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CONODONT BIOSTRATIGRAPHY OF THE LATE DEVONIAN-EARLY CARBONIFEROUS ROCKS OF THE SOUTH CENTRAL CANTABRIAN CORDILLERA

A. C. HIGGINS (*)

ABSTRACT

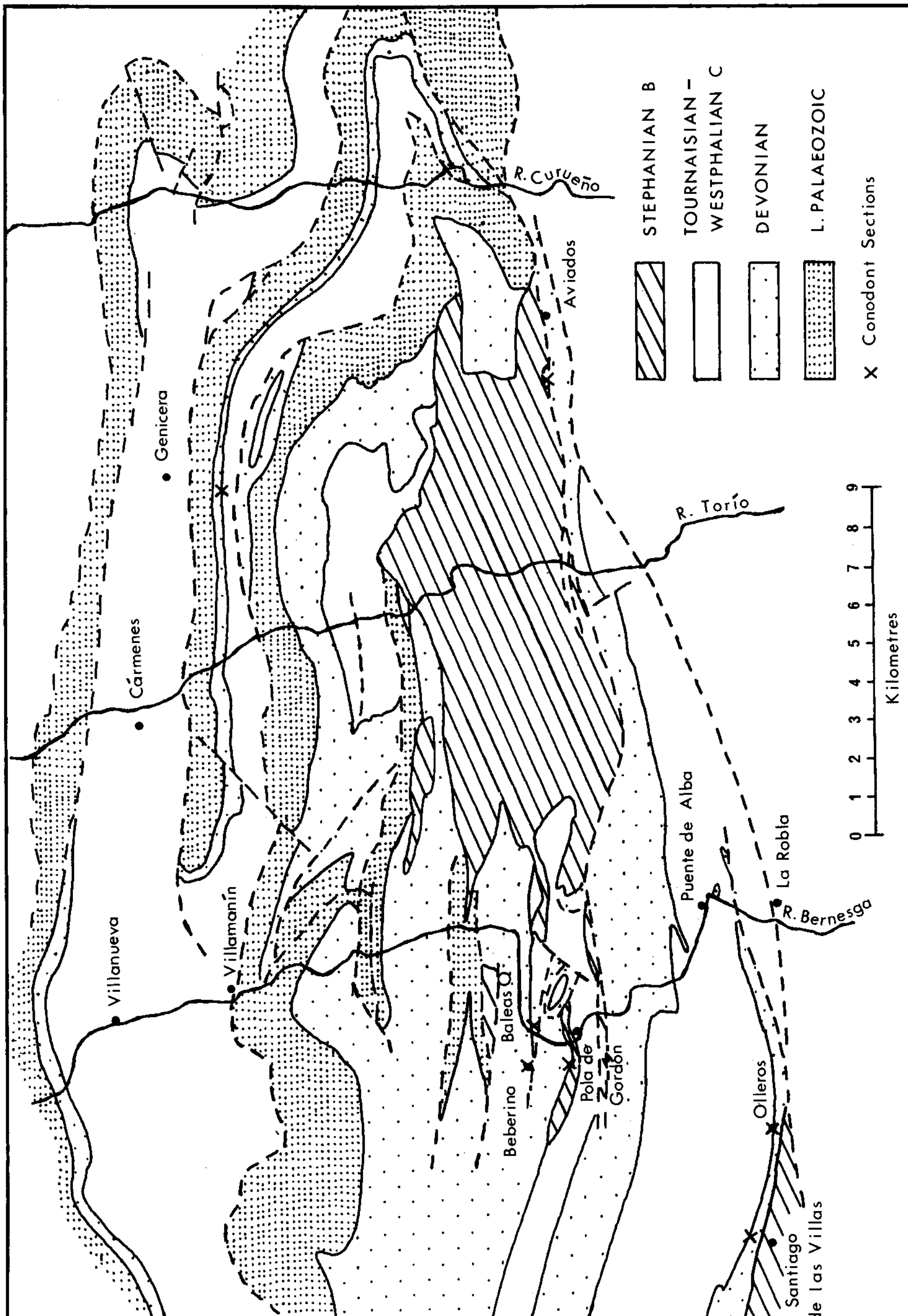
Close sampling of limestones beneath the griotte limestones of the Genicera Formation in northern León (Cantabrian Cordillera) has revealed the presence of *anchoralis* (cu II α / γ) Zone conodont faunas in beds which were formerly referred to the late Devonian or early Tournaisian. These faunas, which are found in the new Baleas Formation of WAGNER, WINKLER PRINS & RIDING (1971), fall into two groups. The lower one, characterised by species of *Gnathodus* with *Polygnathus communis*, *Pseudopolygnathus* and *Siphonodella*, is thought to belong to the early part of the *anchoralis* Zone, probably of cu II α age (MATTHEWS 1970). The upper one, characterised by *Scaliognathus anchoralis*, *Doliognathus latus*, gnathodids and pseudopolygnathids also belongs to the *anchoralis* Zone but is possibly of cu II ß / γ age.

The Baleas Formation has been definitely identified at only a few localities and is thought to have been removed by submarine erosion over much of the area. This must have occurred at some localities before the slightly younger Vegamián Formation was deposited, since this is transitional with the Genicera Formation which overlies both the Vegamián Formation and the Baleas Formation. The Vegamián Formation too is of restricted distribution having been removed from a strip of ground over Pola de Gordón, Beberino and Aviados (see text-fig. 1) prior to the deposition of the Genicera Formation. Since the basal beds of the latter still belong to the *anchoralis* Zone, the movements producing these erosive periods occurred within the span of time represented by one conodont zone.

RESUMEN

El muestreo detallado de las calizas por debajo del mármol grioto (Formación Genicera) en una parte del norte de la provincia de León indica la presencia de conodontos de la zona de *anchoralis* (cu II α / γ) en un tramo atribuido antes al Devónico alto ó Carbonífero más inferior. Estas faunas, obtenidas de la Formación Baleas (WAGNER, WINKLER PRINS & RIDING 1971), permiten una diferenciación en dos grupos. El inferior está caracterizado por varias especies de *Gnathodus* acompañadas por *Polygnathus communis*, *Pseudopolygnathus* y *Siphonodella*. Pertenece a la base de la zona de *anchoralis*, probablemente equivalente a cu II α (MATTHEWS 1970). El grupo superior, caracterizado por *Scaliognathus anchoralis*, *Doliognathus latus*, gnathódidos y pseudopolygnátidos, pertenece igualmente a la zona de *anchoralis*, pero equivale probablemente a cu II ß / γ.

(*) Geology Department, The University, St. George's Square, Sheffield S1 3JD, England.



Text-fig. 1.—Outline geological map of the area of Palaeozoic strata in northern León containing the valleys of Bernesga, Torío and Curueño rivers (adapted from DE SITTER 1962, EVERS 1967, WAGNER *in* WAGNER & ARTIEDA 1970). The large area of Stephanian B rocks corresponds to the Ciñera-Matallana coalfield. The location of sections yielding conodonts is indicated by crosses: near Santiago de las Villas, Olleros de Alba, Pola de Gordón, Beberino, Baleas Quarry, S. W. of Genicera, W. of Aviados.

La Formación Baleas ha sido reconocida con seguridad solamente en algunas localidades y, muy probablemente, fue barrida por abrasión de una zona amplia del norte de León. Fue eliminada antes de la formación de las lutitas negras de Vegamián, ya que estas últimas pasan paulatinamente al mármol grioto de la Formación Genicera en localidades de la parte septentrional de la región investigada, y aquella sigue a la Formación Baleas donde la Formación Vegamián ya no existe. Las lutitas negras de Vegamián fueron eliminadas a su vez de una faja de terreno que se extiende de Pola de Gordón y Beberino a Aviados (Fig. 1). Puesto que la parte inferior de la Formación Genicera pertenece todavía a la zona de *anchoralis*, se nota que los pequeños levantamientos del subsuelo responsables de la eliminación de una formación u otra (según el área que interesa) tuvieron lugar dentro del intervalo de tiempo representado por la zona de *anchoralis*.

INTRODUCTION

In 1964 HIGGINS, WAGNER-GENTIS and WAGNER described conodont and goniatite faunas from Lower Carboniferous sections in the Cantabrian Mountains of NW Spain. In 1967, in a more extensive study, VAN ADRICHEM BOOGAERT described conodont faunas from the Devonian and Lower Carboniferous of a larger area of the Cantabrian Mountains. In both studies it was clear that there were many gaps in the Tournaisian sequence partly due to the absence of faunas in unfossiliferous rocks and partly due to physical breaks. It was also clear that closer sampling was necessary if an accurate account of the late Devonian and early Carboniferous palaeogeography was to be achieved.

With this object in view closer sampling at the top of the Ermita Formation was carried out in some of the sections described in 1964 and in some which were previously undescribed. It was thought that the limestones which sometimes occur at the top of the Ermita Formation might contain faunas which would close the gap between the *kockeli-dentilineata* Zone (cu I) and the *anchoralis* Zone (cu II α) faunas which were described by HIGGINS *et al.* 1964 and VAN ADRICHEM BOOGAERT 1967. During the course of the work it became clear that these limestones were of different ages in different parts of the area, some being associated with the Ermita sandstones, whilst others are much younger and belong to the Baleas Formation of WAGNER, WINKLER PRINS & RIDING (1971). Eight sections have been sampled in detail. The location of these sections is shown in text-fig. 1 and are at Genicera, Olleros de Alba, Santiago de las Villas, Aviados, Beberino, Puente de Alba and two sections at Pola de Gordón, one at the Baleas Quarry and one in Pola de Gordón itself. The sections at Puente de Alba and the Baleas Quarry yielded very sparse faunas, the remaining sequences being more fossiliferous.

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A v i a d o s

This locality is 1.5 km west of the village of Aviados.

Genicera Formation:

1.60 m of red chert.
2.40 m of red griotte.
1171-III at base

0.50 m of grey nodular limestone transitional with the overlying griotte but having an irregular contact with the underlying formation.
1368 at base.

Baleas Formation:

3.60 m of coarsely crystalline limestone, sandy at the base and having an irregular contact with the underlying formation.
1171 - II at top.
1497 at 2.55 m above base.
1496 at 2.25 m above base.
1495 at 1.35 m above base.
1494 at 0.70 m above base.
1498 at 0.35 m above base.
1493 at 0.10 m above base.

Ermita Formation:

8.30 m of quartzitic sandstone.
0.40 m of decalcified sandstone with casts of marine fossils.
1.10 m of sandstone.
0.60 m of shale.
11.30 m of quartzitic sandstone having an irregular contact with the underlying formation.

Nocedo Formation:

3.00 m of sandy limestone with fossils.
1492 at top.
1491 at 0.80 m above the base.
5.80 m of ferruginous sandstone with casts of crinoids and brachiopods.

	Nocedo Fm. 1491	1494	1495	Baleas Fm. 1496	1497	1171-II	Genicera Fm. 1171-III
Ancyrodella lobata	3						
Gnathodus antetexanus							6
Gnathodus delicatus					2	20	
Gnathodus punctatus					2		
Gnathodus semiglaber						5	
Gn. texanus pseudosemiglaber							6
Icriodus sp.	20						
Polygnathus communis communis		27	4	20	15	15	
Polygnathus inornatus		15	10	10	20	12	2
Polygnathus longiposticus		1		2			
Pseudopolygnathus dentilineatus		2		1		1	
Ps. triangulus pinnatus							4
Scaliognathus anchoralis							2
Spathognathodus stabilis							30
Siphonodella cooperi						4	
Siphonodella sp.					1		

Table 1.—Conodont Faunas in the Aviados Section showing the total number of specimens in each sample.

P o l a d e G o r d ó n.

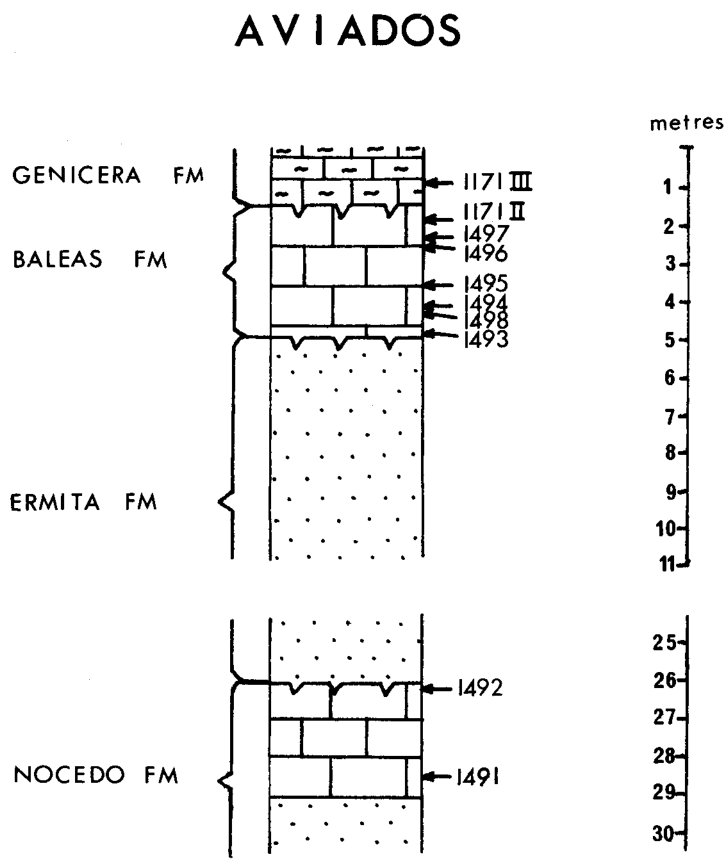
This section is exposed in a quarry in Pola de Gordón at its N. W. tip, west of the railway. The sequence is inverted (WAGNER 1966, Pl. 4).

Genicera Formation:

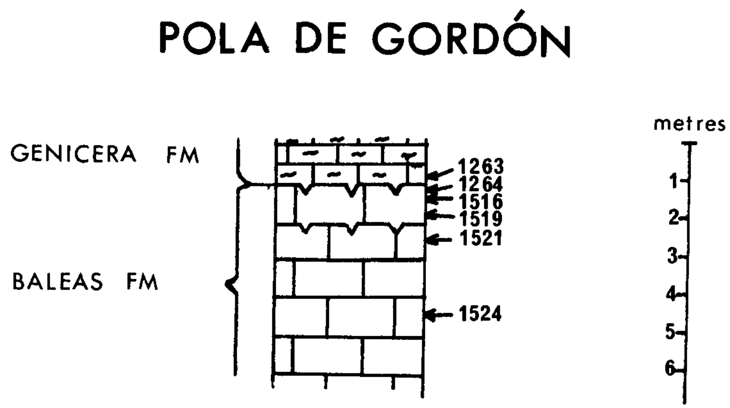
Over 4 m of red griotte having an irregular contact with the underlying formation.
1263 at the base.

Baleas Formation:

3.36 m of red coarsely crystalline limestone.
1264 at 0.17 m from the top.
1516 at 0.25-0.45 m from the top.
1519 at 0.73-0.81 m from the top.
1521 at 1.07-1.20 m from the top.
1524 at 3.26-3.36 m from the top.



Text-fig. 2.—Section at Aviados showing the location of the sampled horizons.



Text-fig. 3.—Section at Pola de Gordón showing the location of the sampled horizons.

	1524	Baleas Fm. 1521	1519	1516	1264	Genicera Fm. 1263
Doliognathus latus	—	—	—	—	3	—
Gnathodus antetexanus	—	—	—	120	50	15
Gnathodus delicatus	—	6	20	—	—	—
Gnathodus cf. *delicatus*	—	—	1	—	—	—
Gnathodus punctatus	—	12	—	—	—	—
Gnathodus semiglaber	—	48	80	10	—	10
Gn. texanus pseudosemiglaber	—	—	—	—	30	10
Polygnathus communis communis	3	60	7	1	—	—
Polygnathus lobatus	—	—	—	—	4	—
Polygnathus bischoffi	—	—	—	—	100	3
Polygnathus inornatus	—	30	1	1	3	—
Polygnathus lacinatus	—	6	—	—	—	—
Polygnathus marginatus	1	—	—	—	—	—
Pseudopolygnathus dentilineatus	—	12	—	—	—	—
Pseudopolygnathus multistriatus	—	6	—	—	—	—
Pseudopolygnathus primus	—	6	—	—	—	—
Ps. triangulus pinnatus	—	—	7	12	—	1
Scaliognathus anchoralis	—	—	—	7	112	1
Spathognathodus stabilis	—	—	—	36	23	5
Spathognathodus tridentatus	—	3	—	—	—	—
Siphonodella cooperi	—	10	—	—	—	—
Siphonodella obsoleta	—	14	—	—	—	—

Table II.—Conodont Faunas in the Pola de Gordón Section, showing the total number of specimens in each sample.

B e b e r i n o

This section is exposed on the western bank of a tributary of the río Bernesga at the village of Beberino.

Genicera Formation:

4-6 metres of red nodular limestones (griotte), having an irregular contact with the underlying formation.
1201-A at 0.45 m from the base.
1200-C at 0.25 m from the base.

Baleas Formation:

6 m of grey, siliceous limestone with ferruginous red bands, having an irregular contact with the underlying formation.
1364 at the top.
1363 at 0.35 m below the top (barren sample).
1200-B at 0.80 m from the top (barren).
1362 at 3.30 m from the base (barren).

Ermita Formation:

Yellow brown sandstones.

	Baleas Fm.	Geniceta Fm.	
	1364	1200-C	1201-A
Doliognathus latus	20		
Doliognathus dubius	2		
Doliognathus cf. *dubius*	1		
Gnathodus antetexanus		24	25
Gnathodus delicatus	40		
Gnathodus punctatus	3		
Gnathodus semiglaber	10	10	15
Gn. texanus pseudosemiglaber	6	50	20
Polygnathus communis communis	12		
Polygnathus communis carinus	1		
Ps. triangulus pinnatus	40	41	
Scaliognathus anchoralis		3	
Spathognathodus stabilis		23	

Table III.—Conodont Faunas in the Beberino Section showing the total number of specimens in each sample.

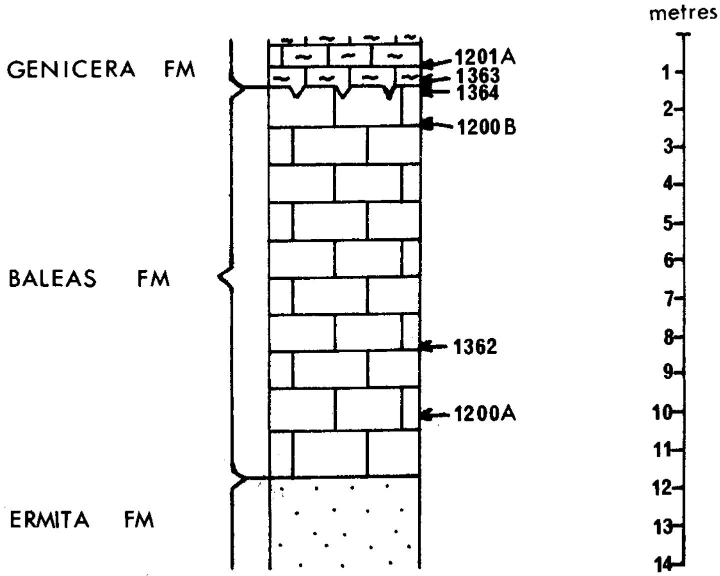
CONODONT STRATIGRAPHY

Ermita Formation.

The Ermita Formation introduced by COMTE (1959), forms the base of most of the described sections.

Summaries of previous work on the Ermita Formation were given by VAN ADRICHEM BOOGAERT (1967) and WAGNER *et al.* (1971) together with an account of its age and distribution. The Formation was first recognised as a transgressive deposit by COMTE (1959) who dated it as Strunian. VAN ADRICHEM BOOGAERT, from an analysis of the basal conodont faunas, indicated that it was diachronous, ranging

BEBERINO



Text-fig. 4.—Section at Beberino showing the location of the sampled horizons.

in age from Upper Famennian (upper to V) to Lower Tournaisian. He also described faunas from samples at the top of the Formation which seemed to indicate a late Tournaisian age, but assumed that the specimens indicating this age leaked in from the overlying Alba Formation (= Genicera Formation of WAGNER *et al.*).

Lithologically, the Ermita Formation consists of quartz sandstones, sometimes ferruginous, up to 140 metres thick, with lenses and beds of detrital limestone at the base and top at some localities. COMTE did not include these limestones in the Ermita Formation and they do not occur in the type section. However, it has been general practice in recent years to extend the Ermita Formation upwards to include several metres of coarsely crystalline limestone which occur above the sandstones but below the overlying Alba (Genicera) or Vegamián formations. Clearly some of these limestones are part of the Ermita Formation since they grade downwards into sandstone. For example, the section at Olleros de Alba (see HIGGINS *et al.* 1964, p. 214 and text-fig. 2) exposes several metres of sandstone which grade upwards into 0.60 metres of limestone (sample 1348, which was mentioned in 1964 but only recently examined). Again, at Santiago de las Villas (HIGGINS *et al.* 1964, p. 212), several metres of sand stone and shale are overlain by 0.25 metres of limestone (sample 1310). In both sections Vegamián black shales and its basal sandstone overlie the limestone, and in both cases the conodont faunas belong to the *kockeli-dentilineata* Zone of VOGES 1959 of early Tournaisian (cu I) age. Similarly, near Genicera, brown decalcified sandstones of the Ermita Formation are followed by 2 metres of coarsely crystalline limestone

(HIGGINS *et al.* 1964, p. 218 and text-fig. 2), which contain *Spathognathodus costatus* sensu ZIEGLER and *Spathognathodus spinulicostatus* sensu ZIEGLER which are characteristic of the *costatus* Zone of probable Strunian age.

Whilst these limestones undoubtedly belong with the Ermita Formation there are others, occupying a similar stratigraphic position, which do not. These limestones occur beneath the Vegamián or Alba (Genicera) Formations but appear to be younger than the Ermita Formation and are separated from it by at least one erosional interval. These limestones belong to the Baleas Formation (WAGNER *et al.* 1971).

Baleas Formation.

The Baleas Formation consists of coarsely crystalline limestones very similar to those of the underlying Ermita Formation.

The conodont faunas are quite different from those of the Ermita Formation. There are two main groups. The lower one is characterised by:

Gnathodus delicatus BRANSON & MEHL.
Gnathodus punctatus (COOPER).
Gnathodus semiglaber BISCHOFF.
Polygnathus communis BRANSON & MEHL.
Polygnathus inornatus BRANSON & MEHL.
Polygnathus lacinatus HUDDLE.
Pseudopolygnathus dentilineatus BRANSON.
Pseudopolygnathus multistriatus MEHL & THOMAS.
Pseudopolygnathus primus BRANSON & MEHL.
Siphonodella cooperi HASS.
Siphonodella obsoleta HASS.
Siphonodella quadruplicata? (BRANSON & MEHL).

This fauna occurs at the locality near Aviados (Samples 1494-1171-II) where it includes the whole of the Baleas Formation and where the Formation has an erosional contact at the base and at the top. It also occurs in the Pola de Gordón section at the northwestern tip of the village (this is not the section described in HIGGINS *et al.* 1964, which is the Baleas Quarry, north of Pola de Gordón), where it occurs below an erosional plane within the limestone (sample 1521). The specimens in this lower fauna are mostly well preserved. There are abundant specimens of species of *Gnathodus* and complete and fairly common specimens of *Siphonodella.* They occur up to one metre below the top of the Baleas Formation and there is, therefore, little possibility of these specimens having leaked in from the overlying beds.

The absence of typical *anchoralis* Zone elements would suggest that this fauna belongs to an older zone. On the other hand, it lacks the typical elements of the underlying *Siphonodella crenulata* Zone of VOGES (1959), such as *Siphonodella crenulata* and *Elictognathus* sp. It compares closely with the *Gnathodus semiglaber/Pseudopolygnathus multistriatus* Zone of COLLINSON, SCOTT & REXROAD (1962) which is generally correlatable with the lower part of the *anchoralis* Zone of VOGES.

The upper conodont faunas are characterised by:

Doliognathus latus BRANSON & MEHL.
Gnathodus antetexanus REXROAD & SCOTT.
Gnathodus delicatus BRANSON & MEHL.
Gnathodus semiglaber BISCHOFF.
Gnathodus texanus ROUNDY *pseudotexanus* THOMSON & FELLOWS.
Polygnathus lobatus BRANSON & MEHL.
Polygnathus communis communis BRANSON & MEHL.
Polygnathus communis BRANSON & MEHL *carinus* HASS.
Polygnathus bischoffi RHODES, AUSTIN & DRUCE.
Polygnathus inornatus BRANSON & MEHL.
Pseudopolygnathus triangulus pinnatus VOGES.
Scaliognathus anchoralis BRANSON & MEHL.
Spathognathodus stabilis (BRANSON & MEHL).

In the Pola de Gordón section this fauna (samples 1519-1516, 1264) occurs in the top 1 metre, i. e. from an erosional contact within the Baleas Formation upwards until the erosional contact with the Genicera Formation is reached. The earliest sample (1519) differs from the later ones in the absence of *Gnathodus texanus pseudosemiglaber*, *Scaliognathus anchoralis* and *Doliognathus latus*, but this may simply be due to the relatively small size of the fauna recovered.

This fauna also occurs in the highest sample of the Beberino section (sample 1364). In this sample *Doliognathus* is moderately abundant, as is *Pseudopolygnathus triangulus pinnatus*.

Clearly, this fauna belongs to the *anchoralis* Zone, and probably to the upper part which is rich in *Scaliognathus anchoralis*. It correlates broadly with the *Bactrognathus / Polygnathus communis* Zone of COLLINSON, SCOTT & REXROAD (1962), and the *Bactrognathus / Pseudopolygnathus multistriatus* Zone of THOMPSON (1967).

Vegamián Formation.

The Vegamián Formation of COMTE (1959) consists of black shales with phosphatic nodule horizons. A thin sandstone occurs at its base. Its distribution is widespread in the Cantabrian Cordillera, but it is not always present within this general area. Its occurrence may have been controlled by low submarine ridges on the crests of which it was removed by submarine erosion (HIGGINS *et al* 1964). Its relationship with the Baleas Formation is not known since it normally rests disconformably on a thin sandstone with phosphatic nodules, which in turn rests on the Ermita Formation. At the top it is succeeded by the Genicera Formation. Near Genicera this boundary is transitional but elsewhere it is often disconformable.

Whilst it is likely to have been deposited slowly (VAN ADRICHEM BOOGAERT 1967) its lower age is unknown. In the three sections which have been studied, near Genicera, Santiago de las Villas and Olleros de Alba, there occurs between the Ermita Formation and the Vegamián Formation a thin sandy bed with phosphatic nodules.

This bed is extremely rich in conodonts but most of the specimens are broken and many of them may be reworked. The faunas consist of large numbers of polygnathids, siphonodellids and pseudopolygnathids, including *Polygnathus communis communis*, *P. communis bifurcatus*, *Pseudopolygnathus dentilineatus*, and *Siphonodella cooperi*. Also included are a few specimens of *Gnathodus punctatus* and *Gnathodus delicatus* which are rather fresher and better preserved than the remaining specimens. These species could belong to the *anchoralis* Zone. In the upper part of the Formation near Genicera WAGNER-GENTIS (*in* WAGNER *et al.* 1971) has recently identified *Munsteroceras arkansanum* GORDON, a late Kinderhookian or early Osagean goniatite, and at the top of the black shales specimens of *Pseudopolygnathus triangulus pinnatus* can be seen on the bedding planes. The latter species is a characteristic form in the *anchoralis* Zone.

Genicera Formation.

The Genicera Formation (Alba Formation in VAN ADRICHEM BOOGAERT 1967) consists of red and grey nodular limestones, commonly known as the Griotte, often with grey or pink limestones at the base. Only the base of the Formation will be considered in this study. This practically always has an erosional contact with the underlying Vegamián or Baleas Formations. An exception occurs near Genicera where there is a gradual passage with the underlying Vegamián Formation.

The conodont faunas include:

Gnathodus antetexanus REXROAD & SCOTT.
Gnathodus semiglaber BISCHOFF.
Gnathodus texanus ROUNDY *pseudosemiglaber* THOMPSON & FELLOWS.
Polygnathus bischoffi RHODES, AUSTIN & DRUCE.
Polygnathus inornatus BRANSON & MEHL.
Pseudopolygnathus triangulus pinnatus VOGES.
Scaliognathus anchoralis BRANSON & MEHL.
Spathognathodus stabilis (BRANSON & MEHL).

This fauna occurs near Aviados (1171-III), at Pola de Gordón (1263), at the Baleas Quarry north of Pola de Gordón (1207A), near Genicera (1166B) and at Beberino (1200C). It is a fauna which belongs to the top of the *anchoralis* Zone.

CONCLUSIONS

The Ermita Formation quite clearly spans the Devonian/Carboniferous boundary in the South Central Cantabrian Mountains and ranges in age from high Famennian to early Tournaisian (COMTE 1959, VAN ADRICHEM BOOGAERT 1967). There followed a long gap in the rock succession which is represented by a non-sequence at the base of the Baleas Formation. This succession could possibly be represented by the section at Puente de Alba (WAGNER & FERNÁNDEZ-GARCÍA 1971), which is unfortunately largely unfossiliferous, but even there many erosive contacts occur.

The Baleas Formation usually contains rich conodont faunas and is therefore probably condensed. Its faunas belong to the *anchoralis* Zone which means that the *Siphonodella-triangulus inaequalis*, *Siphonodella-triangulus triangulus* and probably the *Siphonodella crenulata* Zones of VOGES (1959) are absent or are represented by unfossiliferous beds. The Baleas Limestones have an erosion surface within and are terminated by an erosive contact.

The Vegamián Formation has not been seen in contact with the Baleas Formation and since its faunas are of a similar age could just conceivably be partly of the same age. However, this seems unlikely since the environments in which they were formed are rather different. The upper part of the Vegamián Formation passes gradually into the overlying Genicera Formation near Genicera, but at Olleros de Alba and near Santiago de las Villas there is a transgressive sandstone with an erosional contact which indicates that locally some pre-Genicera erosion occurred.

The Genicera Formation represents the most extensive of the Lower Carboniferous transgressions, its base almost everywhere being of late *anchoralis* age.

REFERENCES

ADRICHEM BOOGAERT, H. A. VAN (1967).— Devonian and Lower Carboniferous Conodonts of the Cantabrian Mountains (Spain) and their Stratigraphic Application. *Leidse Geol. Meded.*, 39, pp. 129-192, text-figs. 1-68, pls. 1-3, encl. 1-6.

BISCHOFF, G. (1957).—Die Conodonten-Stratigraphie des rhenoherzynischen Unterkarbons mit Berücksichtigung der Wocklumeria-Stufe und der Devon/Karbon-Grenze. *Hess. Landesamt Bodenf. Abh.*, 19, pp. 1-64, Tafn. 1-6.

BÖGER, H. (1963).—Zur Stratigraphie des Unterkarbons im Velberter Sattel. *Decheniana*, 114, pp. 133-170.

BOOGAARD, M. VAN DEN (1963).—Conodonts of Upper Devonian and Lower Carboniferous Age from Southern Portugal. *Geol. Mijnb.*, 42, pp. 248-259.

BRANSON, E. B. & MEHL, M. G. (1934).—Conodonts from the Bushberg Sandstone and equivalent formations of Missouri, *in* BRANSON, E. B. & M. G. MEHL (1934), *Conodont Studies* N.º 4, *Univ. Missouri Studies*, 8, n.º 4, pp. 265-301, pls. 22-24.

BRANSON, E. B. & MEHL, M. G. (1941).—New and little known Carboniferous conodont genera. *J. Paleontology*, 15, pp. 97-106, pl. 19.

CANIS, W. F. (1968).—Conodonts and Biostratigraphy of the Lower Mississippian of Missouri. *J. Paleontology*, 42, pp. 525-555, pls. 72-74.

COLLINSON, C., SCOTT, A. J. & REXROAD, C. B. (1962).—Six Charts showing Biostratigraphic Zones, and Correlations based on Conodonts from the Devonian and Mississippian Rocks of the Upper Mississippi Valley. *Illinois Geol. Survey, Circ.* 328, pp. 1-32, charts 1-6.

COMTE, P. (1959).—Recherches sur les terrains anciens de la Cordillère Cantabrique. *Mem. Inst. Geol. Min. España*, 60, pp. 1-440.

CONIL, R. (1964). Localités et coupes types pour l'étude du Tournaisien inférieur (Révision des limites sous l'aspect micropaléontologique). *Mém. Acad. Roy. Belgique*, Mém. 4.º, 2e série, XIV, 4, pp. 1-87, pls. I-XIV.

CONIL, R., LYS, M. & MAUVIER, A. (1964).—Critères micropaléontologiques essentiels des formations-types du Carbonifère (Dinantien) du Bassin Franco-Belge. *C. R. 5e Congrès Carbonifère, Paris 1963*, I, pp. 325-332.

COOPER, C. L. (1939).—Conodonts from a Bushberg-Hannibal horizon in Oklahoma. *J. Paleontology*, 13, pp. 379-422, pls. 39-47.

EVERS, H. J. (1967). Geology of the Leonides between the Bernesga and Porma Rivers. Cantabrian Mountains, N. W. Spain. *Leidse Geol. Meded.*, 41, pp. 83-151, figs. 1-77, geol. map. & sections.

HASS, W. H. (1959).—Conodonts from the Chappel Limestone of Texas. *U. S. Geol. Survey Prof. Paper* 294-J, pp. 265-399, pls. 46-50.

HIGGINS, A. C. (1962).—Conodonts from the «Griotte» limestone of NW Spain. *Notas y Comuns. Inst. Geol. Min. España*, 65, pp. 5-22, pls. 1-3.

HIGGINS, A. C., WAGNER-GENTIS, C. H. T. & WAGNER, R. H. (1964).—Basal Carboniferous Strata in Part of Northern León, NW. Spain: Stratigraphy, Conodont and Goniatite Faunas: *Bull. Soc. belge Geol. Paléont. Hydrol.*, LXXII (1963), pp. 205-248, pls. I-V.

KLAPPER, G. (1966).—Upper Devonian and Lower Mississippian conodont zones in Montana, Wyoming and South Dakota. *Univ. Kansas Paleont. Contrib.*, *Paper* 3, pp. 1-43, pls. 1-6.

MATTHEWS, S. C. (1970).—A New Cephalopod Fauna from the Lower Carboniferous of East Cornwall. *Palaeontology*, 13, pt. 1, pp. 112-131, pls. 25-28.

REXROAD, C. B. & SCOTT, A. J. (1964).—Conodont zones in the Rockford Limestone and the lower part of the New Providence Shale (Mississippian) in Indiana: *Indiana Geol. Survey, Bull.* 30, pp. 1-54, pls. 2-3.

RHODES, F. H. T., AUSTIN, R. L. & DRUCE, E. C. (1969).—British Avonian (Carboniferous) conodont faunas and their value in local and intercontinental correlation. *Bull. Brit. Mus. (Nat. Hist.) Geol. Suppl.* 5, pp. 1-313, text-figs. 1-91, pls. 1-30.

SITTER, L. U. DE (1962).—The structure of the southern slope of the Cantabrian Mountains. *Leidse Geol. Meded.*, 26, pp. 255-264, geol. maps & sections.

THOMPSON, T. S. (1967).—Conodont zonation of lower Osagean rocks (lower Mississippian) of southwestern Missouri. *Missouri Geol. Survey and Water Resources Rept. Inv.* 39, pp. 1-87, text-figs. 1-6, tables 1-6, pls. 1-6.

VOGES, A. (1959).—Conodonten aus dem Unterkarbon I und II (*Gattendorfia*-und *Pericyclus*-Stufe) des Sauerlandes. *Paläont. Zeitschr.*, 33, n.º 4, pp. 226-314, Tafn 33-35.

WAGNER, R. H. (1966).—Palaeobotanical Dating of Upper Carboniferous Folding Phases in N. W. Spain. *Mem. Inst. Geol. Min. España*, LXVI (1965), pp. 1-169, pls. 1-77.

WAGNER, R. H. & ARTIEDA, J. I. (1970).—La cuenca minera Ciñera-Matallana. *S. A. Hullera Vasco-Leonesa, Sta. Lucía (León)*, pp. 1-288, figs. 1-41, láms. I-XIX.

WAGNER, R. H. & FERNÁNDEZ-GARCÍA, L. (1971).—The Lower Carboniferous and Namurian rocks north of La Robla (León). *Trabajos de Geología, Fac. Ci. Univ. Oviedo*, 4.

WAGNER, R. H., WINKLER PRINS, C. F. & RIDING, R. E. (1971).—Lithostratigraphic units of the lower part of the Carboniferous in northern León, Spain. *Trabajos de Geología, Fac. Ci. Univ. Oviedo*, 4.

WIRTH, M. (1967).—Zur Gliederung des höheren Paläozoikums (Givet-Namur) in Gebiet des Quinto Real (Westpyrenäen) mit Hilfe von Conodonten. *Abh. Neues Jahrb. Geol. Pal.*, 127, 2, pp. 179-240, Tafn 19-23.

PLATES 1-5 (Conodonts)

PLATE 1

× 40

All figured specimens are housed in the Micropalaeontology Laboratory, University of Sheffield.

Figs. 1-5.—*Pseudopolygnathus triangulus pinnatus* VOGES
1. oral view (1516-1).
2. oral view (1519-2).
3. aboral view (1519-2)
4. aboral view (1516-1).
5. oral view (1516-2).
Baleas Formation, Pola de Gordón.

Figs. 6, 8.—*Polygnathus lacinatus* HUDDLE.
6. oral view (1521-3).
8. aboral view (1521-3).
Baleas Formation, Pola de Gordón.

Fig. 7.—*Polygnathus inornatus* BRANSON & MEHL.
7. oral view (1524-4).
Baleas Formation, Pola de Gordón.

Figs. 9, 12.—*Polygnathus bischoffi* RHODES, AUSTIN & DRUCE.
9. oral view (1264-10).
12. aboral view (1264-10).
Baleas Formation, Pola de Gordón.

Fig. 10.—*Pseudopolygnathus dentilineatus* BRANSON.
10. oral view (1496-1).
Baleas Formation, 1.5 km west of Aviados.

Fig. 11.—*Spathognathodus stabilis* BRANSON & MEHL.
11. lateral view (1264-II).
Baleas Formation, Pola de Gordón.

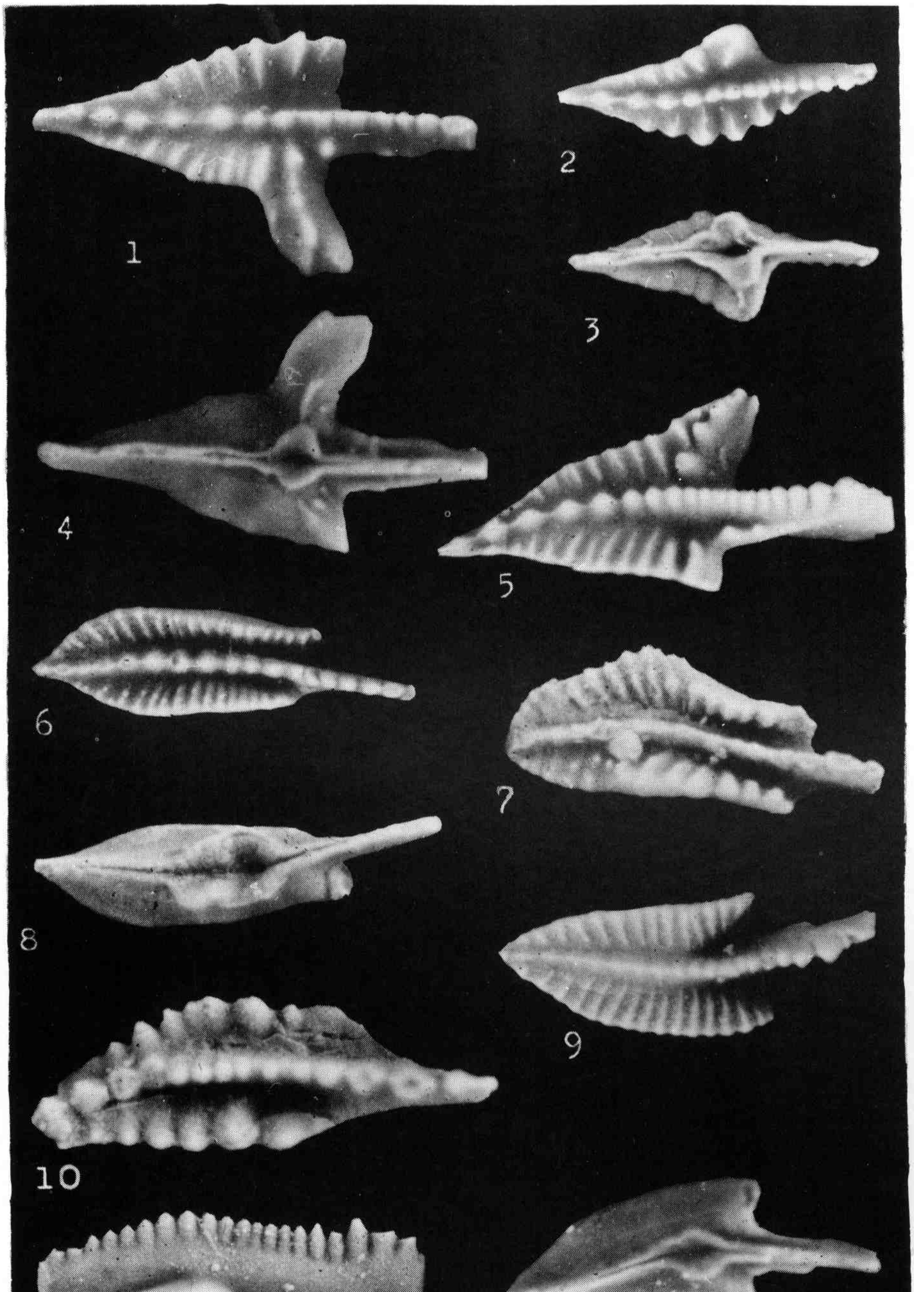

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PLATE 2

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Figs. 1, 3-6, 8.—*Doliognathus latus* BRANSON & MEHL.

1. oral view (1364-1).
3. oral view (1364-2).
4. aboral view (1364-2).
5. oral view (1364-3).
6. aboral view (1364-4).
8. oral view (1364-5).

Baleas Formation, Beberino.

Figs. 2, 7.—*Doliognathus* cf. *latus* BRANSON & MEHL.

2. oral view (1364-6).
7. oral view (1364-7).

Baleas Formation, Beberino.

Fig. 9.—*Doliognathus* cf. *dubius* BRANSON & MEHL.

9. oral view (1364-8).

Baleas Formation, Beberino.

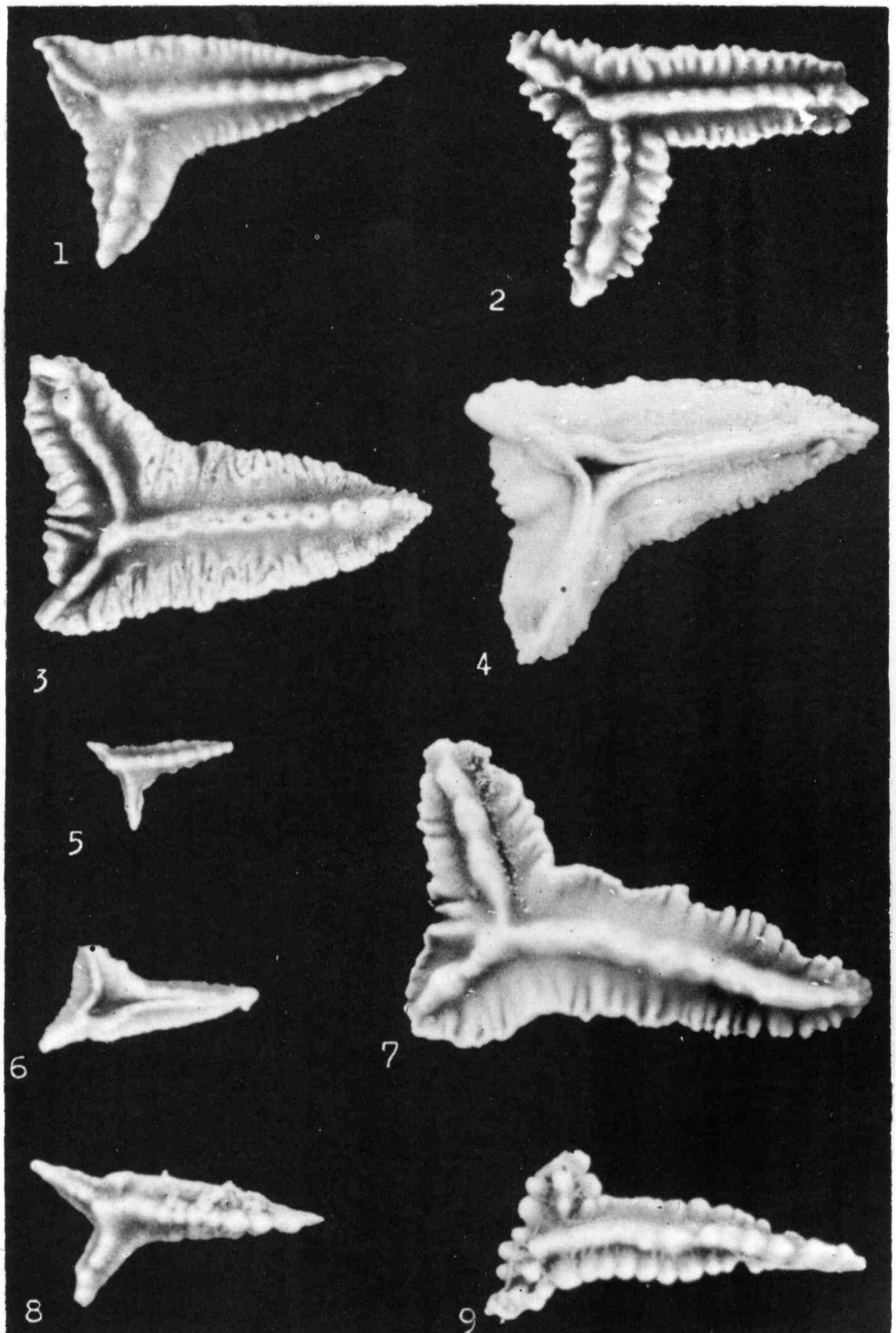
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PLATE 3

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Figs. 1-10.—*Scaliognathus anchoralis* BRANSON & MEHL.

1. oral view (1264-1).
2. aboral view (1264-1).
3. oral view (1264-2).
4. oral view (1264-3).
5. aboral view (1264-2).
6. oral view (1264-4).
7. aboral view (1264-4).
8. oral view (1264-5).
9. oral view (1264-6).
10. oral view (1264-7).

Baleas Formation, Pola de Gordón.

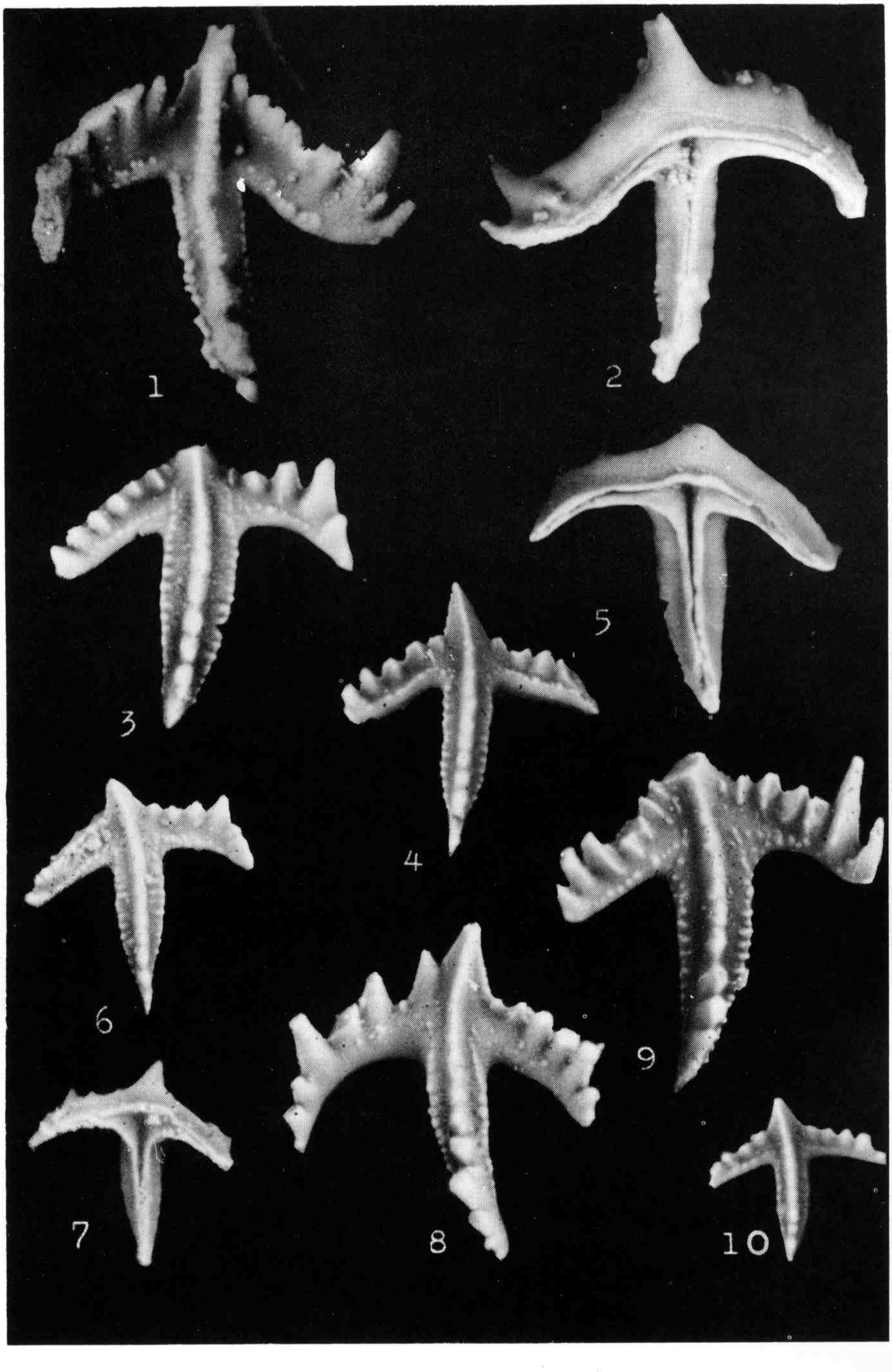
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PLATE 4

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Figs. 1, 3.—*Polygnathus lobatus* BRANSON & MEHL.
1. oral view (1264-8).
3. aboral view (1264-8).
Baleas Formation, Pola de Gordón.

Fig. 2.—*Scaliognathus anchoralis* BRANSON & MEHL.
2. oral view (1264-9).
Baleas Formation, Pola de Gordón.

Fig. 4.—*Pseudopolygnathus marginatus* (BRANSON & MEHL).
4. oral view (1524-1).
Baleas Formation, Pola de Gordón.

Fig. 5.—*Polygnathus longiposticus* BRANSON & MEHL.
5. oral view (1495-1).
Baleas Formation, 1.5 km west of Aviados.

Fig. 6.—*Ancyrodella lobata* BRANSON & MEHL.
6. oral view (1491-1).
Nocedo Formation, 1.5 km west of Aviados.

Figs. 7, 9.—*Icriodus* sp.
7. oral view (1491-2).
9. aboral view (1491-2).
Nocedo Formation, 1.5 km west of Aviados.

Figs. 8, 10.—*Siphonodella cooperi* HASS.
8. oral view (1521-1).
10. oral view (1521-2).
Baleas Formation, Pola de Gordón.

Fig. 11.—*Siphonodella quadruplicata?* (BRANSON & MEHL).
11. oral view (1521-5).
Baleas Formation, Pola de Gordón.

Figs. 12, 13.—*Polygnathus communis* BRANSON & MEHL.
12. oral view (1519-1).
13. oral view (1494-1).
Baleas Formation, 1.5 km west of Aviados.

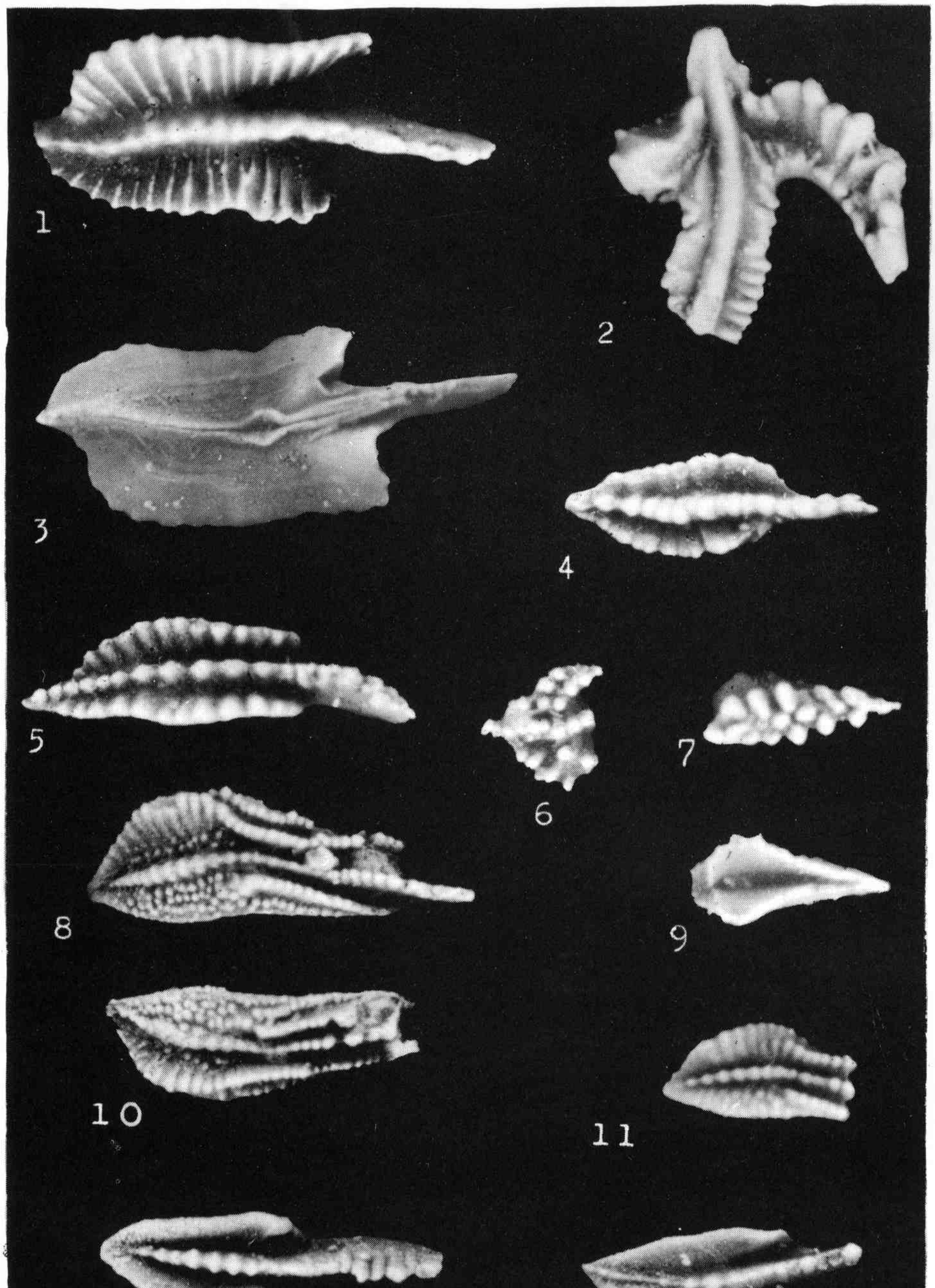
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Fig. 1.—*Gnathodus* cf. *delicatus* BRANSON & MEHL.
1. oral view (1519-3).
Baleas Formation, Pola de Gordón.

Figs. 2, 6.—*Gnathodus texanus* ROUNDY *pseudosemiglaber* THOMPSON & FELLOWS.
2. oral view (1264-12).
6. oral view (1264-13).
Baleas Formation, Pola de Gordón.

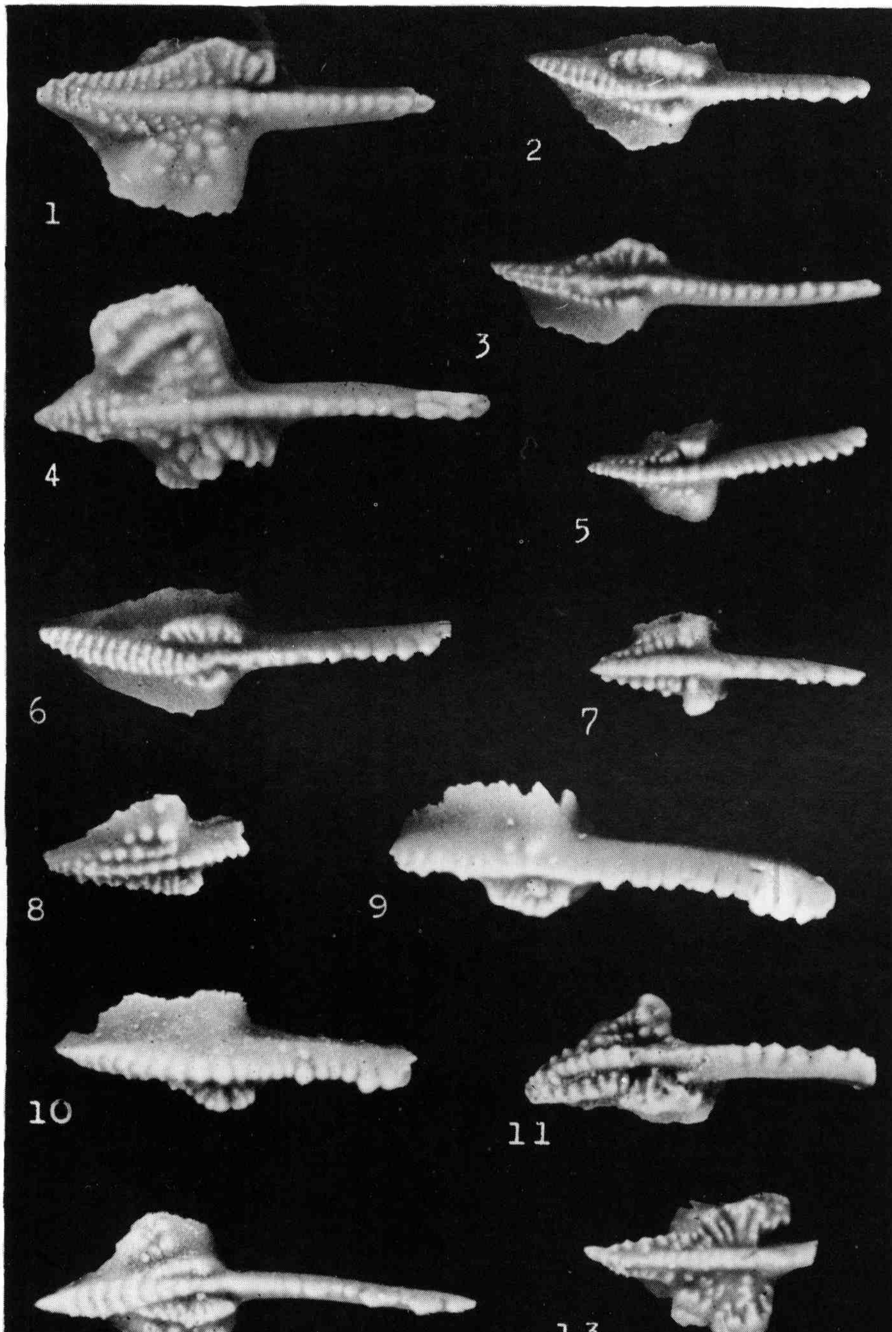
Fig. 3.—*Gnathodus* cf. *girtyi* HASS.
3. oral view (1264-14).
Baleas Formation, Pola de Gordón.

Fig. 4.—*Gnathodus punctatus* (COOPER).
4. oral view (1521-6).
Baleas Formation, Pola de Gordón.

Figs. 5, 7, 8, 11, 13.—*Gnathodus delicatus* BRANSON & MEHL.
5. oral view (1519-4).
7. oral view (1519-5).
11. oral view (1364-9).
13. oral view (1364-10).
Baleas Formation, Beberino.

Figs. 9, 10.—*Gnathodus antetexanus* REXROAD & SCOTT.
9. oral view (1264-15).
10. oral view (1264-16).
Baleas Formation, Pola de Gordón.

Fig. 12.—*Gnathodus semiglaber* BISCHOFF.
12. oral view (1264-17).
Baleas Formation, Pola de Gordón.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