodes are often present on the anterior part of the outer side and these are separated from the carina by a sulcus. The transverse ridges of the inner side may be continuous with those of the outer side for up to half the length of the platform.

Lateral View. — The oral surface of the platform is longitudinally convex and the outer side of it may be higher than the inner.

Aboral View. — The aboral side of the cup is concave and is crossed by a longitudinal groove which is continued along the blade. The outer side of the cup is wider and shorter than the inner side.

Comparisons. — *Streptognathodus lateralis* differs from other species of *Streptognathodus* in lacking accessory lobes.

Discussion. — ELLISON and GRAVES (1941) figured a specimen (pl. 3, fig. 6)) which is incomplete but which has a median blade and a short carina which terminates against an outer transverse ridge. This specimen has a gnathodid cup and is therefore not referable to *Cavusgnathus nodulifera* as stated by ELLISON and GRAVES. However, it may be referable to *Streptognathodus lateralis*.

Distribution. — *H2c-G2b*.

Streptognathodus elegantulus STAUFFER and PLUMMER.

(Pl. 5, figs. 8, 10.)

Streptognathodus elegantulus STAUFFER and PLUMMER, 1932, pl. 4, figs. 6, 7, 22, 27.

Discussion. — This species shows little variation in its morphological characters. The main variation concerns the number of nodes in the oral trough which may continue almost to the posterior end. The same variation was noted by ELLISON (1941).

Distribution. — *H2c-G2b*.

Genus **ROUNDYA** HASS, 1952.

Type species : *Roundya barnettana* HASS, 1952.

Roundya barnettana HASS, 1953.

Roundya barnettana HASS, 1952, pl. 16, fig. 18.

Distribution. — *V3c-R2b1*.

Genus **SPATHOGNATHODUS** BRANSON and MEHL, 1941.

Type species : *Ctenognathus murchisoni* PANDER.

Spathognathodus campbelli REXROAD.

Spathognathodus campbelli REXROAD, 1957, pl. 3, figs. 13-15.

Distribution. — *V3c.*

Genus **SUBBRYANTODUS** BRANSON and MEHL, 1934.

Type species : *Subbryantodus arcuatus* BRANSON and MEHL, 1934.

Subbryantodus subaequalis HIGGINS.

(Pl. 3, figs. 1, 2.)

Subbryantodus subaequalis HIGGINS, 1961, pl. XII, fig. 15.

Distribution. — *V3c.*

Genus **SYNPRIONIODINA** ULRICH and BASSLER, 1925.

Type species : *Synprioniodina alternata* BASSLER, 1925.

Synprioniodina microdenta ELLISON.

(Pl. 1, fig. 6.)

Synprioniodina sp. GUNNELL, 1933, pl. 31, fig. 6.
Synprioniodina microdenta ELLISON, 1941, pl. 20, figs. 43-46.
Synprioniodina component RHODES 1952, pl. 126, figs. 4, 8, 9.
Synprioniodina forsenta STAUFFER, 1940, HIGGINS 1961, pl. XII, fig. 8.
Synprioniodina microdenta ELLISON, MURRAY and CHRONIC, 1965, pl. 73, figs. 12, 13.

Distribution. — *V3c-G2.*

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PLATE 1

EXPLANATION OF PLATE 1.

All figures ×50, except figure 12 which is ×36.

FIGS. 1-3. — *Hindeodella ibergensis* BISCHOFF.
Inner lateral views.
Locality : Pl. 135 E, 191.
Verviers (XVIII).

FIG. 4. — *Hindeodella undata* BRANSON and MEHL.
Inner lateral view.
This figure illustrates the short anterior process and the lack of undulation in the posterior bar denticles adjacent to the main cusp.
Locality : Pl. 135 E, 191.
Verviers (XVIII).

FIG. 5. — *Hindeodella uncata* (HASS).
Oral view.
Locality : Pl. 135 E, 191.
Verviers (XVIII).

FIG. 6. — *Synprioniodina microdenta* ELLISON.
Inner lateral view.
Locality : Pl. 135 E, 191.
Verviers (XVIII).

FIG. 7. — *Angulodus simplex* sp. nov.
Inner lateral view of holotype, posterior bar incomplete.
Locality : Pl. 135 E, 191.
Verviers (XVIII).

FIG. 8. — *Neoprioniodus singularis* (HASS).
Inner lateral view.
Locality : Pl. 166 W, 122.
Merbes-Sprimont Quarry, bed 7 (V).

FIG. 9. — *Hibbardella acuta* MURRAY and CHRONIC.
Inner lateral view.
Locality : Pl. 135 E, 191.
Verviers (XVIII).

FIG. 10. — *Hibbardella pennata* HIGGINS.
Posterior view.
Locality : Pl. 135 E, 191.
Verviers (XVIII).

FIG. 11. — *Neoprioniodus scitulus* (BRANSON and MEHL.).
Inner lateral view.
Locality : Pl. 135 E, 191.
Verviers (XVIII).

FIG. 12. — *Hindeodella germana* HOLMES.
Inner lateral view.
Locality : Pl. 135 E, 191.
Verviers (XVIII).

FIG. 13. — *Lonchodina* ? sp.
Outer lateral view.
Locality : Pl. 135 E, 191.
Verviers (XVIII).

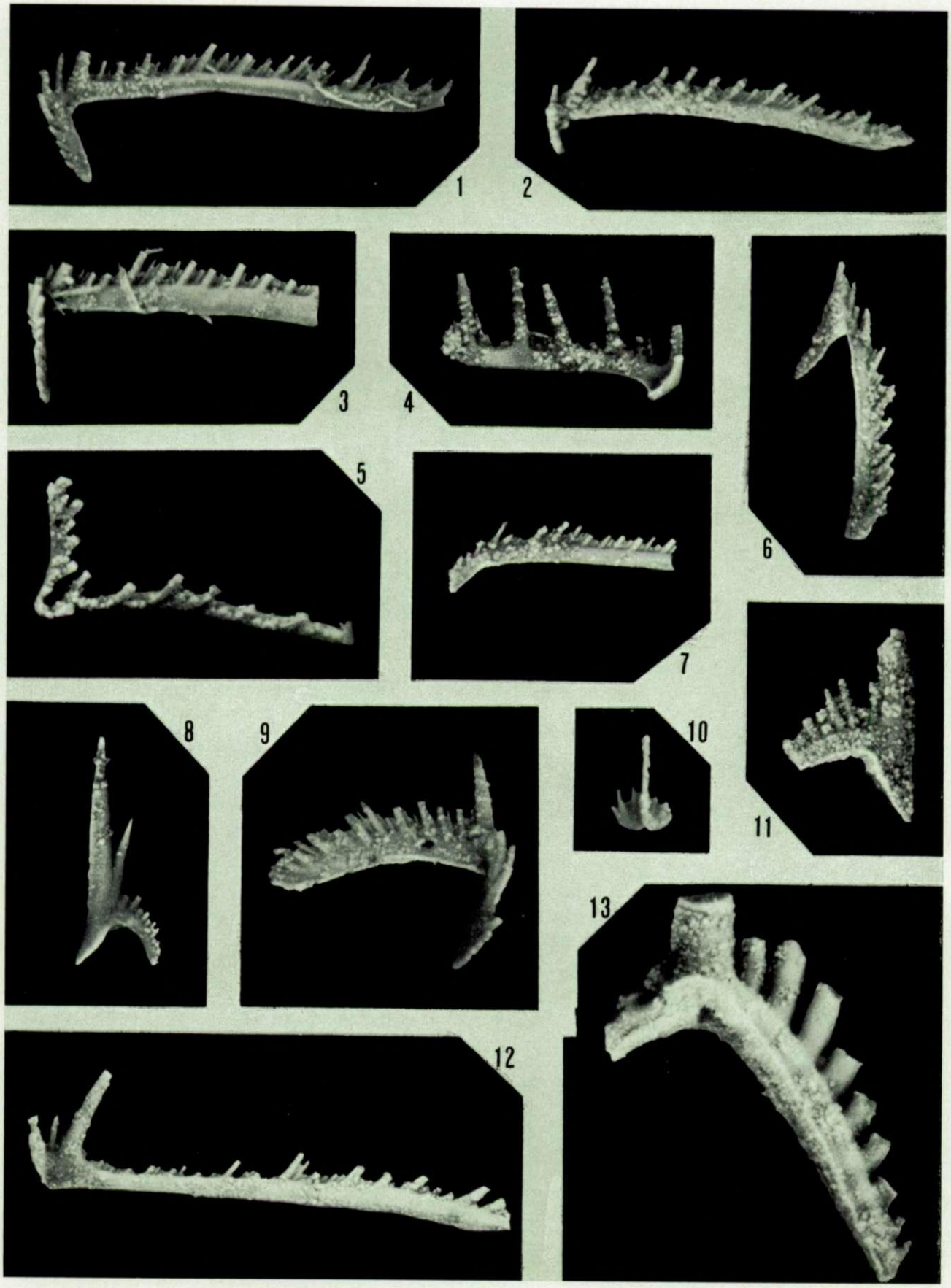

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PLATE 2

EXPLANATION OF PLATE 2.

All figures ×50, except figure 10 which is ×40.

FIG. 1. — *Lonchodina clarki* (GUNNELL).
Inner lateral view.
Locality : Pl. 145 E.
Moha Colliery (XIVa).

FIGS. 2, 3. — *Gnathodus nodosus* BISCHOFF.
Oral views.
2. Jaiffe à Warnant Quarry, bed 28 (XIX).
3. Jaiffe à Warnant Quarry, bed 28 (XIX).
Locality : Pl. 166 W, 151.

FIG. 4. — *Metalonchodina* sp.
Inner lateral view.
Locality : Pl. 166 W, 151.
Jaiffe à Warnant Quarry, bed 28 (XIX).

FIG. 5. — *Gnathodus commutatus* (BRANSON and MEHL).
Oral view.
Locality : Pl. 166 W, 151.
Jaiffe à Warnant Quarry, bed 28 (XIX).

FIGS. 6, 12. — *Gnathodus noduliferus* (ELLISON and GRAVES).
Oral views.
Locality : Pl. 155 W, 688.
Citadel of Namur (VIII).

FIGS. 7, 8. — *Cavusgnathus navicula* (HINDE).
Oral and inner lateral views respectively.
Locality : Pl. 166 W, 151.
Jaiffe à Warnant Quarry, bed 23 (XIX).

FIG. 9. — *Gnathodus* cf. *girtyi* HASS.
Oral view.
Locality : Pl. 143 E, 211.
Spy (XVII).

FIGS. 10, 13. — *Gnathodus bilineatus bollandensis* sub. sp. nov.
Oral views of the holotype and an immature specimen respectively.
Locality : Pl. 139 W, 279.
Nimy-Blaton Canal cutting, bed 1 (XX).

FIG. 11. — *Ligonodina typa* (GUNNELL).
Inner lateral view.
Locality :
Verviers 191 (XVIII).

FIG. 14. — *Idiognathoides sinuata sinuata* (HARRIS and HOLLINSWORTH).
Oral view of a specimen showing partial fusion of the nodes on the oral surface of the platform.
Locality : Pl. 145 E.
Moha Colliery (XIVa).

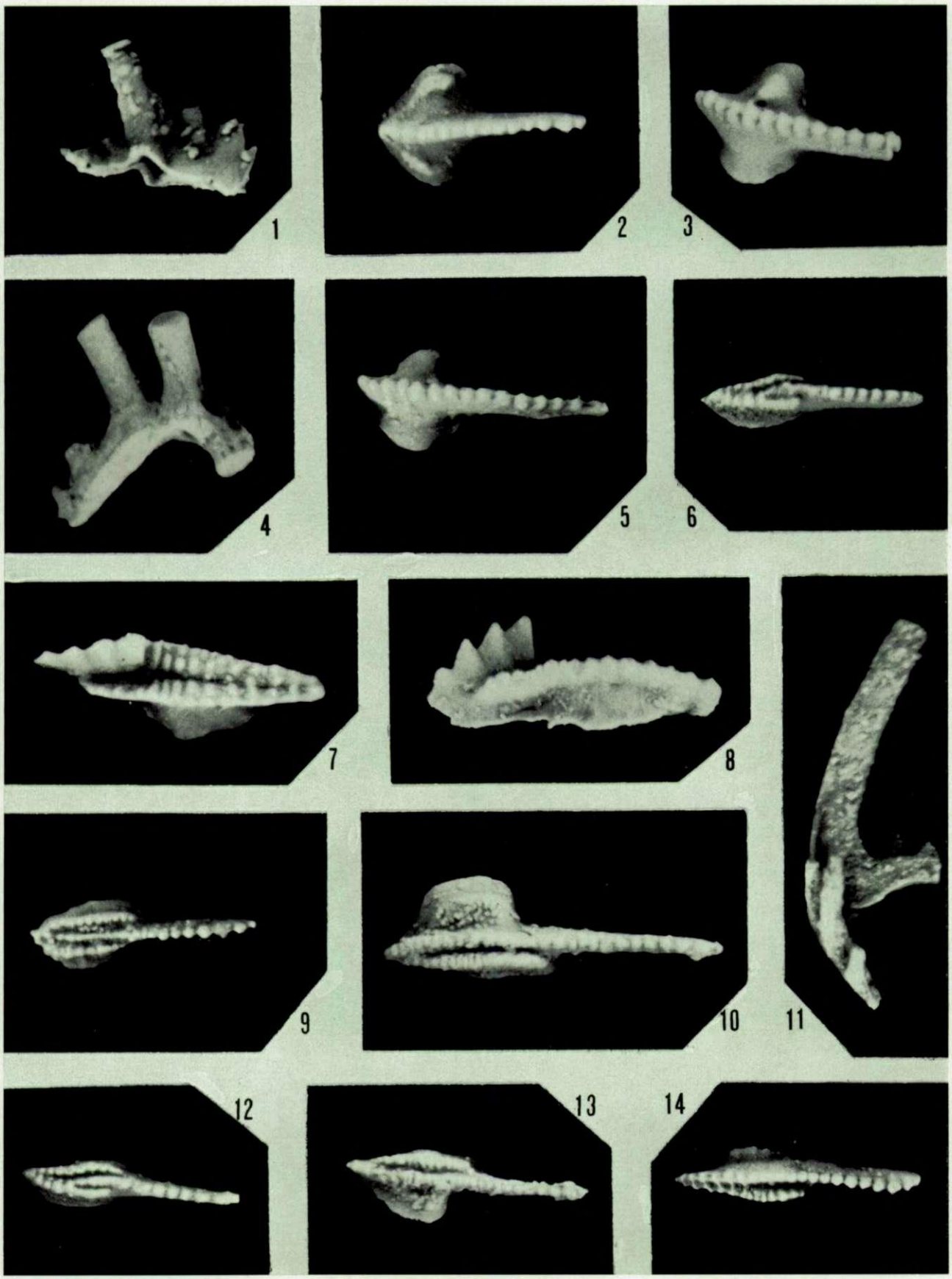

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PLATE 3

EXPLANATION OF PLATE 3.

All figures ×50.

FIGS. 1, 2. — *Subbryantodus subaequalis* HIGGINS.
Outer lateral views.
Locality : Pl. 135 E, 191.
Verviers (XVIII).

FIG. 3. — *Ozarkodina delicatula* STAUFFER and PLUMMER.
Outer lateral view.
Locality : Pl. 135 E, 191.
Verviers (XVIII).

FIGS. 4-8, 10. — *Gnathodus bilineatus bollandensis* sub. sp. nov.
Figs. 4-6, 8 : oral views; fig. 7 : aboral view; fig. 10 : outer lateral view. Figs. 8, 10 show a specimen which is transitional in character between *Gnathodus bilineatus bollandensis* and *Gnathodus bilineatus bilineatus*.
Localities : Pl. 122 W, 260 and Pl. 139 W, 279.
4. Bolland Borehole 260, bed 456 (I).
5-8, 10. Nimy-Blaton Canal cutting, bed 1 (XX).

FIG. 9. — *Gnathodus bilineatus bilineatus* (ROUNDY).
Oral view.
Locality : Pl. 166 W, 122.
Merbes-Sprimont Quarry, bed 5 (V).

FIG. 11. — *Gnathodus girtyi intermedius* GLOBENSKY.
Oral view.
Locality : Pl. 166 W, 122.
Merbes-Sprimont Quarry, bed 7 (V).

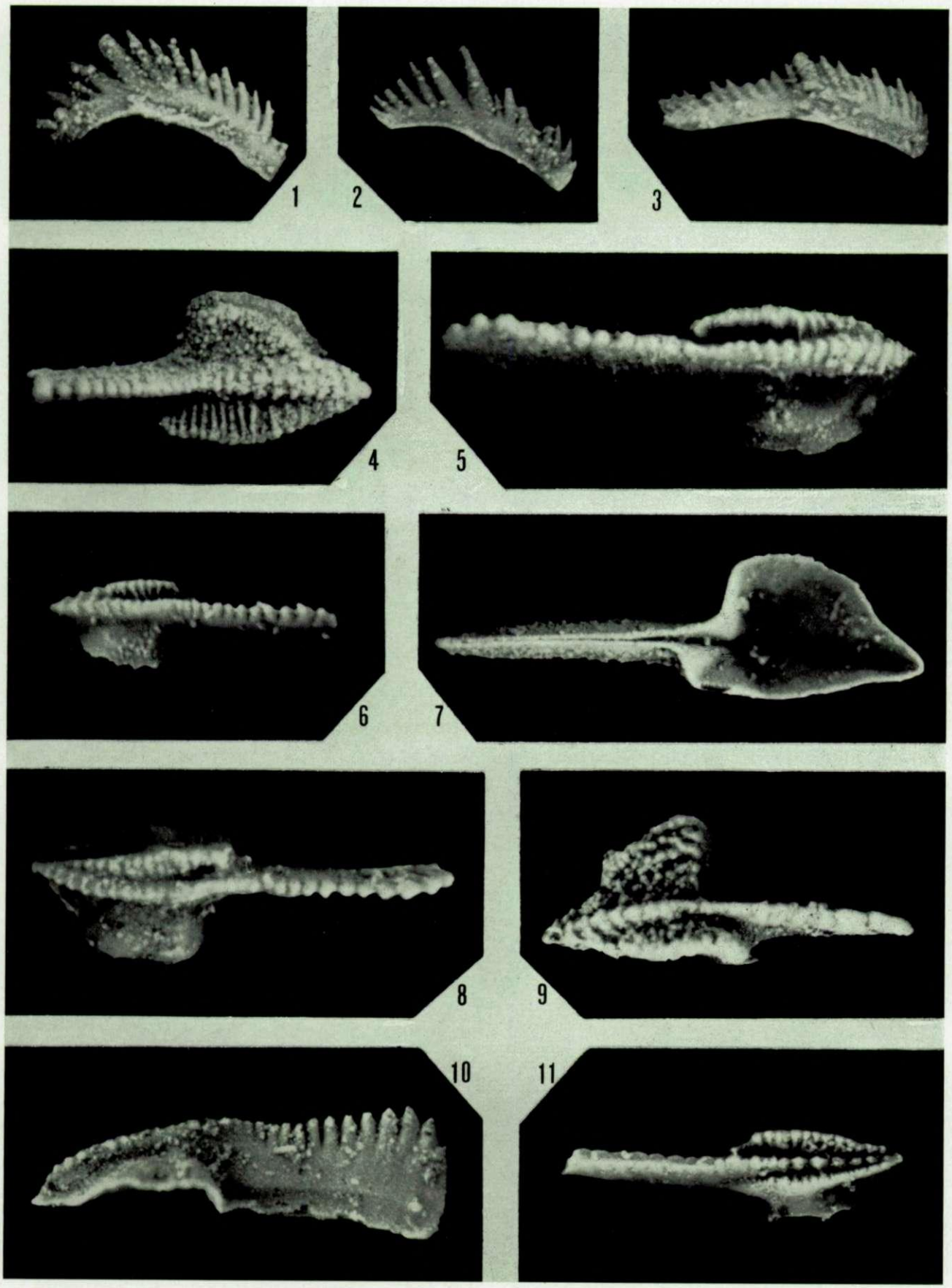

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PLATE 4

EXPLANATION OF PLATE 4.

All figures ×50.

FIGS. 1, 2, 4. — *Gnathodus japonicus* (IGO and KOIKE).
Oral views.

Localities: Pl. 155 W, 688 and 426; Pl. 76 W, 264.

1. Citadel of Namur 688 (VIII).
2. Webbekom Borehole (IV).
3. Flawinne 426, bed k (VI).

FIG. 3. — *Idiognathoides convexa* (ELLISON and GRAVES).
Oral view.

Locality: Pl. 145 E.
Moha Colliery (XIVa).

FIGS. 5, 8, 9. — *Idiognathoides sinuata* HARRIS and HOLLINSWORTH.
Figs. 5, 8: oral views; fig. 9: inner lateral view.

Localities: Pl. 76 W, 264.
Webbekom Borehole (IV).

FIGS. 6, 7. — *Idiognathoides sulcata* sp. nov.
Oral views. Fig. 6: holotype. Fig. 7: illustrates a specimen transitional in character between *I. sulcata* and *I. sinuata*.

Localities: Pl. 122 W, 260 and Pl. 17 E, 120.

6. Bolland Borehole 260, bed 316 (I).
7. Turnhout Borehole 120, bed 6 (III).

FIG. 10. — *Idiognathoides attenuata* (HARRIS and HOLLINSWORTH).
Oral view.

Locality: Pl. 145 E.
Moha Colliery (XIVa).

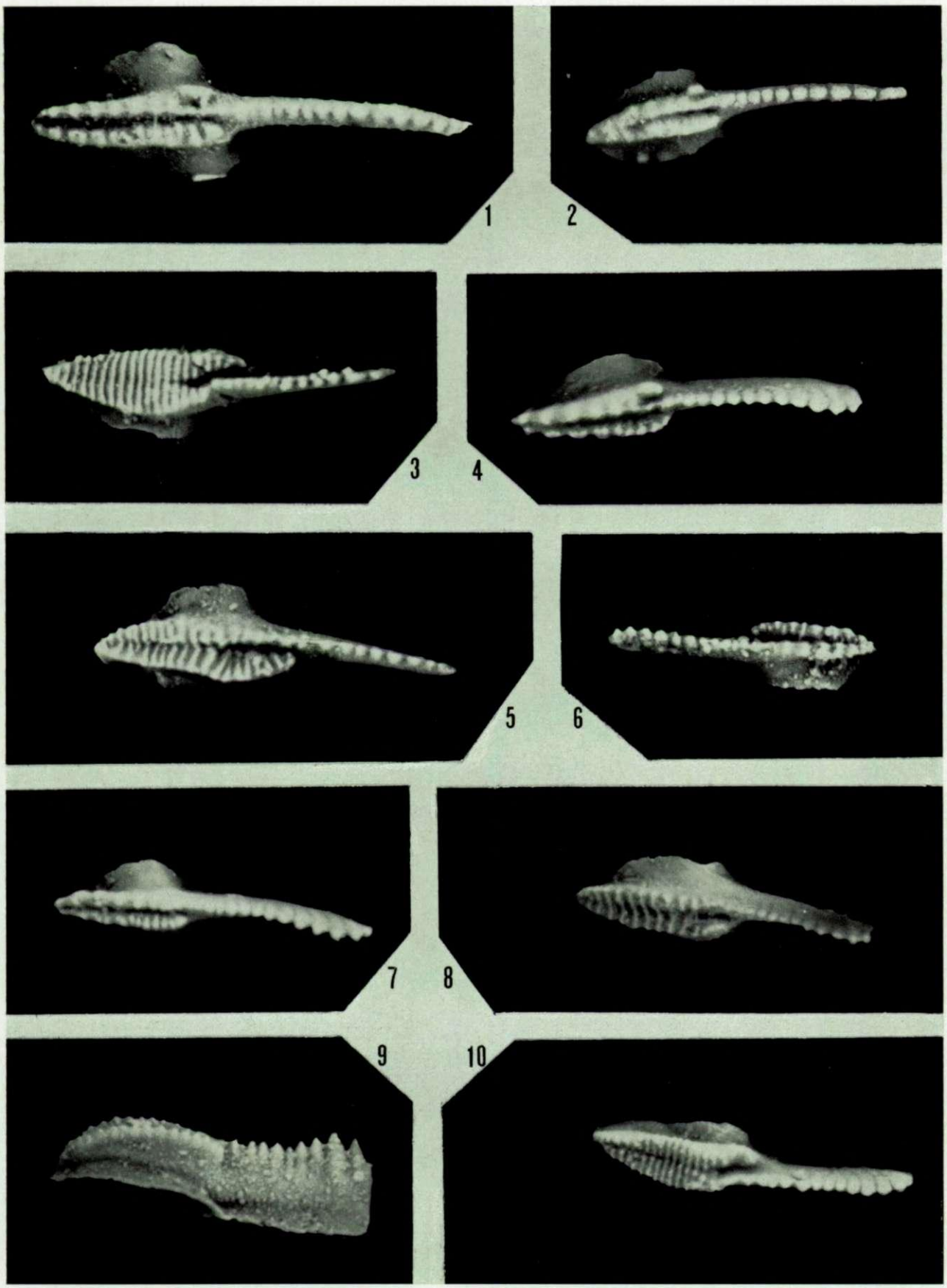

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PLATE 5

EXPLANATION OF PLATE 5.

All figures ×50.

FIGS. 1-4, 7. — *Streptognathodus lateralis* sp. nov.
Oral views. Holotype fig. 7.
Localities : Pl. 143 E, 211 and Pl. 155 W, 688.
1, 2. Spy 211 (XVII).
3, 4, 7. Citadel of Namur 688 (VIII).

FIGS. 5, 6. — *Gnathodus* cf. *girtyi* HASS.
Oral views.
Locality : Pl. 143 E, 211.
Spy (XVII).

FIGS. 8, 10. — *Streptognathodus elegantulus* STAUFFER and PLUMMER.
Oral and outer lateral views respectively.
Locality : Pl. 155 W, 688.
Citadel of Namur (VIII).

FIG. 9. — *Idiognathoides corrugata* (HARRIS and HOLLINGSWORTH).
Oral view.
Locality : Pl. 155 W, 426.
Flawinne, bed k (VI).

FIG. 11. — *Idiognathoides sinuata* HARRIS and HOLLINGSWORTH.
Oral view.
Locality : Pl. 76 W, 264.
Webbekom Borehole (IV).

FIG. 12. — *Gnathodus girtyi* subsp. nov.
Oral view.
Locality : Pl. 166 W, 151.
Jaiffe à Warnant Quarry, bed 23 (XIX).

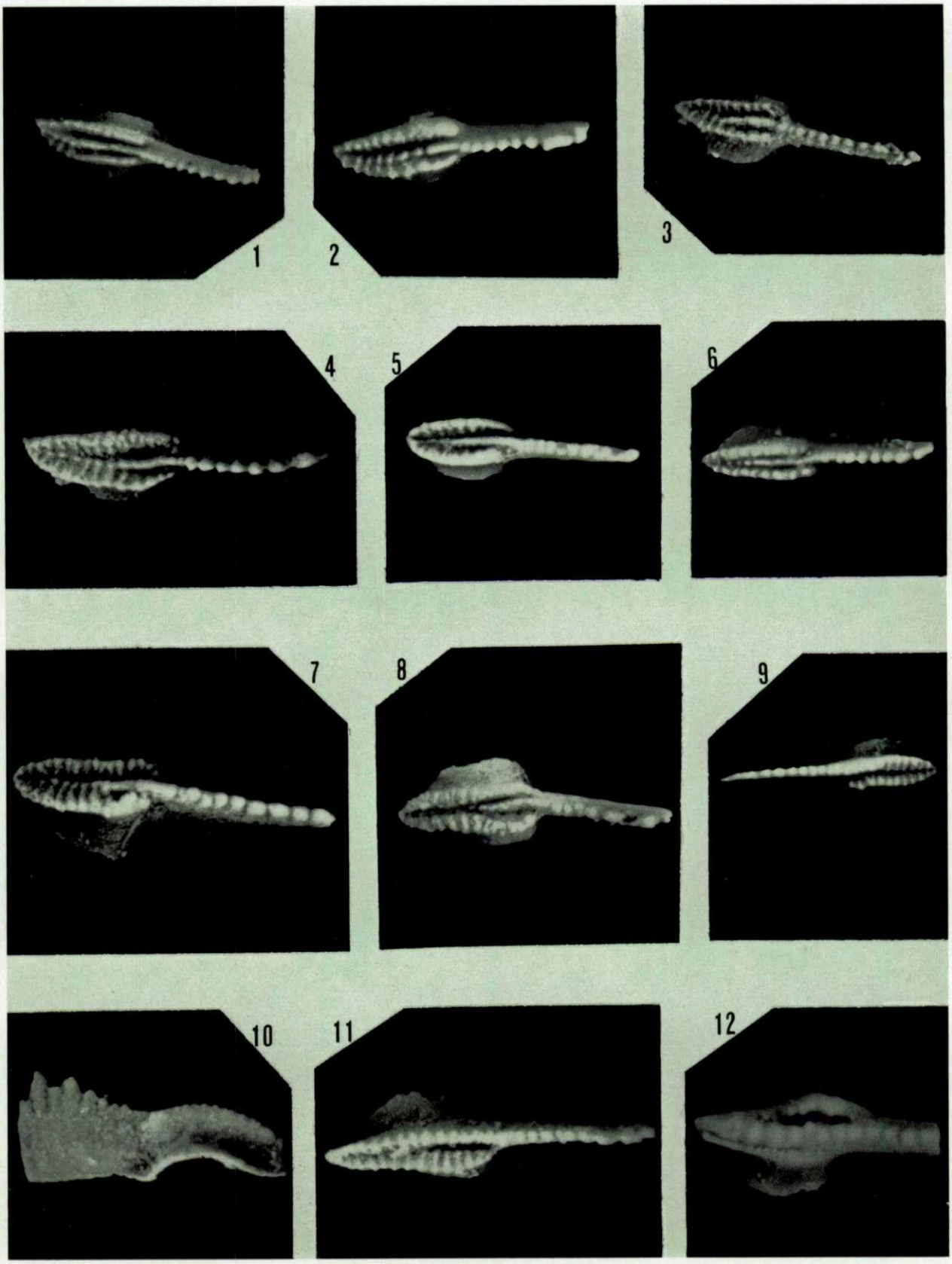

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PLATE 6

EXPLANATION OF PLATE 6.

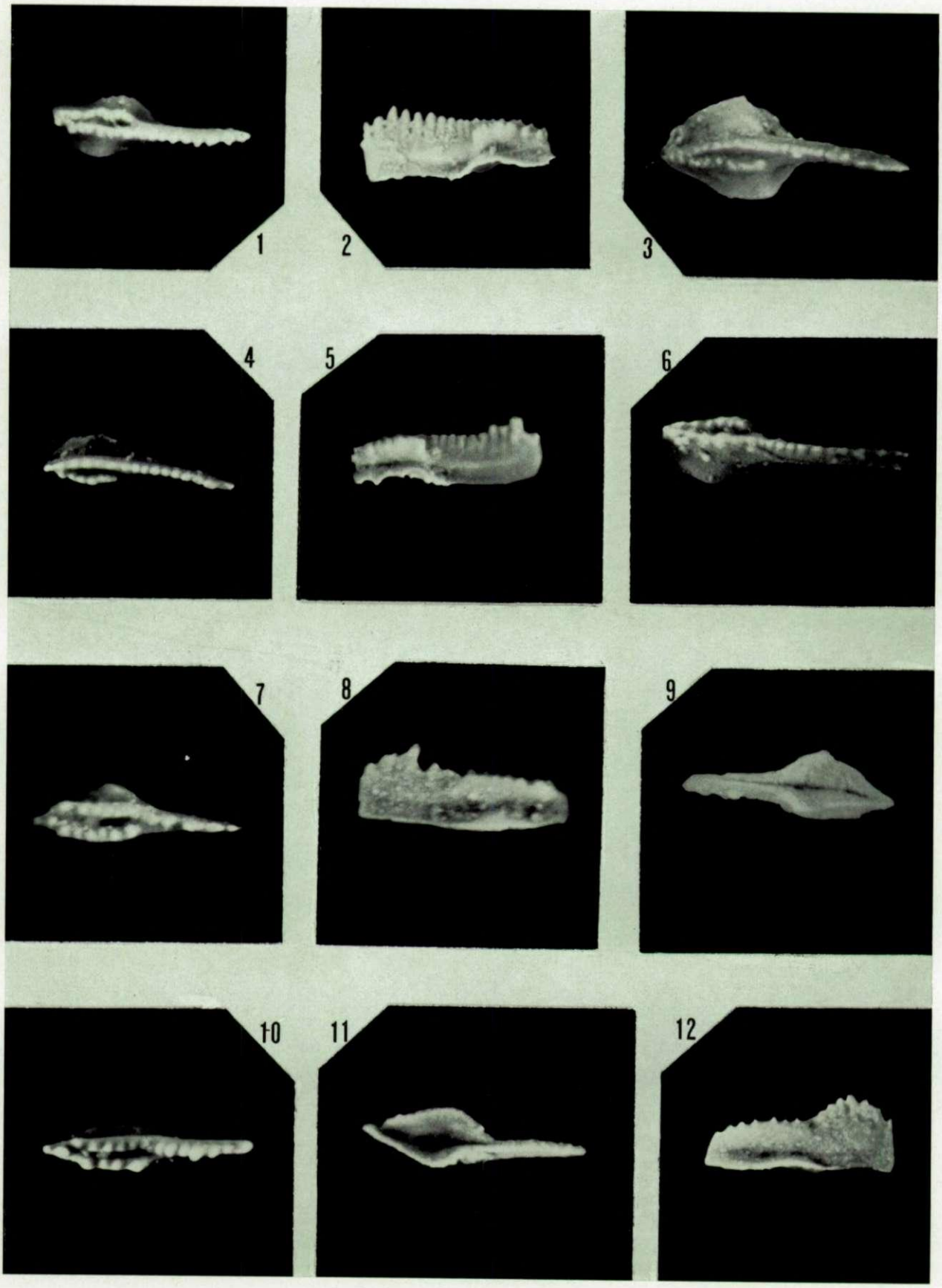
All figures ×50, except figure 6 which is ×60.

FIGS. 1-6. — *Idiognathoides sulcata parva* sp. and sub. sp. nov.
Figs. 1, 3, 4, 6 : oral views; figs. 2, 5 : inner lateral views. Fig. 6, holotype.

Locality : Pl. 145 E.
Moha Colliery (XIVa).

FIGS. 7-12. — *Idiognathoides minuta* sp. nov.
Figs. 7, 10 : oral views; figs. 8, 12 : inner and outer lateral views respectively; 9, 11 : aboral views. Holotype figs. 7-9.

Locality : Pl. 122 W, 260.
Bolland Borehole, bed 449 (I).



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