

ÉTUDE BIOSTRATIGRAPHIQUE DE L'ENCRINITE DE TRAMAKA

Par AUSTIN R., CONIL R., GROESSENS E. et PIRLET H.

1) INTRODUCTION (H. PIRLET)

La carrière du four à chaux de Tramaka, située au Nord de Seilles, le long de la route de Tramaka à Couthuin, est bien connue des géologues du calcaire carbonifère. Le front sud de cette carrière expose de bas en haut la succession suivante (H. PIRLET, 1964):

- 23 mètres de calcaires organoclastiques et algaires gris clair à gris bleu à structures rythmiques appartenant à un ensemble de 46 mètres de calcaires de même nature qui forme la base du Viséen supérieur (repris par sigle lithostratigraphique *V3a*) à *Productus giganteus*, *Lithostrotion martini*, *L. irregulare*, *Carcinophyllum vaughani*, *Archaeodiscus convexus*, *Endothyra omphalota minima*, *Endothyra convexa*, *Endothyra foeda*, *Tetrataxis paraminimus*. Nous y avons également trouvé des *Goniatites* qui sont actuellement à l'étude.

a — 14 mètres de calcaire algaire beige clair à stromatolithes qui constitue le sommet de ce *V3a*.

- contact ravinant souligné par de très petites poches de dissolution.

b — 3,7 m d'encreinite grossière (macro-organoclastite) grise légèrement dolomitisée qui s'altère en roux. Abondances de très petits Brachiopodes non encore étudiés.

c — Schistes noirs du Namurien, ici peu épais, qui forme le sommet de la falaise; zone H1b.

Il existe dans les calcaires sous-jacents au Namurien de nombreuses poches de dissolution, localement minéralisées

par de la blende et de la galène, qui appartiennent à un karst datant du début du Namurien.

On y trouve en effet des débris de schistes noirs et des *Goniatites* des zones E2b2, E2c et H1a (CALEMBERT L. et VAN LECKWIJCK W., 1941) qui n'existent plus en position normale au-dessus des calcaires et en-dessous de la zone H1b.

Nous pouvons donc voir qu'il existe au sommet du calcaire carbonifère une importante lacune stratigraphique d'environ 250 mètres en stampe normale. Il y manque en effet les couches calcaires du sommet du *V3a*, tout le *V3b* calcaire normalement épais de 100 mètres, le *V3c* épais de 25 mètres dans le synclinorium de Dinant et une certaine épaisseur de couches schisteuses namuriennes des zones E1 et E2.

Lors de travaux précédents (H. PIRLET 1964, 1968), nous avons attribué à l'encreinite grossière de Tramaka un âge viséen supérieur (sigle lithostratigraphique: *V3c sup.*) sur la base de son caractère un peu dolomitique. Les minces couches du *V3c* qui couronnent les carrières du *V3b* de la vallée du Samson présentent en effet ce caractère dolomitique et, en l'absence de détermination de fossiles, il est compréhensible que nous ayons parallélisé ces deux formations qui se situent chacune sous la base immédiate du Namurien.

Dépôt des collections

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Introduction

La microfaune d'Anton comporte un assemblage extrêmement riche d'Archaeiscidae, parmi d'autres foraminifères beaucoup moins abondants et peu caractéristiques. On observe une majorité d'*Archaeodiscus* alignés, évolutes, des *Nodosarchaediscus* du même type et des *Ammarchaediscus* dont une nouvelle espèce: *Amm. leckwijcki*. Les profils des loges tubulaires sont principalement de type *angulatus* et *tenuis*. L'ensemble des caractères de l'association montre un degré d'évolution plus avancé que celui du *V3c* inférieur de Warnant.

L'encreinte de Tramaka ne montre habituellement que des foraminifères mal préservés et difficilement identifiables; c'est la raison pour laquelle aucune mention ne fut faite de cette faunule dans la monographie de CONIL & LYS, en 1964.

Seuls les gîtes de Tramaka et d'Anton avaient fait l'objet de recherches; le hasard de lames récemment taillées dans des échantillons éboulés, provenant de la carrière d'Anton, devait amener la découverte d'un assemblage particulièrement intéressant, dominé par les Archaeiscidae.

11 plaques minces taillées dans le même échantillon montrent les éléments suivants:

Earlandia minor (RAUSER) — peu abondantes.
Tetrataxis sp. — peu abondants; certains spécimens atteignent un diamètre de 1050 µ.

Endothyra sp. — petites espèces peu caractéristiques et peu abondantes
 Archaeiscidae — extrêmement abondants et de taille petite à moyenne. On en dénombre fréquemment plusieurs centaines par cm 2.

Ostracodes.

Coquilles diverses.

Conodontes.

La disproportion énorme entre les divers constituants de l'association sont le reflet de conditions de vie très particulières; elles

expliquent l'absence d'autres guides, que l'on s'attendrait à y rencontrer.

Les Archaeiscidae montrent des caractères très évolués et différents de tout ce qui a été rencontré dans les derniers niveaux à foraminifères du Viséen en Belgique (*V3c* inférieur; zone à *Gon. striatus striatus*). Semblable faune d'Archaeiscidae n'a jamais été publiée en Europe occidentale et méritait d'être figurée, même si l'état actuel des révisions de la famille ne permet pas encore une identification appropriée de tous ses composants.

Archaeodiscus BRADY

L'assemblage des *Archaeodiscus* montre une tendance accusée et généralisée à former un enroulement évolué. On y distingue cependant deux types caractérisés par la forme de la loge tubulaire:

— Les planchers sont concaves ou tout au moins montrent un relèvement latéral, dû à la présence d'épaulements, dans les tours sous-jacents (subsp. *angulatus* et *evolutus*); ce caractère peut disparaître dans les derniers tours des formes alignées (pl. III, figs. 9-11). La couche radiée des tours internes participe à la formation d'une masse radiée centrale, recouvrante.

Ces formes prolongent les tendances viséennes typiques du *V3b-c*.

— Les tours successifs s'individualisent de plus en plus. La couche radiée acquiert une épaisseur uniforme, ne participe plus au recouvrement latéral des tours inférieurs et ne forme plus d'épaulements. Il en résulte un retour à des planchers convexes, tandis que le profil de la loge tubulaire devient typiquement semi-circulaire et se moule sur la forme des tours sous-jacents. Ces caractères (subsp. *tenuis*) sont bien illustrés par les figures 1 à 4 de la planche III. Les figures 2 et 3 montrent très nettement cette tendance dès les tours initiaux.

Archaeodiscus kolymensis A.D. — M. MAKLAY, 1960 montre la même particularité.

Ces formes apparemment issues des précédentes avec lesquelles elles montrent à Anton d'évidentes transitions, sont exceptionnelles dans le Viséen d'Europe occidentale. Le spécimen le plus remarquable de ce type a été trouvé dans le sondage de Soiron, associé à *Leptodiscus* CONIL & PIRLET (SG, 135W, n° 376/665 m); il possède cependant un étoilement initial naissant que nous n'avons pas retrouvé à Anton.

La classification des Archaediscidae proposée par CONIL & PIRLET accorde au mode d'enroulement une valeur de groupe d'espèces et à l'évolution lente du profil de la loge tubulaire une valeur de sous-espèce chronologique.

Les principaux modes d'enroulement sont reconnaissables chez les *Archaediscus* d'Anton:

- groupe
- aligné (figs. 1, 4, 9-12, 17-20);
- oscillant (figs. 14, 15);
- sigmoïdal imparfait (fig. 2);
- sigmoïdal parfait (fig. 3).

L'évolution du profil de la loge tubulaire passe depuis le *V1b* jusqu'au *V3c/Nm* par les stades suivants: *involutus*, *concavus*, *angulatus*, *evolutus* et *tenuis*. Ces deux derniers sont probablement plus ou moins contemporains). Les types *angulatus* et *tenuis* dominent dans l'association d'Anton.

Nodosarchaediscus CONIL et PIRLET

Ce genre est essentiellement représenté par des (*Asperodiscus*) à enroulement aligné (pl. III, fig. 13); certaines formes à enroulement oscillant et à occlusion plus avancée rappellent les (*Asteroarchaediscus*) (fig. 16) qui sont plutôt rares à Anton.

Ammarchaediscus CONIL & PIRLET

Deux types principaux ont été rencontrés:

- formes complètement évolutes, sans épaulements, à tours parfaitement individualisés et couche radiée uniformément épaisse et non recouvrante. Dépressions ombilicales.
Amm. leckwijcki nov. sp., pl. III, figs. 6-8

— formes évolutes dans les derniers tours.

La couche radiée des tours initiaux forme un remplissage des régions ombilicales qui ne sont pas ou guère déprimées. Vraisemblablement deux espèces (Pl. III, fig. 5).

Ces deux types se rapprochent par leur caractère complètement évoluté de *Tubispirodiscus* BROWNE & POHL, mais ils en diffèrent par leurs planchers bien convexes (et la présence d'un liseré sombre interne).

Ammarchaediscus leckwijcki nov. sp.

Derivatio nominis: nous dédions cette espèce au prof. W. van LECKWIJCK.

Holotype: RC 9087 (9655), fig. 8.

Locus typicus: Anton, bord nord du Synclinorium de Namur, Belgique.

Stratum typicum: Namurien inférieur.

Diagnose

Test discoïdal ombiliqué.

Enroulement: planispiralé.

Spires: 4 - 5.

Diamètre: 400 - 460 μ .

Largeur: 100 - 120 μ .

1/d: 0,25 - 0,30.

Description

La loge tubulaire croît régulièrement en dimensions; son profil est subcirculaire et son enroulement complètement évoluté. Les sutures sont nettement marquées.

La paroi a une épaisseur uniforme et est dépourvue d'épaulements ou de tout prolongement latéral; il en résulte que le plancher des tours est convexe dans tout le test. La couche foncée interne est marquée par un liseré pelliculaire.

Rapports et Différences

Cette espèce appartient au sous-genre A des *Ammarchaediscus* décrits par CONIL & PIRLET. Il se distingue par son profil discoïde, sa taille relativement grande et son enroulement complètement évoluté et dégagé, avec planchers convexes.

Le degré d'évolution des originaux correspond à la sous-espèce chronologique *tenuis* des *Archaediscus* (voir fig. 1).

Répartition Stratigraphique

A notre connaissance, cette espèce n'est connue qu'au locus typicus d'Anton.

Les Archaediscidae d'Anton, bien que présentant des caractères plus évolués que ceux du $V3c$ inférieur de Warnant, montrent curieusement une prédominance des *Archaediscus* sur les *Nodosarchaediscus*, ainsi que des *Ammarchaediscus* d'un type rare. La plupart des espèces ont un enroulement aligné et aucune des formes géantes, communes dans le $V3b$ n'a été rencontrée.

3) A CONODONT FAUNA FROM ANTON, BELGIUM (R.L. AUSTIN et E. GROESSENS)

Introduction

An interesting conodont fauna was reported by Austin and Rhodes (1970) from beds assigned to the $V3c$ at Tramaka. The fauna included *Adetognathus unicornis* (Rexford & Burton), *Adetognathus* sp., *Apatognathus geminus* (Hinde), *Cavusgnathus* sp., *Cavusgnathus unicornis* (Youngquist & Miller), *Gnathodus bilineatus* (Roundy), *Gnathodus commutatus* (Branson & Mehl), *Gnathodus nodosus* Bischoff, *Gnathodus semiglaber* (Bischoff), *Hindeodella undata* (Branson & Mehl), *Hibbardella* sp., *Hindeodus* sp., *Ligonodina* sp., *Ligonodina levigata* (Branson & Mehl), *Neopriioniodus montanaensis* (Scott) and *Subbryantodus* sp.

This was the first record of the genus *Adetognathus* in Western Europe. In North America *A. unicornis* is the diagnostic species for high Chesterian levels. Varker and Austin (in press) report the occurrence of *A. unicornis* in beds of Namurian age. It has been suggested that the $V3c$ beds at Tramaka are not of Viséan age and it was thought possible that other $V3c$ horizons of Belgium might also be younger than Dinantian and possibly of Namurian age. In order to test this hypothesis samples have been collected from other $V3c$ localities and a fauna from the $V3c$ at Anton is reported here.

Upper Viséan ($V3$) Belgian conodont faunas have been reported by BOUCKAERT and

HIGGINS (1963), CONIL (1959), LYS and MAUVIER (1964), CONIL and PIRLET (1970), PIRLET (1968) SERRE and LYS (1959), DEMANET (1958), AUSTIN and RHODES (1970) and HIGGINS and BOUCKAERT (1968).

HIGGINS and BOUCKAERT (1968) examined two sections of $V3c$ in detail. Six horizons yielded conodonts at Jaiffe at Warnant and four horizons yielded conodonts at the Merbes — Sprimont Quarry at Bioul. The $V3c$ fauna according to Higgins and Bouckaert was varied and there was a preponderance of one genus, *Gnathodus*, in most samples. *Gnathodus bilineatus* and *Gnathodus girtyi* were particularly common and at some horizons *Gnathodus nodosus* was abundant. Other abundant species included *Gnathodus commutatus* and *Neopriioniodus singularis*. *Gnathodus nodosus*, *Lambdagnathus macrodonta* and *Neopriioniodus spathus* were stratigraphically important as according to Higgins and Bouckaert they have not been recorded below the horizon of $V3c$. *Cavusgnathus* was thought to be useful locally as it had not been recorded below $V3b$ or above $V3c$ in Belgium. *Gnathodus girtyi* subsp. nov. was not recorded in the Namurian. HIGGINS and BOUCKAERT concluded that the $V3c$ conodont fauna belonged to the *bilineatus* — *nodosus* zone.

THE CONODONT FAUNA

The following form genera and species are reported:

<i>Cavusgnathus laetus</i> GUNNELL	1
<i>Cavusgnathus unicornis</i> YOUNGQUIST and MILLER	21
<i>Gnathodus bilineatus</i> bilineatus ROUNDY	189
<i>Gnathodus bilineatus</i> cf. <i>bollandensis</i> HIGGINS and BOUCKAERT	22
<i>Gnathodus commutatus</i> (BRANSON and MEHL)	51
? <i>Gnathodus girtyi</i> HASS	12
<i>Gnathodus nodosus</i> BISCHOFF	24
<i>Hibbardella</i> sp.	4
<i>Hindeodella</i> sp.	17
<i>Ligonodina</i> sp.	8

<i>Lonchodina</i> sp. A.	30
<i>Lonchodina</i> sp. B.	42
<i>Magnilaterella</i> sp.	3
<i>Metalonchodina</i> sp.	5
<i>Neopriioniodus singularis</i> (HASS)	35
<i>Neopriioniodus</i> sp. A.	4
<i>Neopriioniodus</i> sp. B.	5
<i>Ozarkodina</i> sp.	26
<i>Polygnathus</i> sp.	
<i>Roundya</i> sp.	10
<i>Subbryantodus</i> sp.	3

The presence of *Polygnathus* in the faunal list is anomalous as the genus would not be expected to occur within a typical *Gnathodus bilineatus* — *Gnathodus nodosus* association. It is probable that the *Polygnathus* elements have been reworked from older rocks. Thompson (1970) reported that he had recovered specimens of *Polygnathus* from rock of Chesterian and Lower Pennsylvanian age. Thompson concluded that although an extension of the range of *Polygnathus* (Lower Devonian — Upper Lower Mississippian Osagean) was possible the specimens he found in Lower Pennsylvanian rocks were possibly the result of reworking. The large *Cavusgnathus* elements are similar to those which are found in *Gnathodus bilineatus* — *Gnathodus nodosus* associations of other regions. There is one specimen which we refer to? *Cavusgnathus laetus*, as the blade occupies a left to central position. This element is trending towards *Adetognathus* — a genus reported by AUSTIN and RHODES (1970) from Tramaka. Left and right elements similar to *Cavusgnathus* occur in high Tournaisian and low Viséan levels (Austin 1973). It is possible that the specimen of? *Cavusgnathus laetus* is reworked from older horizons.

Multi-element apparatuses

The conodonts listed above may be referred to multi-element apparatuses. Two of the apparatus types (type 1 and type 3) described by KLAPPER and PHILIP (1971) are recognised. We have not used the multi-element notations for numerous reasons chief of which is the small size of our collection. We recognise elements in our fauna which may be referred

to *Idiopriioniodus* GUNNELL sensu BAESEMAN (1973), or to *Neopriioniodus* RHODES and MULLER sensu von BITTER (1972). This is a representative of the type 3 apparatus of KLAPPER and PHILIP (1971) and of the *Duboisella* association of RHODES (1952). Recognition of some of the components of *Idiopriioniodus* highlights the problems of conodont taxonomy during the transition period from form generic nomenclature to multi-element nomenclature. The nomenclature proposed by von BITTER (1972) should have priority as he was the first revisor. He named a species *Neopriioniodus conjunctus* (Gunnell) after the Ne element of the apparatus. The synonymy of the Ne element given by VON BITTER is unsatisfactory, as specimens listed under *N. conjunctus* by RHODES et al (1969) for example, are from older stratigraphic horizons than the type specimens. BAESEMAN (1973) named a species *Idiopriioniodus lexingtonensis* which contains two distinct types of B1 elements (B1a and B1b) and B3 elements (B3a and B3b). The generic name bearer is the B1a element and the specific name bearer is the B2 element. *Idiopriioniodus lexingtonensis* (Gunnell) according to BAESEMAN has the following elements.

N element	<i>Prioniodus conjunctus</i>
	GUNNELL
B1a element	<i>Idiopriioniodus typicus</i>
	GUNNELL
B1b element	<i>Prioniodus clarki</i> GUNNELL
B2 element	<i>Prioniodus lexingtonensis</i> GUNNELL
B3a element	<i>Prioniodus subacodus</i> GUNNELL
B3b element	<i>Lonchodina</i> ? <i>pondersa</i> ELLISON

Neopriioniodus conjunctus (GUNNELL) according to VON BITTER (1972) has the following elements.

N element	<i>Prioniodus conjunctus</i>
	GUNNELL
Ni element	<i>Idiopriioniodus typicus</i>
	GUNNELL
Pl element	<i>Prioniodus clarki</i> GUNNELL

Tr element *Prioniodus subacodus*
GUNNELL

We refrain from commenting further, but are impressed that two writers independently have reconstructed an apparatus, which is strikingly similar and we note the value of blade and bar illustration.

The *Cavusgnathus* elements of our collection form part of a type 1 apparatus (the P. element). In order to complete the apparatus O₁ elements, N elements and A₁ — A₃ elements are required. The nature of these elements is uncertain at this time. (cf. VON BITTER 1962, and BAESEMANN 1973) SCOTT (1973) has referred associations containing *Cavusgnathus* to the genus *Lewistownella*. They were of Chesterian (probably E₂ to H₁) age.

Gnathodus bilineatus is the P element of a type 1 apparatus and it probably was associated with O elements (similar to pl. 2 fig. 1), N elements (similar to pl. 1 fig. 14) and A₁ — A₃ elements (of which two are represented in our collections pl. 2, fig. 13, pl. 2, fig. 23). We believe that *Gnathodus commutatus* is another type 1 apparatus and that the generic name should be changed. Some specimens in our collection (pl. 1, fig. 1) are probably different to *G. bilineatus* and we assign them in the faunal list to ? *Gnathodus girtyi*. This form species is part of a transition series to the genus *Idiognathodus*, a form genus which itself shows a transition series to *Streptognathodus*. The advent of multi-element taxonomy to conodont systematics has led to a peculiar situation with regard to these form genera. VON BITTER (1972) defined the genera *Streptognathodus* and *Idiognathodus* within a multi element concept. Rhodes and Austin (in preparation) have made observations on Von Bitter's treatment of *Idiognathodus* and *Streptognathodus* and they are not repeated here. BAESEMANN (1973) recognised a genus *Idiognathodus* which was diagnosed as follows "Type 1 apparatus P, O, N, A₁, A₂, A₃, P element is Idiognathodontan". BAESEMANN placed the form genus *Streptognathodus* in synonymy with *Idiognathodus* and he also included in the *Idiognathodus* synonymy the bedding plane association described

as *Scottella* by RHODES (1952) and as *Scottognathus* by RHODES (1953). MELTON and SCOTT (1973) have retained the genus *Scottognathus* for assemblages containing hindeodellids, synprioniodinids, ozarkodinids and Idio-Streptognathodids. They illustrated a fossil referable to *S. elizabethi*. BAESEMANN (1973, p. 699) has not been able to confirm that the elements of his *Idiognathodus* occur in *Scottognathus*, neither have MELTON and SCOTT (1973 p. 62 - 64) identified the form species in their *Scottognathus elizabethi*. In terms of terminology one has to choose between the multi-element concepts of VON BITTER (1972) or BAESEMANN (1973) and between one of these and the animal concept of MELTON and SCOTT (1973). In addition one has to decide the limits of generic and specific variation permitted within transition series. This situation was foreseen by AUSTIN (1972) who urged caution in conodont nomenclature during the transition period from form generic identification to multi-element identification. Whilst accepting the multi element apparatus concept we continue to use form genera and form species in the transitional period of conodont taxonomy.

ENVIRONMENTAL SIGNIFICANCE OF THE FAUNA

The faunal list given above lists all the conodonts we have found. Four spot samples were collected over a short interval and of special significance is that one of the samples contained all the *Cavusgnathus* elements. MERRILL (1973) has summarised his work on Pennsylvanian conodont paleoecology. MERRILL concluded that a near shore biofacies, characterised by the platform genus *Cavusgnathus*, can be distinguished from more offshore faunas in which *Idiognathodus* or *Streptognathodus* dominate depending on the age of the samples. VON BITTER (1972) also noted a similar distribution of platform conodont elements of the genera *Adetognathus*, *Cavusgnathus*, *Idiognathodus* and *Streptognathodus*.

Chamberlain and Clark (1973) have reported their work on the distribution of trace fossils and conodonts. They reported that an

Adetognathus fauna characterises the *Cruziana* assemblage, an *Idiognathodus* fauna the *Zoophycos* assemblage and no indigenous conodonts characterise the *Nereites* fauna. It would have been of interest to see a comparison of their results with those of VON BITTER (1972) and MERRILL (1973). Appreciation of the different biotypes is a distinct advantage, when interpreting the V_{3c} faunas of Belgium.

Attention is drawn to the absence of *Gnathodus girtyi* HASS and *Gnathodus homopunctatus* ZIEGLER from our faunal list. These are characteristic species in conodont collections of this age from other areas. Their absence we attribute to environmental factors.

CORRELATION

BOUCKAERT and HIGGINS (1963, 1970) and HIGGINS and BOUCKAERT (1968) commented on Upper Dinantian and Lower Namurian conodont faunas and have suggested correlation to other areas. The Anton fauna may be compared with those reported from the Namurian of England (HIGGINS 1961), Scotland (CLARKE 1960), Ireland (ALDRIDGE, AUSTIN and HUSRI, 1968), Germany (MEISCHNER 1970), the Sahara (REMACK-PETITOT, 1960), Japan (IGO and KOIKE 1964, 1965, KOIKE 1967), Spain (MARKS and WEINSINK 1970), South America (STIBANE 1967), Australia (PALMIERI, 1969), from the Upper Mississippian and Namurian of eastern Europe (SPASSOV 1966, 1968, SPASSOV and FILIPOVIC 1967, DURDANOVIC 1967, 1971) and from the Upper Mississippian and Pennsylvanian of North America (REXROAD and FURNISH 1964, THOMPSON 1970, 1973, DUNN 1970, LANE 1967, LANE, SANDERSON and VEVILLE 1972, MERRILL and KING 1971, VON BITTER 1972, WEBSTER 1969, MERRILL 1973, BAESEMAN 1973, COLLINSON, REXROAD and THOMPSON 1971, REXROAD and BURTON 1961, LANE *et al.* 1970).

Thompson (1972) has documented Chesterian conodont faunas from Missouri and compared them with those described from the type Chesterian strata of southern Illinois

(COLLINSON, REXROAD and THOMPSON, 1971) and from the Chesterian strata of Arkansas, Texas, and Oklahoma. THOMPSON also emphasised that the correlation of Chesterian strata is complicated by the fact that two dissimilar conodont faunal sequences are known. One from the type Chestertan and the other from Texas and Oklahoma called the "southern province" by Rexroad and Jarrell (1961). We equate our fauna with a level within the Fayetteville Formation of THOMPSON.

WEBSTER (1969) noted an abundance of *C. laetus* in the Bird Spring formation above the *Rhipidomella nevadensis* Zone, and the species first appeared at younger stratigraphic levels than the first appearance of *Cavusgnathus gigantus* (*C. unicornis*). *Streptognathodus unicornis* in Nevada according to Webster appears before both *C. laetus* and *C. gigantus*. WEBSTER also noted that *Gnathodus commutatus* and *Gnathodus bilineatus* were not found in the Zone of *Millerella* which overlies the zone of *Rhipidomella nevadensis* in southern Nevada. We correlate our Anton fauna with an horizon approximately at the boundary between the Indian Springs Formation and the Bird Spring formation of WEBSTER 1969, that is high in the Zone of *Rhipidomella nevadensis*.

THOMPSON (1972) illustrated *G. commutatus* (BRANSON and MEHL). Not all illustrated specimens of *G. commutatus* are like the Branson and Mehl specimens. One of our illustrated specimens is similar and other specimens have been reported from other areas, although under different names (for example *Gnathodus* sp. A of PALMIERI 1969). This form might be useful for correlation.

The Anton fauna compares most closely with those described from the Arnsbergian (E₂) by HIGGINS and BOUCKAERT (1968). These authors noted that *Gnathodus bilineatus bollandensis* made its first appearance in the E_{2b2} subzone at Monceau-sur-Sambre and was a common element of middle and upper Arnsbergian faunas.

MARKS and WENSINK (1970) have recognised a zone of *Gnathodus macer*, which they

equated with E2. WIRTH (1967) described a similar fauna from limestones intercalated in shales directly underlying greywackes and siliceous shales forming the top of the section in the Quinto Real region of the Western Pyrenees. *Gnathodus girtyi* illustrated on plate I fig I, is comparable with *Gnathodus macei* WIRTH.

CONCLUSION

"It has been recently recognised that there is no palaeontological evidence for beds of E₁ age in Belgium. Do we now have to admit that the conodont record conflicts with this assumption?" so enquired Professor VAN LECKWIJCK at Liege in 1969, after *Adetognathus unicornis* had been reported from the V_{3e} superior rocks at Tramaka.

BOUCKAERT and HIGGINS (1963) noted that goniatites at the base and the top of the Bioul and Jaiffe sections have been dated as uppermost Viséan (V_{3c}) and basal E₂ respectively. Between the two horizons some 10 metres of shales and limestones occur of which the upper 5 metres are non fossiliferous. The lower 5 metres contain a fauna which was dated as V_{3c} by DEMANET.

The base of the Namurian in terms of conodonts has not been recognised. The work of Collinson and Druce remains unpublished. An important observation in their study was that *Gnathodus homopunctatus* was abundant in the highest Viséan limestone

they examined, but was absent from the basal Namurian *C. leion* beds. *G. homopunctatus* does extend up into the Namurian in other areas (HIGGINS 1961) and its absence from the Lower Namurian rocks of Ireland may be explained in terms of its ecological restriction. The absence of *G. homopunctatus* at Anton and at Tramaka we believe suggests that the faunas are of Namurian age. The full stratigraphic range of *Adetognathus unicornis* is not known, but VARKER and AUSTIN (In press) report the species from a Yoredale sequence in the north of England, where the species is confined to a short stratigraphic (and also lithologic) sequence within E_{2a}.

The barren shale interval at Bioul and Jaiffe may be the lateral equivalent of the calcareous development at Anton and Tramaka and may be of early Namurian age. We emphasise in making this statement that our evidence is not strong and more work has to be completed before the question of the earliest Namurian rocks of Belgium can be resolved.

ACKNOWLEDGMENTS

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BIBLIOGRAPHIE

- ALDRIDGE, R.J., AUSTIN, R.L. and HUSRI, S. 1968. Viséan conodonts from North Wales and Ireland. *Nature*, 219, pp. 255-258, 3 tables.
- AUSTIN, R.L. 1972. Problems of conodont taxonomy with Special Reference to Upper Carboniferous forms. *Geologica et Palaeontologica SBl*, pp. 115-126, 2 pls., 2 text-figs. 1 table.
- 1973. A note on the Genus *Cavusgnathus*, Harris and Hollingsworth. *Geol. Soc. Amer. Nth. Central Section Mtg*. Missouri. Abstract. pp. 295-296.
- and RHODES, F.H.T. 1970. New Dinantian conodont faunas of France and Belgium — A preliminary note. In "Colloque sur la Stratigraphie du Carbonifère". *Congrès et Colloques Univ. Liège*, pp. 193-196.
- BAESEMAN, J.F. 1973. Missourian (Upper Pennsylvanian) Conodonts of Northeastern Kansas. *Jour. Paleontology*, 47, pp. 689-710, 3 pls., 2 text-figs.
- BOUCKAERT, J. and HIGGINS, A.C. 1963. La Base du Namurien dans le Basin de Dinant. *Bull. Soc. belge. Géol. Paléont. Hydrol.* 72, pp. 106-120, pls. 1-7.
- — 1970. The position of the Mississippian-

- Pennsylvanian boundary in the Namurian of Belgium.
- In Colloque sur la Stratigraphie du Carbonifère. *Congrès et colloques Univ. Liège*.
- CALEMBERT, L. et VAN LECKWYCK W. 1941. Sur des phénomènes de dissolution au contact des terrains viséens et namuriens dans la région du Samson. *Ann. Soc. Géol. de Belgique*, t. 55, B. pp. 41-46.
- CHAMBERLAIN, K.C. and CLARK D.L. 1973. Trace fossils and conodonts as evidence for deep-water deposits in the Oquirrh Basin of Central Utah. *Jour. Paleontology*, 47, pp. 663-682, 3 pls., 7 text-figs.
- CLARKE, W.J. 1960. Scottish Carboniferous conodonts. *Trans. Edin. Geol. Soc.* 31 pp., 5 pls., 1 table.
- COLLISON, C., REXROAD, C.B. and THOMPSON, T.L. 1971. Conodont zonation of the North American Mississippian. In: Symposium of conodont biostratigraphy. *Geol. Soc. Am. Mem.* 127, pp. 353-394, 8 text-figs. 1 table.
- CONIL, R. 1959. Recherches stratigraphiques sur les terrains dinantiens dans le bord nord du bassin de Namur (région S'étendant de la Dendre à l'Orneau). *Acad. roy. de Belg., Cl. des Sc. Mem.* 14, 5, pp. 5-156. (after Pirlet 1968).
- DEMANET, F. 1958. Contribution à l'étude du Dinantien de la Belgique. *Inst. Roy. des Sc. Natur. de Belg. Mem.* 141.
- DUNN, D.L. 1970. Conodont zonation near the Mississippian — Pennsylvanian boundary in Western United States. *Geol. Soc. Am. Bull.*, 81, pp. 2959-2974, 4 text-figs.
- DURDANOVIC, Z. 1968. Knodonte donjeg Devona i donjeg Karbona Zapadno od Dvora na uni (Hrvatska-Jugoslavija). pp. 93-103, 1 pl.
- 1971. About the Paleozoic and the Triassic of Medvednica Mountain and the area near Dvor Na Uni on the basis of conodonts, pp. 29-49, 6 pls., 2 text-figs.
- HIGGINS, A.C. 1961. Some Namurian conodonts from North Staffordshire. *Geol. Mag.* 98, pp. 210-224, pls. 10-12, 4 text-figs.
- and BOUCKAERT, J. 1968. Conodont Stratigraphy and Palaeontology of the Namurian of Belgium. *Mém. Expl. Cartes Géologiques et Minières de la Belgique*. 10, 64 pp. 6 pls., 6 text-figs.
- IGO, H. and KOIKE, T. 1964. Carboniferous conodonts from the Omi Limestone, Nigata Prefecture, Central Japan. (Studies of Asian conodonts, part 1). *Trans. Proc. Palaeont. Soc. Japan*, 53, pp. 179-193, pls. 27, 28, 1 text-fig.
- 1965. Carboniferous conodonts from Tobarai Akiyoshi Limestone, Japan. (Studies of Asiatic conodonts, part 11). *Trans. Proc. Palaeont. Soc. Japan*, 59, pp. 83-91, pls. 8, 9, 1 text-fig.
- KLAPPER, G. and PHILIP, G.M. 1971. Devonian conodont apparatuses and their vicarious skeletal elements. *Lethaia*, 4, pp. 429-452, 14 text-figs.
- KOIKE, T. 1967. A Carboniferous succession of conodont faunas from the Atetsu Limestone in Southwest Japan. (Studies of Asiatic conodonts, part IV). *Sci. Rep. Tokyo. Kyoiku Daigaku. Sect. C*, 93, pp. 279-318, 4 pls., 1 text-fig. 3 tables.
- LANE, H.R. 1967. Uppermost Mississippian and Lower Pennsylvanian Conodonts from the type Morrowan region, Arkansas. *Jour. Paleontology* 41, pp. 920-942, pls. 119-123, 2 text-figs.
- , SANDERSON, G.A. and VERVILLE, G.J. 1972. Uppermost Mississippian — basal Middle Pennsylvanian Conodonts and fusulinids from several exposures in the South-Central and Southwestern United States. *Rept. International Geological Congress*. Section 7, pp. 549-555, 3 text-figs.
- , MERRILL, G.K., STRAKA, J.J. and WEBSTER, G.D. 1970. North American Pennsylvanian conodont biostratigraphy. In. Symposium of conodont biostratigraphy *Geol. Soc. Am. Mem.* 127, p. 395-414, 1 pl., 4 text-figs.
- MARKS, P. and WENSINK, H. 1970. Conodonts and the age of the "Griotte" Limestone Formation in the Upper Aragon Valley (Huesca, Spain). 1. *Procs. Koninkl. Nederl. Akademie van Wetenschappen*, 73, pp. 238-275, 4 pls. 4 tables.
- MEISCHNER, D. 1970. Conodonten-Chronologie des Deutschen Karbons. *Compte Rendu 6e Congrès Intern. Strat. Geol. Carbonif.* Sheffield, 1967. pp. 1169-1180, 3 text-figs.
- MELTON, W. and SCOTT, H.W. 1973. Conodont-bearing animals from the Bear Gulch Limestone Montana, *Geol. Soc. Amer. Special Paper* 141, pp. 31-65, 20 text-figs.
- MERRILL, G.K. 1973. Pennsylvanian Conodont Paleoecology. *Geol. Soc. Amer. Special paper* 141, pp. 239-274, 12 text-figs.
- and KING, C.W. 1971. Platform conodonts from the lowest Pennsylvanian rocks of north-western Illinois. *Jour. Paleontology*, 45, pp. 645-664, pls. 75, 76, 2 text-figs.
- PALMIERI, V. 1969. Upper Carboniferous conodonts from limestones near Murgon, southeast Queensland. *Geological Survey of Queensland*,

- Publication 341, Palaeontological Papers*, № 17, 13 pp., 7 pls., 2 tables, 1 text-fig.
- PIRLET, H. 1964. La sédimentation de la partie inférieure du V3a dans le bassin de Namur; les relations entre le Dinantien et le Namurien de Namèche à Moha. *Ann. Soc. Géol. de Belgique*, t. 86, B. pp. 461-468; 1 fig., 1 hors-texte.
- PIRLET, H. 1968. La sédimentation rythmique et la stratigraphie du Viséen supérieur, V3b, V3c inférieur dans les synclinoriums de Namur et de Dinant. *Acad. Roy. de Belgique*, Classe des Sciences, Mémoires coll. in 4°, deuxième série, t. 17, fasc. 4.
- PIRLET, H. & CONIL, R. L'évolution des Archaeodiscidae viséens. *Soc. belge Géol.*, vol. Biostrat. et micropal. du Dinantien, à l'impression. (Contient la bibliographie essentielle des Archaeodiscidae).
- REMACK-PETITOT, M.L. 1960. Contribution à l'étude des Conodontes du Sahara (bassins de Fort-Polignac, d'Adrar Reggane et du J. Bechar). Comparaison avec les Pyrénées et la Montagne Noire. *Bull. Socl. Geol. France* 7, pp. 240-262, 4 text-figs. 1 table.
- REXROAD, C.B. and BURTON R.C. 1961. Conodonts from the Kinkaid Formation (Chester) in Illinois. *Jour. Paleontology* 35, pp. 1143-1158, pls. 138-141.
- and FURNISH, W.M. 1964. Conodonts from the Pella Formation (Mississippian) South-Central Iowa. *Jour. Paleontology*, 38, pp. 667-676, pl. 111, 1 text-fig.
- RHODES, F.H.T. 1952. A classification of Pennsylvanian conodont assemblages. *Jour. Paleontology*, 26, pp. 886-901, pls. 126-129.
- 1953. Nomenclature of conodont assemblages with a footnote on a correction of the name "Scottella". *Jour. Paleontology* 27, pp. 610-612.
- and AUSTIN, R.L. (In preparation). Conodont assemblages from the Carboniferous of Britain.
- — and DRUCE, E.C. 1969. British Avonian (Carboniferous) conodont faunas, and their value in local and international correlation. *Brit. Mus. (Nat. Hist.) Bull. Geol. Suppl.* 5, 313 pp. 31 pls.
- SCOTT, H.W. 1973. New conodonts chordata from the Bear Gulch Limestone (Namurian, Montana). *Michigan State University Mus. Pub.* 1, 2, pp. 85-99, 3 pls., 7 text-figs.
- SPASSOV, H. 1966. Significance of the conodont fauna for the stratigraphy of the Palaeozoic. *Bull. Strasimir Dimitrov*. Institute of Geology, 15, pp. 89-97, pl. 1.
- STIBANE, F.R. 1967. Conodonten des karbons aus den Nördlichen Anden Südamerikas. *N. Jb. Geol. Palaont. Abh.* 128, pp. 329-340. pls. 35-37, 1 text-fig., 1 table.
- STOJANOVIC, KUZENKO, S.S. and PAJIC, V. 1968. Les nouveaux résultats obtenus par l'étude des conodontes Paleozoïques de la Serbie du Nord-Ouest. *Vesnik Knjiga* 26, pp. 153-166, 3 pls.
- and FILIPOVIC, I. 1967. Devonian and Carboniferous conodont fauna from north-western Serbia (Yugoslavia). *Bulgarian Acad. Sc. Bull. Geol. Inst.* 16, pp. 53-86, 8 pls. 3 text-figs.
- THOMPSON, T.L. 1970. Lower Pennsylvanian conodonts from McDonald County, Missouri. *Jour. Paleontology* 44, pp. 1041-1048, pl. 139, 2 text-figs.
- 1972. Conodont biostratigraphy of Chesterian strata in South Western Missouri. *Missouri Geol. Surv. and Wat. Res. Rept. of Invst.* № 50, 48 pp., 1 pl. 5 text-figs.
- VARKER J. and AUSTIN, R.L. In press. The significance of *Adetognathus unicornis* (Rexroad and Burton) in the Mirk Fell Beds (E3a) of the North of England.
- VON BITTER, P. 1972. Environmental control of conodont distribution in the Shawnee Group (Upper Pennsylvanian) of Eastern Kansas. *University of Kansas Publications*, 59, 105 pp., 16 pls. 19 tables. 18 text-figs.
- WEBSTER, G.D. 1969. Chester through Derry conodonts and stratigraphy of northern Clark and southern Lincoln counties, Nevada. *Univ. California Publ.* 79, 105 pp. 8 pls., 27 text-figs.
- WIRTH, M. 1967. Zur Gliederung des höheren Palaeozoikums (Givet-Namur) im Gebiet des Quinto Real (Westpyrenäen) mit Hilfe von Conodonten. *Neues Jahrb. Geologie u. Palaontologie* Abh., 127, pp. 179-244, Pls. 19-23.

1974

PLATE 1

- Fig. 1. *?Gnathodus girtyi* Hass. Specimen An/2/40
- Figs. 2, 3, 6, 13. *Gnathodus nodosus* Bischoff.
- Fig. 2 specimen An/2/43 Fig. 3 specimen An/2/37
- Fig. 6 specimen An/2/41 Fig. 13 specimen An/1/34
- Figs. 4, 5, 15, 19, *Gnathodus bilineatus bilineatus* (Roundy)
- 22, 23, 24, 25. Fig. 4 specimen An/2/67 Fig. 5 specimen An/1/54
- Fig. 15 specimen An/2/63 Fig. 19 specimen An/2/39
- Fig. 22 specimen An/1/36 Fig. 23 specimen An/2/68
- Fig. 24 specimen An/2/66 Fig. 25 specimen An/2/38
- Figs. 7, 10, 12. *Gnathodus commutatus* (Branson and Mehl)
- Fig. 7 specimen An/2/36 Fig. 10 specimen An/2/42
- Fig. 12 specimen An/1/30
- Figs. 8, 14. *Cavusgnathus unicornis* Youngquist and Miller
- Fig. 8 specimen An/2/34 Fig. 14 specimen An/2/33
- Fig. 11. *Polygnathus* sp. Specimen An/2/59
- Fig. 18. *?Cavusgnathus laetus* Gunnell. Specimen An/2/35
- Figs. 16, 17, 20, 21. *Gnathodus bilineatus* cf *bollandensis* Higgins and Bouckaert
- Fig. 16 specimen An/2/69 Fig. 17 specimen An/2/6.2.
- Fig. 20 specimen An/2/65 Fig. 21 specimen An/2/58

Plate 1

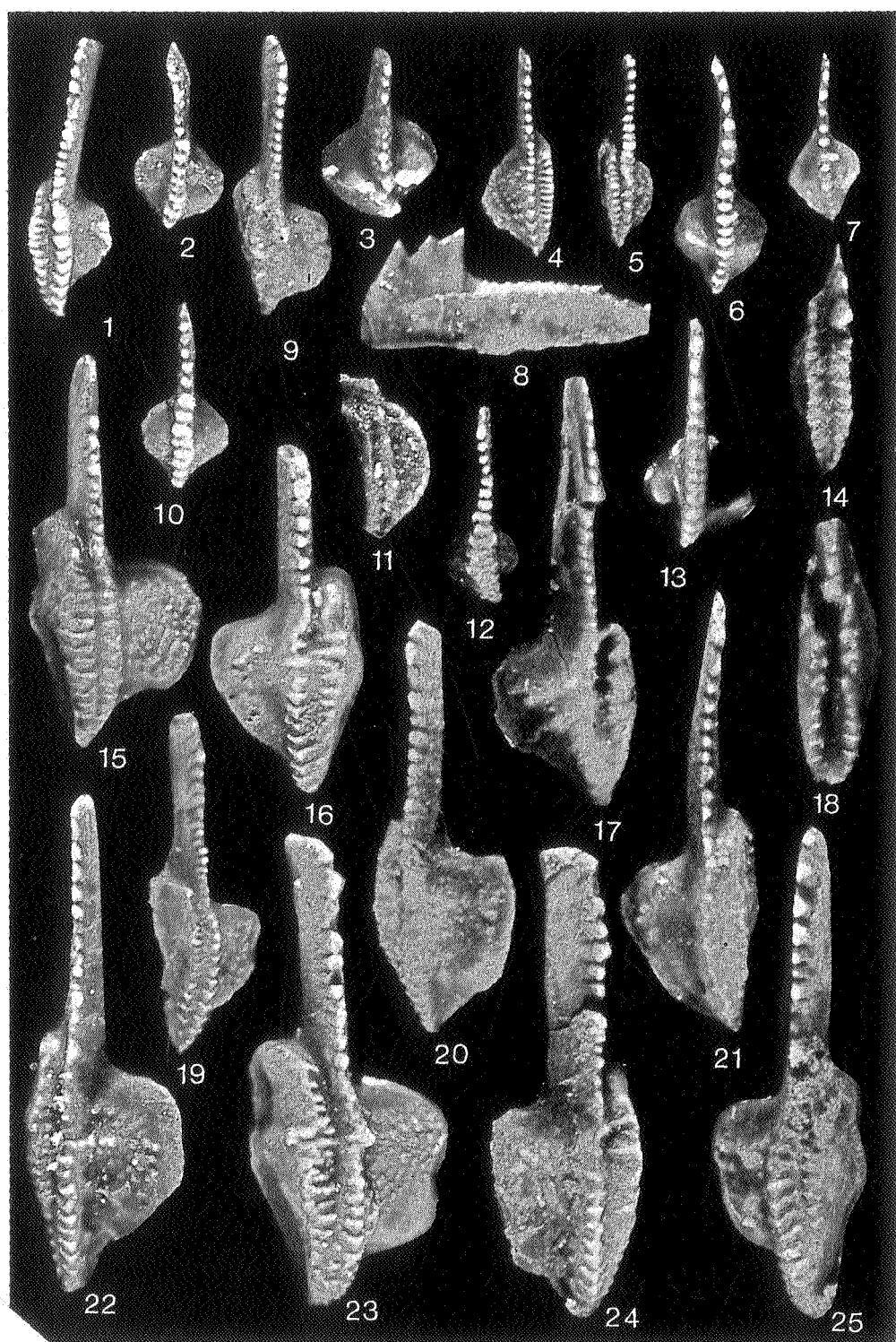


PLATE 2

Figs. 1, 2, 4, 19.	<i>Ozarkodina</i> sp. O1 elements	
	Fig. 1 specimen An/1/60	Fig. 2 specimen An/1/67
	Fig. 3 specimen An/1/40	Fig. 19 specimen An/1/37
Figs. 3, 5.	<i>Metalonchodina</i> sp.	
	Fig. 3 specimen An/1/35	Fig. 5 specimen An/1/60
Figs. 6, 10.	<i>Roundya</i> sp.	
	Fig. 6 specimen An/1/33	Fig. 10 specimen An/1/39
Figs. 7, 13.	<i>Hibbardella</i> sp.	
	Fig. 7 specimen An/1/58	Fig. 13 specimen An/1/59
Fig. 8.	<i>Ligonodina</i> sp.	
	Specimen An/1/41	
Fig. 9.	<i>Subbryantodus</i> sp.	
	Specimen An/1/55	
Figs. 11, 14, 17.	<i>Neopriioniodus singularis</i> (Hass)	
	Fig. 11 specimen An/2/45	
	Fig. 14 specimen An/1/66	
	Fig. 17 specimen An/2/41	
Fig. 12.	<i>Kladognathodus</i> sp.	
	Specimen An/1/64	
Figs. 15, 16.	<i>Lonchodina</i> sp. A	
	Fig. 15 specimen An/1/38	
	Fig. 16 specimen An/1/57	
Fig. 18.	<i>Neopriioniodus</i> op. A	
	Specimen An/1/65	
Figs. 20, 22.	<i>Lonchodina</i> sp. B	
	Fig. 20 specimen An/1/32	Fig. 22 specimen An/1/42
Fig. 21.	<i>Neopriioniodus</i> sp. B	
	Specimen An/1/62	
Fig. 23.	<i>Hindeodella</i> sp.	
	Specimen An/2/61	
Fig. 24.	Gen. indet. A	
	Specimen An/1/63	

Plate 2

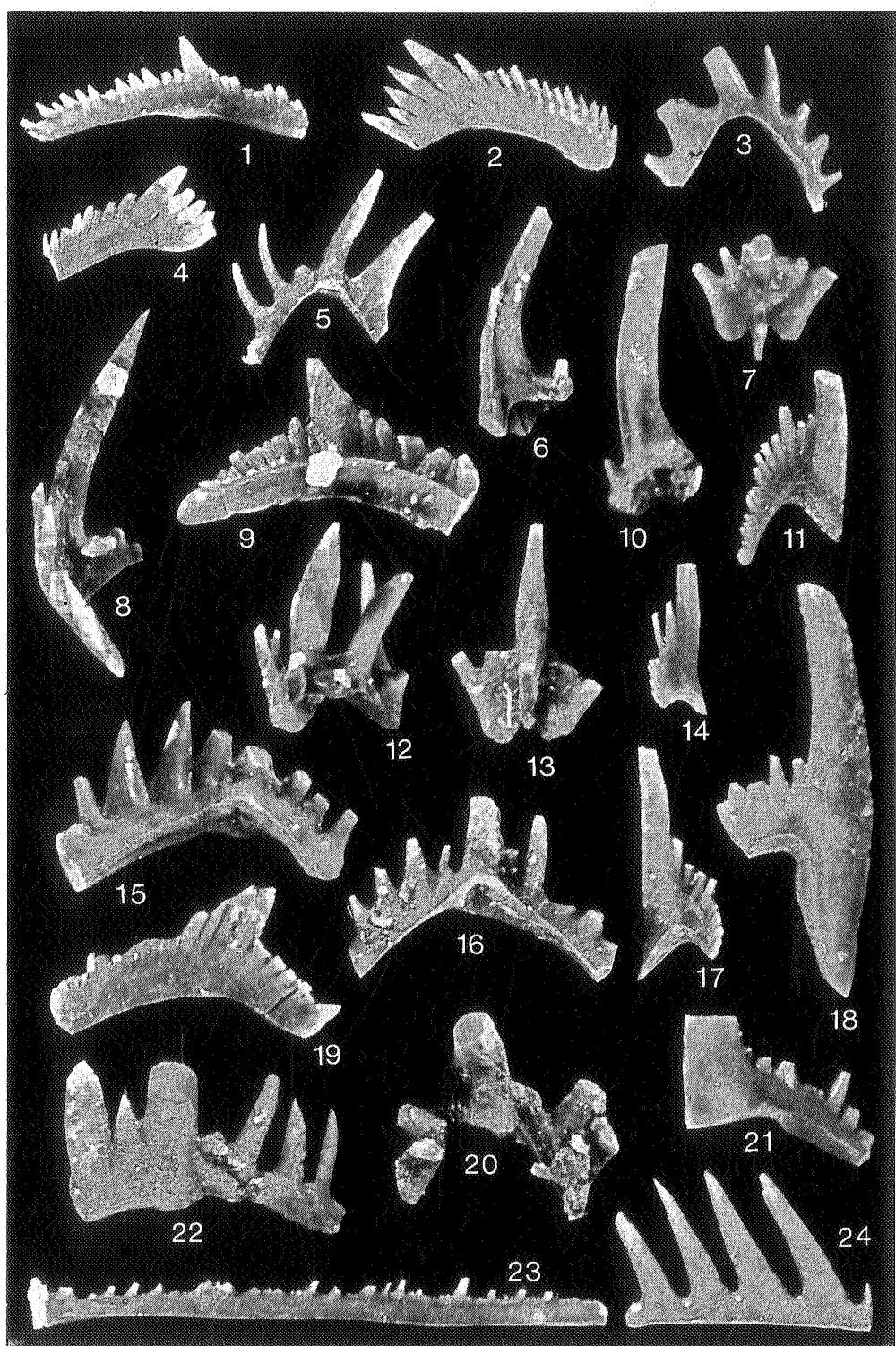


PLATE 3

Anton

- Archaediscus (Arch.) ex gr. *stilus* Gr. et L.; subsp. *tenuis* C. et L.*
- Fig. 1. RC.9085. (9633). $\times 140$.
*Archaediscus (Arch) *declinatus* C. et L.; subsp. *tenuis* C. et L.*
- Fig. 2. RC.9082. (9641). $\times 140$.
*Archaediscus (Arch.) *convexus* G. et L.; subsp. *tenuis* C. et L.*
- Fig. 3. RC.9088. (9665). $\times 140$.
*Archaediscus (Arch.) ex gr. *stilus* C. et L.; subsp. *tenuis* C. et L.*
- Fig. 4. RC.9090. (9660). $\times 140$.
- Ammarchaediscus* (subgen. A C. et P.)
- Fig. 5. RC.9085. (9634). $\times 140$.
Ammarchaediscus (subgen. A C. et P.) *leckwijcki* nov. sp.
- Fig. 6. RC.9214. (9711). $\times 140$.
- Fig. 7. RC.9083. (9712). $\times 140$.
- Fig. 8. RC.9087. (9655). $\times 140$.
- Archaediscus (Arch.) ex gr. *stilus* GROZD. et LEBED. subsp. *angulatus* C. et P.*
- Fig. 9. RC.9086. (9652). $\times 140$.
- Fig. 10. RC.9086. (9651). $\times 140$.
- Fig. 11. RC.9082. (9644). $\times 140$.
- Fig. 12. RC.9085. (9632). $\times 140$.
- Nodosarchaediscus (Asperodiscus) sp.*
- Fig. 13. RC.9088. (9664). $\times 140$.
- Archaediscus (Arch.) *chernousovensis* MAMET subsp. *angulatus* C. et P.*
- Fig. 14. RC.9089. (9657). $\times 140$.
- Fig. 15. RC.9084. (9636). $\times 140$. (Retouché).
- Nodosarchaediscus*
- Fig. 16. RC.9090. (9659). $\times 140$. (Retouché).
- Archaediscus (Arch.) *stilus* GROZD. et LEBED. subsp. *angulatus* C. et P.*
- Fig. 17. RC.9088. (9664). $\times 140$.
- Fig. 18. RC.9087. (9654). $\times 140$.
- Fig. 19. RC.9084. (9638). $\times 140$.
- Fig. 20. RC.9082. (9645). $\times 140$.
- Nodosarchaediscus (Asperodiscus) sp.*
- Fig. 21. Serv. géol. (9631). $\times 140$.
Endothyra sp.
- Fig. 22. RC.9088. (9671). $\times 75$.

