

SIGNIFICANCE FOR INTERNATIONAL CORRELATION OF THE PERAPERTÚ FORMATION IN NORTHERN PALENCIA, CANTABRIAN MOUNTAINS. TECTONIC/STRATIGRAPHIC CONTEXT AND DESCRIPTION OF MISSISSIPPIAN AND UPPER BASHKIRIAN GONIATITES

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Kullmann, J., Wagner R. H. & Winkler Prins, C.F. 2007. Significance for international correlation of the Perapertú Formation in northern Palencia, Cantabrian Mountains. Tectonic/stratigraphic context and description of Mississippian and Upper Bashkirian goniatites. [El significado de la Formación Perapertú para la correlación internacional, norte de Palencia, Cordillera Cantábrica. Contexto tectónico/estratigráfico y descripción de goniatítidos misisípicos y del Bashkiriense Superior.] *Revista Española de Paleontología*, **22** (2), 127-145. ISSN 0213-6937.

ABSTRACT

Small ammonoid assemblages are recorded from the Perapertú Formation in northern Palencia. This is a mudstone unit with local platform limestones characterised by carbonate debris flows on the limestone margins. This unit, of Late Bashkirian to Early Moscovian age, participates in a series of southwards verging thrust slices North of a major fault zone which originated as the head (leading edge) of a large thrust sheet with an internal deformation consisting of thrust slices and at least one nappe structure. Opposed vergencies at the head of this major thrust sheet (Carrionas Thrust Front) and the Ruesga Fault which locally modifies its trace, mark the position where the northern branch of the Cantabric-Asturian arcuate fold belt has overridden the southern branch in early Westphalian (Langsettian) times. Two different palaeogeographic areas are found here in juxtaposition, i.e. the Asturian-Leonese Domain to the South and the Palentian Domain to the North. The contrasting stratigraphic developments are summarised in figure 2. Upper Bashkirian and Lower Moscovian formations elsewhere in the Cantabric-Asturian orogen are discussed, and the sporadic records of ammonoids in the lower part of the Pennsylvanian in various parts of the Cantabrian Mountains are commented on. The chronostratigraphic significance of the Perapertú Formation is discussed in the context of marine-terrestrial correlations for the Late Bashkirian-Early Moscovian time interval. It is concluded that the evidence from NW Spain suggests a position of the base of the Moscovian at the level of basal Westphalian or even within the highest Namurian. A brief analysis of the literature shows this position to be different to some of the correlations admitted in recent publications.

A newly discovered goniatite fauna from the lower part of the Perapertú Formation contains *Branneroceras* sp. indicating Late Bashkirian to earliest Moscovian, and *Deleshumardites cantabricus* Kullmann gen. et sp. nov. This fauna is figured and described in conjunction with the new subfamily Dombaritinae Kullmann (family Delepinoceratidae). The new genus *Deleshumardites* is erected with "*Proshumardites*" *delepinei* Schindewolf, 1939 as its type species. Ammonoid descriptions and illustrations include that of *Deleshumardites cantabricus* sp. nov. from strata of an earlier, Serpukhovian age in northern León.

Keywords: Ammonoids, Carboniferous, Bashkirian, Moscovian, Westphalian, Palentian Domain, Cantabrian Mountains, Tectonics.

RESUMEN

Se dan a conocer dos faunas de ammonoideos de la Formación Perapertú (norte de Palencia). Se trata de una unidad lutítica que incorpora plataformas carbonatadas de cuyos márgenes procedían *debris flow* calcáreos. Esta formación, de edad Bashkiriense Superior a Moscoviense Inferior, se encuentra en una serie de escamas tectónicas de vergencia Sur que forman parte de un cabalgamiento de grandes dimensiones donde la rama Norte del orógeno Cántabro-Astúrico cabalga a la rama Sur. Las vergencias opuestas en este frente (Cabalgamiento de Carrionas) y la Falla de Ruesga que lo modifica, indican el lugar donde dos áreas paleogeográficas diferentes se ponen en contacto sobre el mapa. Son los dominios Astur-Leonés y Palentino, al Sur y al Norte, respectivamente (Fig. 2). Se indican las formaciones equivalentes a la Fm. Perapertú en otras partes del orógeno, y se mencionan los registros esporádicos de ammonoideos del Pensilvánico inferior en la Cordillera Cantábrica. Por otro lado, se comenta el significado cronoestratigráfico de la Formación Perapertú en relación con las correlaciones entre las escalas marinas y continentales para el intervalo Bashkiriense Superior/Moscoviense Inferior. Se llega a la conclusión de que los datos obtenidos en el NO de España sugieren que la base del Moscoviense coincide aproximadamente con la del Westfaliense, o se sitúa aún más abajo, en el Namuriense superior. Esta conclusión discrepa con algunas correlaciones admitidas en publicaciones recientes, que se mencionan escuetamente.

Por último, se describen y figuran varios ammonoideos del Pensilvánico inferior en la Cordillera Cantábrica. La nueva fauna de goniátidos en la parte inferior de la Formación Perapertú incluye *Branneroceras* sp. del Bashkiriense Superior al Moscoviense más bajo (Langsettiense), así como *Deleshumardites cantabricus* Kullmann gen. et sp. nov. Se describe ésta última de una localidad del Serpujoviense Superior en León, y se introduce una nueva subfamilia, Dombaritinae Kullmann, de la familia Delepinoceratidae, así como el nuevo género *Deleshumardites* (especie tipo "*Proshumardites*" *delepinei* Schindewolf, 1939).

Palabras clave: Ammonoideos, Carbonífero, Bashkiriense, Moscoviense, Westfaliense, Dominio Palentino, Cordillera Cantábrica, Tectónica.

INTRODUCTION

The present paper aims primarily at the documentation of a goniatite fauna of stratigraphic significance, which has been collected from a low position in the Perapertú Formation, a stratigraphic unit belonging to the Palentian Domain in the southeastern part of the Palaeozoic Cantabrian Mountains. Limestones in the higher part of this formation yielded Lower Moscovian foraminiferal faunas (Rumyantseva *in* Wagner & Bowman, 1983) as well as more limited conodont assemblages (*op. cit.*). Calcareous mudstones associated with these limestones produced a goniatite fauna of Atokan affinities (Wagner-Gentis, 1985). The newly discovered goniatite fauna is here described by the first author (JK), who has also undertaken a reappraisal of the fauna described earlier. The opportunity has been taken also to describe a new goniatite species from a locality of different (earlier) age elsewhere in the Cantabrian Mountains, and to introduce a new genus which includes this species as well as certain elements of the Perapertú fauna.

The new find of a goniatite fauna low in the Perapertú Formation was made by the third author (CFWP) in the course of a stratigraphic and tectonic reinvestigation of a structurally complex area in northern Palencia, involving strata of pre-latest Langsettian age, i.e. below the totally unconformable Curavacas Formation which initiates a fundamentally different episode in the regional geological history. This investigation, which has been carried out over

a long period of time, close to a quarter century, by two of the present writers (RHW, CFWP), initially focused on the revision of Carboniferous formations on both sides of a major fault zone, identified as the Ruesga Fault (compare Wagner & Winkler Prins, 2000). However, it became apparent that the Ruesga Fault continued the trace of a major thrust front, which is now identified as the Carrionas Thrust (Fig. 1). Large scale thrusting produced shortening which resulted in the juxtaposition of two different palaeogeographic domains (Fig. 2). The existing geological maps, at 1:50,000 scale, proved inadequate as a base for stratigraphic revision. A certain amount of remapping thus became inevitable, for which 1:10,000 scale topographic base maps were obtained. Indeed, the geological structures proved to be much more intricate than was originally anticipated, and it was found that the tectonic interpretations as published by the different authors were often poorly constrained by factual data. Inaccurate mapping was part of the problem, but the rather imprecise use of formations and lack of attention to the evidence of stratigraphic breaks, such as palaeokarst surfaces, compounded the problem.

The stratigraphic revision of Carboniferous formations carried out by the present writers, but not yet published in detail, can only be referred to briefly in the present paper, i.e. only in so far as is necessary. One new formation is named and briefly discussed but not described in detail, this being reserved for a more exhaustive paper currently in preparation. Likewise, the complex geological structure is

explained only in so far as has been deemed necessary for the understanding of the geological history of the area.

This involves primarily the recognition of two different facies realms, known as the Asturian-Leonese and Palentian domains, with opposed vergencies and separated by a major fault zone which Wagner & Winkler Prins (2000) identified as the Ruesga Fault, but which more recent work has shown to be separable into the frontal part of a major thrust sheet, here named the Carrionas Thrust Front, and a normal fault which interferes with the trace of the thrust and which corresponds to the original concept of the Ruesga Fault as introduced by Kanis (1956). It is noted that the structural interpretations published by Frankenfeld (1984) and Rodríguez Fernández (1994), who postulated a southern origin of the Palentian Domain, and northern vergencies for the strata involved, proved incompatible with the field data collected by the present writers. In fact, these suggest the complete opposite. A recent paper by Keller *et al.* (2006) also presents a regional synthesis which bears no relation to the factual information. A full

discussion of the various structural hypotheses published in the geological literature of the study area will have to be postponed in view of the biostratigraphic emphasis of the present paper.

Biostratigraphic dating of the various Carboniferous formations, up to and including lower Langsetian, is discussed with particular reference to goniatite faunas. The correlation between East European (Russian/Ukrainian) chronostratigraphic units and those recognised in western Europe are discussed in the light of marine faunal and terrestrial floral data obtained in northern Palencia and the adjacent area in southern Cantabria (Liébana region).

GEOLOGICAL CONTEXT

(R.H. Wagner & C.F. Winkler Prins)

The Palaeozoic structures of northern Palencia and adjacent parts of León and Cantabria (formerly the province of Santander) are the most complex ones of an arcuate

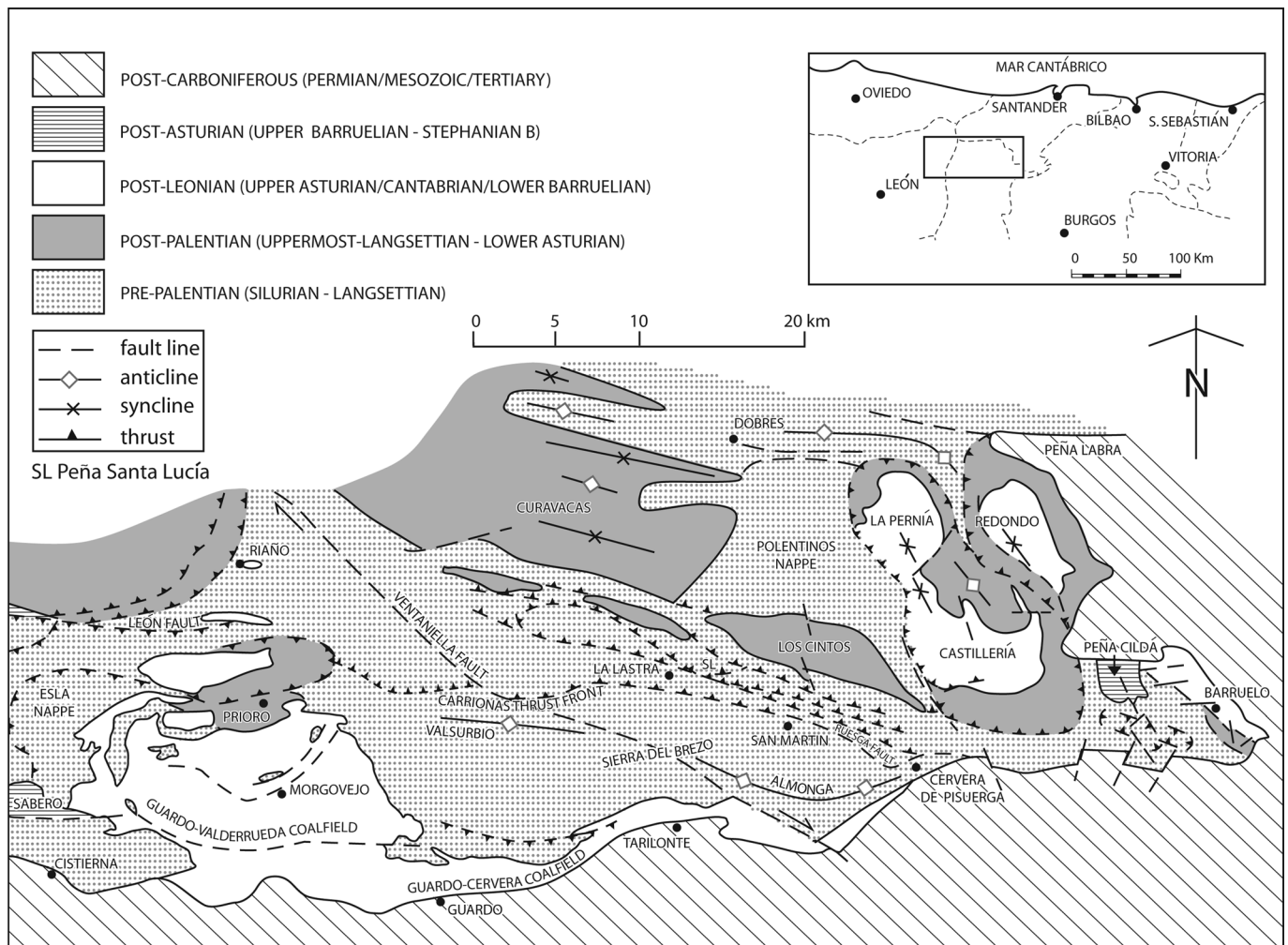


Figure 1. Outline geological map of northern Palencia and adjacent parts of NE León and southern Cantabria (southeastern part of Cantabric-Asturian arcuate fold belt). Prepared by RHW and CFWP.

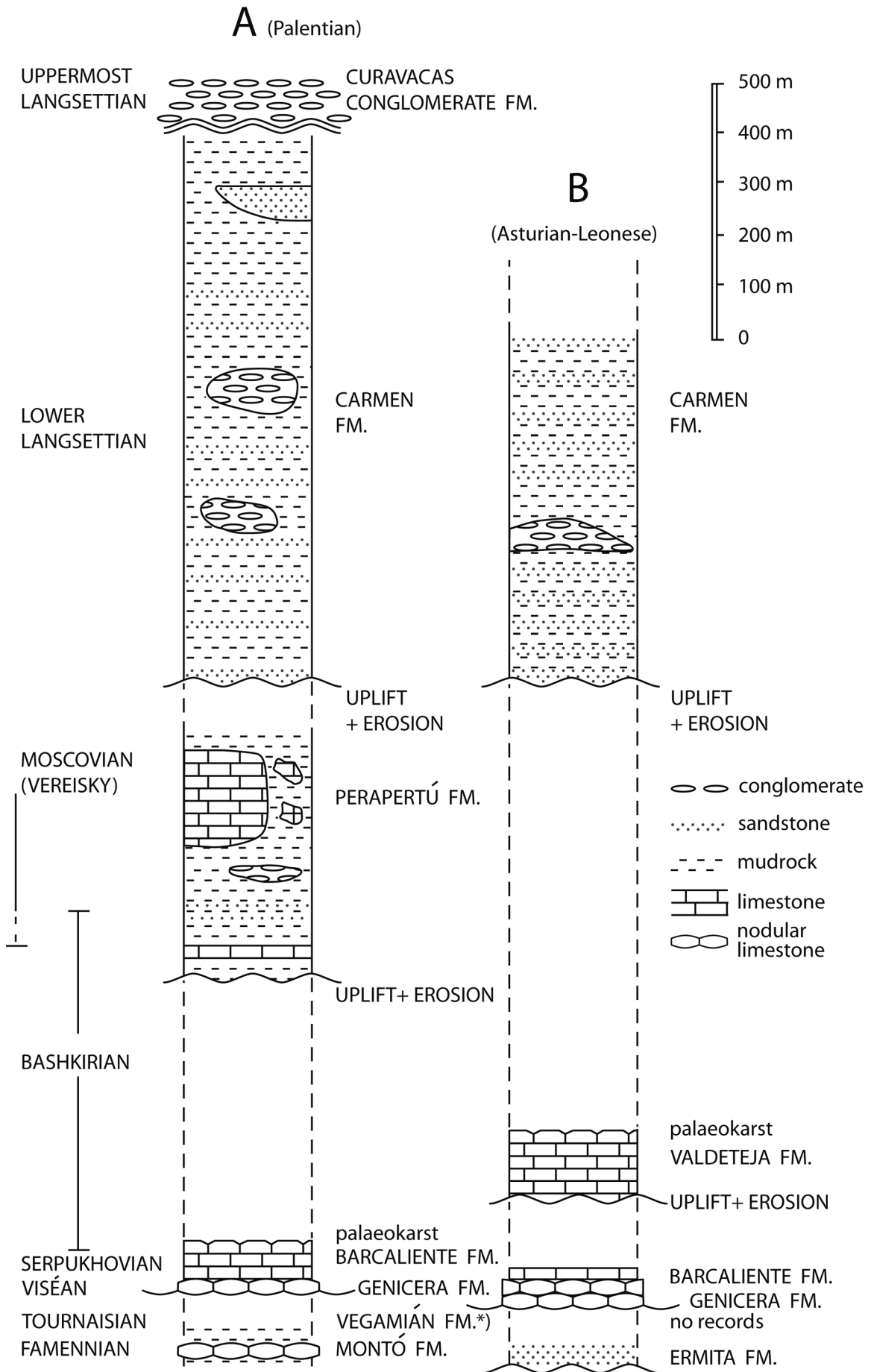
fold belt in Northwest Spain, which may be referred to as the Cantabric-Asturian Orogen. Geographically, this corresponds to most of the Cantabrian Mountains. The arcuate fold belt experienced progressive tightening in several pulses of tectonic deformation in Pennsylvanian times. Most extreme tightening took place in the eastern part of the orogen. One of these pulses, in Langsettian (early Westphalian) times, led to the strike turning around in 180° in the area corresponding to northern Palencia, confronting South- and North-verging thrust units at a major geological fault zone which Wagner & Winkler Prins (2000) identified with the Ruesga Fault, but which is presently referred to as the Carrionas Thrust Front. Major tectonic shortening took place at this fault line, with the northern branch of the arcuate fold belt overriding the southern branch (Fig. 1). It has long been recognised that two different facies and structural domains are in juxtaposition at this fault line, with the Asturian-Leonese Domain to the South and the Palentian Domain to the North. This has become apparent primarily from the rather different developments of mid- to Upper Devonian strata in these different domains (Brouwer, 1964). The sediments corresponding to the Asturian-Leonese Domain are of near-shore facies, whereas those of the Palentian domain reflect deposition more remote from shore and, consequently nearer the foreland than the hinterland. Carboniferous successions South and North of the fault zone also proved to be quite different (Wagner & Winkler Prins, 2000, and *in prep.*), but this has been less immediately apparent lithologically. Previous authors (e.g. Savage *in* Savage & Boschma, 1980, and Rodríguez-Fernández *et al.*, 1985) applied formational names of generalised usage in the Carboniferous of the Cantabrian Mountains, thus blurring the differences that have now become apparent. General columns for the stratigraphic successions involved are depicted in figure 2. Stratigraphic breaks appear at different parts of the succession in the two different areas. Facies changes also operated in North-South direction. A detailed account of these facies changes, which are accompanied by thickness variations and slight differences in the stratigraphic ranges of broadly time-equivalent formations, must be left to another publication (Wagner & Winkler Prins, *in prep.*) Only a brief outline of the tectonic structure may be provided here.

The major fault zone where the Asturian-Leonese and Palentian domains occur in juxtaposition, has proved to correspond basically to the frontal part of a large thrust sheet which placed the Palentian Domain on top of the Asturian-Leonese Domain (Fig. 1). This thrust sheet moved from North to South. It is here named the Carrionas Thrust

Sheet, using a regional name which reflects the major importance of this southward directed tectonic unit involving up to 4,000 m of strata ranging from upper Silurian to lower Pennsylvanian. Its frontal part is represented by an anticlinal structure, with overturned strata at the thrust front and small southward verging anticlines and synclines constituting the normal flank. Whereas the frontal part of the thrust sheet dips c. 30-35° N, a number of successive thrust slices which developed within this large thrust sheet, dip generally 55° N. These thrust slices override each other, with a progressive elimination of tectonic slices eastwards. At least one of the series of WNW-ESE striking thrust slices has developed into a fairly important nappe structure, the Polentinos Nappe (Fig. 1). Reverse thrusting at a fairly late stage of structural deformation has led to the generation of at least two small nappes involving strata of the Asturian-Leonese Domain which were moved northwards across the main thrust front (marked as Carrionas Thrust Front on the map). One of these nappes (i.e. the Revilla Nappe – Wagner, 1971), with strata which are palaeogeographically identifiable as corresponding to the northernmost part of the Asturian-Leonese Domain as found in the Sierra del Brezo (Fig. 1), is overlain in turn by a klippe of the Polentinos Nappe of the Palentian Domain; it thus being clear that one is dealing with late developments in the structural deformation of the major (Carrionas) thrust sheet. All these structures are overlain with strongly marked (highly angular) unconformity by the Curavacas Conglomerate Formation of late Langsettian and early Duckmantian ages (Wagner & Álvarez-Vázquez, 1995), which fossilised the earlier structures. The Curavacas Formation marks the onset of a totally different phase in the geological history of northern Palencia and adjacent areas. A well developed palaeokarst is associated with the Curavacas unconformity wherever the underlying structures involve limestone formations. This palaeokarst marks the erosion surface corresponding to a period of emergence after compressive tectonic deformation.

The most complex structures associated with the Carrionas Thrust Sheet are at the head (leading edge) of this sheet. These structures are regarded as belonging to the first thrust slice within the major thrust sheet. They are cut, slightly obliquely, by the second thrust slice, which is basically subparallel, but affecting the width of outcrop of the first thrust slice, which is therefore quite variable. In the area North of San Martín de los Herreros (Fig. 3), the first thrust slice shows both the overturned flank of the anticlinal structure at the head of the Carrionas Thrust Sheet and small near-isoclinal anticlines and synclines of the normal flank (see also the section of Fig. 4). In the east-

Figure 2. Generalised columns illustrating the stratigraphic successions in Carboniferous strata of Asturian-Leonese and Palentian domains South and North of the Carrionas Thrust Front and Ruesga Fault (prepared by RHW and CFWP). The Palentian column represents the succession in the first thrust slice North of the fault.



ern part of the map of figure 3, a normal fault developed which cut the overturned flank of the anticlinal structure at the head of the thrust sheet, with the progressive elimination eastwards of this overturned flank. This normal fault (Fig. 4) is here identified as the "Ruesga fracture zone" as described by Kanis (1956). On the map (Fig. 1) it continues the trace of the Carrionas Thrust Front eastwards. The fairly complex Ruesga fault zone extends further eastwards into Cervera de Pisuerga and passes underneath the Mesozoic cover, which appears to have been affected by this fracture zone; it thus seems to have been rejuvenated in Mesozoic times (Carralleira *in* Wagner *et al.*, 1984, and Espina *et al.*, 1996).

The geological structure of the area North of San Martín de los Herreros, where the recently discovered goniatite fauna has been found, is depicted in figures 3 and 4. Originally mapped as forming part of the northward verging thrust slices found in the Sierra del Brezo (Asturian-

Leonese Domain) (Koopmans, 1964), an interpretation which has been maintained in later papers (e.g. Savage *in* Savage & Boschma, 1980, and Marín, 1997), it has now proved to belong to the southward verging structures of the Palentian Domain. The map at scale 1:10,000 (Fig. 3) shows the overturned flank, with repetitions, of the anticlinal structure at the head of the Carrionas Thrust Sheet. It also shows small anticlines and synclines belonging to the normal flank, which are cut off obliquely by the steeply dipping fault underlying the second thrust slice. No detail is shown on the map for the Asturian-Leonese Domain which has been overridden by the Carrionas Thrust Sheet. Three Carboniferous formations are involved in the first thrust slice, viz. the Genicera, Barcaliente, and Perapertú formations. The latter is clearly disconformable, with a well developed palaeokarst surface on top of limestones of the Barcaliente Formation (compare Fig. 2). The newly discovered goniatite fauna, described in the present paper,

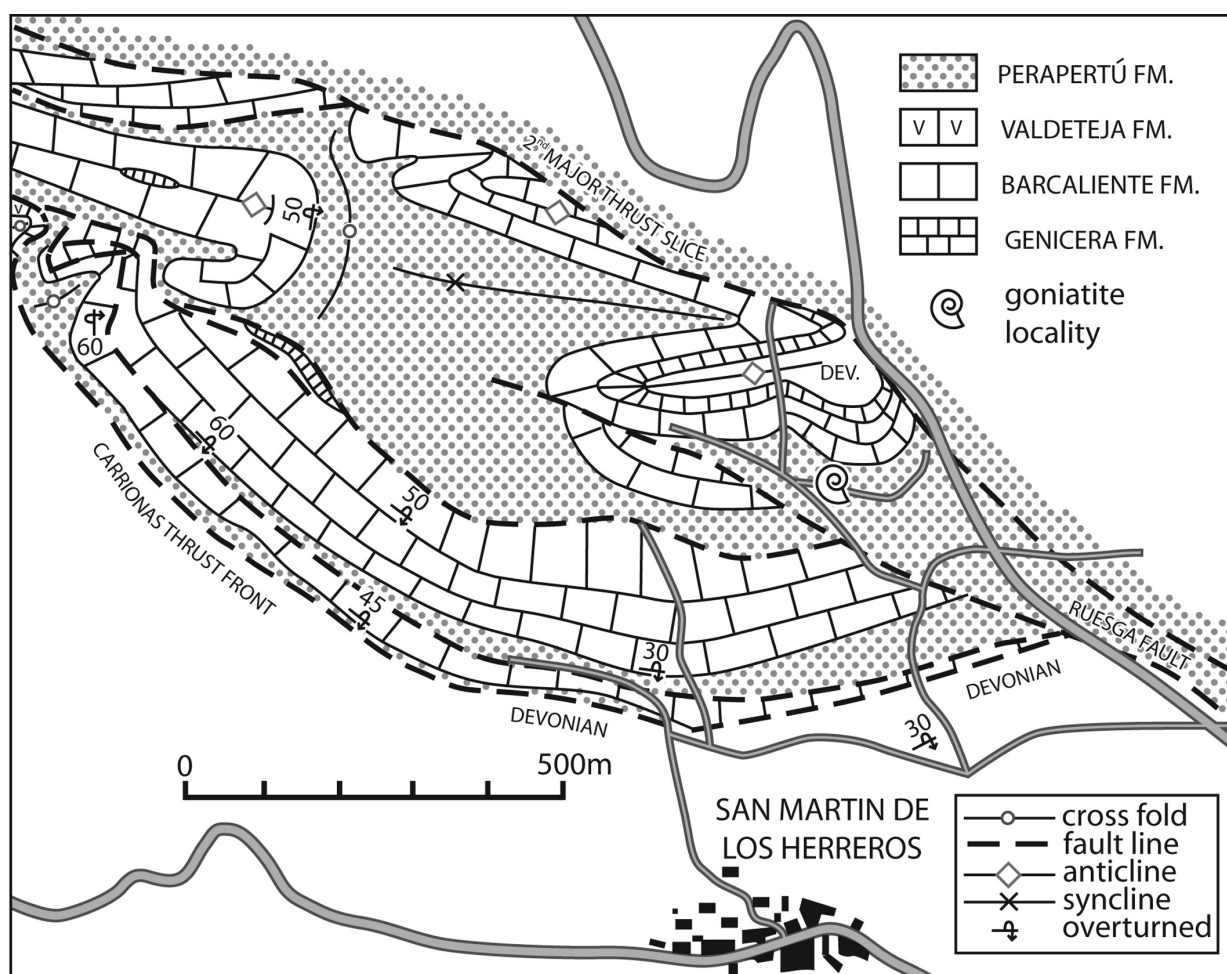


Figure 3. Geological map of the area North of San Martín de los Herreros at 1:10,000 (prepared by R.H.W. and C.F.W.P.). Represents overturned flank of anticlinal structure (with small repetitions) at the Carrionas Thrust Front, small folds in the normal flank, and the initiation of a normal fault (Ruesga Fault) which has its major development further eastwards. These structures are cut off by the second thrust slice. Note late cross-fold. Overturned symbol with arrow marking way-up. (Compare Fig. 4).

occurs at 14 m above the base of the Perapertú Formation in the locality shown on the map (see also Fig. 5). A small outcrop of shales attributable to the Upper Devonian Montó (= Vidrieros) Formation occurs in the core of one of the small anticlines. It is noted that this outcrop of shales is shown on the map in Marín (1997) as a small klippe of presumed Carboniferous strata of the “Cervera” Formation. This seems an unlikely interpretation.

In the western part of the map of figure 3, internal thrusting and a small cross fold complicate the structure of the first thrust slice of the Carrionas Thrust Sheet even further.

PERAPERTÚ FORMATION

(R.H. Wagner & C.F. Winkler Prins)

The strata which yielded the small goniatite fauna described herein, belong to the Perapertú Formation, a stratigraphic unit of the Palentian Domain within the southward verging Carrionas Thrust Sheet (Fig. 1). This formation, defined originally by Wagner & Wagner-Gentis (1963), has been discussed more exhaustively in Wagner *et al.* (1984). It is being redescribed by Wagner & Winkler Prins (*in prep.*) The Perapertú Formation, which is restricted to the Palentian Domain (Fig. 2), follows in disconformable succession on a Serpukhovian to Lower Bashkirian limestone attributed to the Barcaliente Limestone Formation in the area of the first thrust slice immediately North of the

Carrionas Thrust Front. Evidence of palaeokarst is found on the limestone surface below this formation, this being the result of regional uplift in the Palentian Domain and consequent erosion (Figs 2 and 5). A fairly appreciable stratigraphic gap is involved. The Perapertú Formation has been dated in the past as Early Moscovian on foraminiferal evidence (Rumyantseva *in* Wagner & Bowman, 1983). This was obtained from limestones in the higher part of the Perapertú Formation. It is overlain, again with disconformity, and palaeokarst where the appropriate lithological conditions existed, by a siliciclastic turbidite unit, the Carmen Formation. The latter is the highest stratigraphic unit occurring in the southward verging thrust slices which underlie the strongly unconformable, post-orogenic Curavacas Conglomerate Formation, of late Langsetian and early Duckmantian ages. The Carmen Formation is the same as the Cervera Formation of Brouwer & van Ginkel (1964), a name which has been used in a rather imprecise manner by subsequent authors, and which should be avoided (compare Wagner *et al.*, 1984). It is recalled that a mid-Bashkirian (Tashatinsky) age has been claimed for the “Cervera Formation” in the Asturian-Leonese Domain of the Sierra del Brezo (Marín *et al.*, 1996), but a re-examination of the locality involved has shown that the fossils identified by Villa (*in* Marín *et al.*, 1996) originated from the underlying Valdeteja Limestone Formation (Wagner & Winkler Prins, 1997, 2000).

The facies characteristics of the Perapertú Formation are those of an unstable marine basin, primarily a mud en-

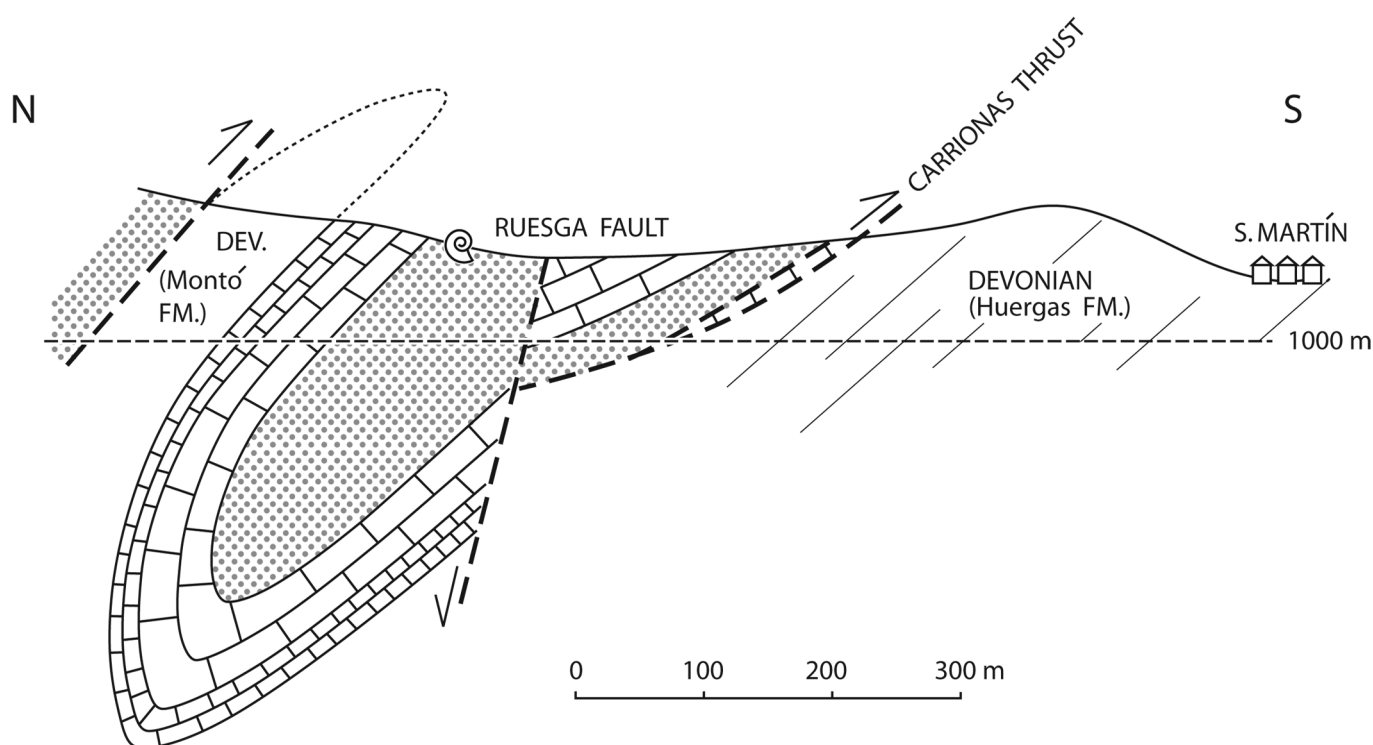


Figure 4. Section across the map of figure 3, coincident with goniatite locality n° 9795 (RHW/CFWP).

vironment with upstanding fault-bounded platform areas which accumulated limestones. The platform margins were subject to syn-sedimentary faulting since they released carbonate debris flows as well as major limestone blocks which are incorporated as megabreccias in the surrounding mud basin. A maximum development of 300 m of platform limestone is registered in an area South of the mountain pass of Piedrasluengas (van de Graaff, 1971), which is West of Peña Labra (Fig. 1). The Piedrasluengas Limestone, which was regarded originally as a separate formation (Brouwer & van Ginkel, 1964), was dated as Early Moscovian on foraminiferal evidence (van Ginkel, 1965). This limestone occupies the upper part of the Perapertú Formation. A more substantial list of foraminifera, including both fusulinoideans and small foraminifera, as identified by Z.S. Rumyantseva, was published by Wagner & Bowman (1983: table 4) from a number of limestone localities in the general vicinity of Perapertú village, West of the Stephanian B outlier of Peña Cildá (Fig. 1). These were generally attributed to the Vereisky Horizon of the Moscovian Stage. The foraminifera of the Perapertú Formation range in Russia from Late Bashkirian to Early Moscovian (Einor, 1996: fig. 25) with one subspecies (*Profusulinella rhombiformis nibelensis* Rauser-Chernousova, 1951) being confined to the Late Bashkirian; whereas several species occur both in the Late Bashkirian and Vereisky [*Profusulinella pararhomboides* Rauser-Chernousova & Beljaev, 1936, *Pr. ex. gr. rhomboides* (Lee & Chen, 1930)]. Many others occur only in the Vereisky or later deposits (e.g. *Pr. prisca* (Deprat, 1912), *Schubertella pauciseptata* Rauser-Chernousova, 1938, *Sch. obscura* Lee & Chen, 1930, *Pseudostaffella subquadrata* Grozdilova & Lebedeva, 1950, *Aljutovella distorta* Leontovich, 1951, and *A. subaljutovica* Safonova, 1951); a few are even restricted to the "Tsninsky" (*Pr. paratimanic* Rauser-Chernousova, 1951, *A. complicata* Safonova, 1951). A late Vereisky age seems the most likely (E. Villa, *pers. comm.*, August 2005).

The foraminiferal faunas are not the only marine faunas of stratigraphic significance encountered in the Perapertú Formation. From shales immediately below the Piedrasluengas Limestone a small goniatite fauna was figured and described by Wagner-Gentis (1985), who compared it with Lower Pennsylvanian Atokan faunas from North America. A revision of the same specimens by J. Kullmann (this paper) suggests the *Diaboloceras-Winslowoceras* Genozone of Early Moscovian age, which is in substantial agreement with the original age identification. Another small goniatite fauna was found more recently at 14 m above the base of the Perapertú Formation in folded strata almost immediately North of the Ruesga Fault in a locality at c. 500 m North of San Martín de los Herreros (Figs 3, 4 and 5). This fauna, which is figured and described in the present paper, appears to be marginally older than that below the Piedrasluengas Limestone, since it con-

tains *Branneroceras* which characterises the higher Morrowan in North America and ranges from Late Bashkirian to earliest Moscovian in Russia and the Ukraine. The slight difference in age between these two goniatite assemblages agrees with the different positions within the Perapertú Formation.

TIME-EQUIVALENT FORMATIONS

(R.H. Wagner & C.F. Winkler Prins)

In other parts of the Cantabrian Mountains (*i.e.* the Asturian-Leonese realm, as meant by Wagner & Winkler Prins, 2000) the time-equivalent sediments to the Perapertú Formation of the Palentian Domain (North of the Carriónas/Ruesga fault trace) are first of all the highest part of the Valdeteja Limestone Formation (in those places where this formation with a diachronous top is developed in maximum thickness), and part of the overlying San Emiliano

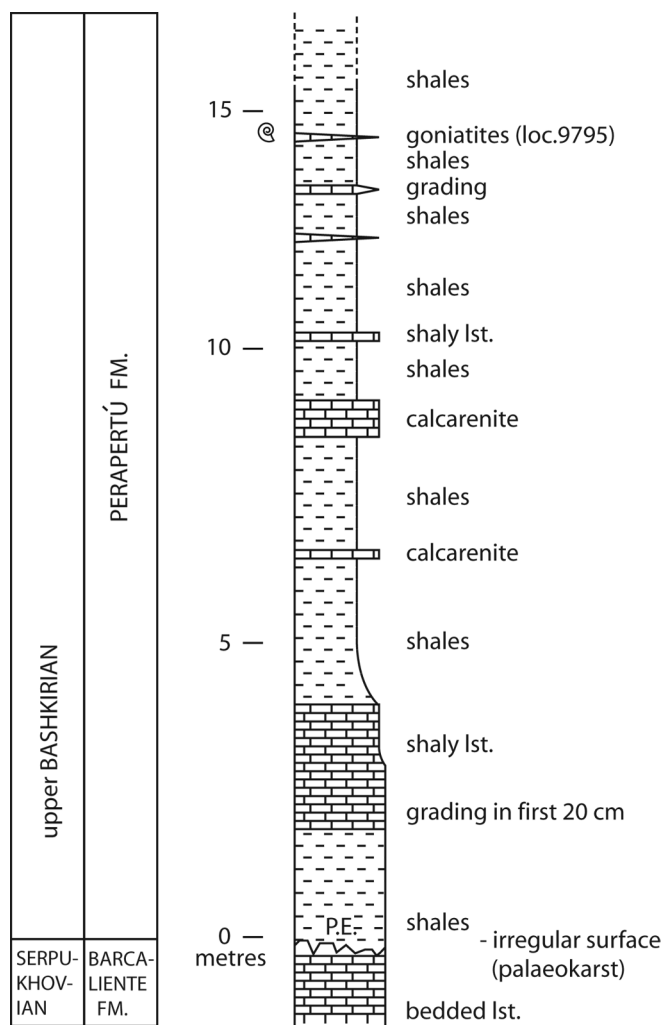


Figure 5. Section of the basal part of the Perapertú Formation at the collecting locality n° 9795 (compare Figs 3 and 4) (RHW/CFWP). P.E. poorly exposed.

Formation; furthermore, the condensed Ricacabiello Formation, and the lower parts of the Lena Formation and the Cuera Limestone.

The Valdeteja Limestone Formation generally belongs to the Upper Bashkirian, and reaches into Lower Moscovian (including the Asatausky – see below) in some sections (Villa, 1982; Villa *et al.*, 2001). Locally, it is confined to the Bashkirian, e.g. in the Sierra del Brezo (Wagner & Winkler Prins, 2000: 396), the Sierra del Sueve (Villa, 1989) and at Latores (Martínez Chacón & Winkler Prins, *in press*). The overlying San Emiliano Formation, with a diachronous base, ranges from Upper Bashkirian to Lower Moscovian in the San Emiliano type area (Bowman, 1985; Carballeira *et al.*, 1985; van Ginkel & Villa, 1996). The Villamanín beds of the Bernesga Valley section in northern León may be largely equivalent to the highest (Candemuela) member of the San Emiliano Formation, being of Vereisky age (*op. cit.*), and thus correspond in age to the Perapertú Formation.

The Ricacabiello Formation (Martínez-Chacón *et al.*, 1985) is a lateral equivalent of the Valdeteja Formation and also corresponds to the Bashkirian, reaching into Moscovian. The Lena Formation of the Central Asturian Coalfield is largely equivalent to the San Emiliano Formation (Leyva *et al.*, 1985). The Cuera Limestones of eastern Asturias (Villa *et al.*, 2000: 8) comprise the Valdeteja Formation in their lower part, but continue upwards into the Upper Moscovian. This is the general pattern of continual limestone deposition in the foreland area of the Cantabric-Asturian orogen.

DATING OF BARCALIENTE/PEÑA, PERAPERTÚ, AND CARMEN FORMATIONS

(R.H. Wagner, C.F. Winkler Prins & J. Kullmann)

Conodont and foraminiferal evidence is available for the Barcaliente Formation (and the still undescribed Peña Formation which is its lateral equivalent in most of the Palentian Domain – Wagner & Winkler Prins, *in prep.*) as well as for the Perapertú Formation. The type section of the Peña Formation in Peña Santa Lucía, West of Santibañez de Resoba (Fig. 1), has yielded conodont faunas of Serpukhovian age in the lower part which follows in conformable succession upon the Carrión Limestone unit (in the same thrust slice) which Nemyrovskaya (2005) has determined as ranging from Viséan to lower Serpukhovian. Foraminiferal faunas from the higher part of the Peña Formation have been studied by E. Villa (*pers. comm.*, 13/02/1996), who identified Lower Bashkirian, probably equivalent to Siuransky Horizon. This agrees with the results obtained by T. Nemyrovskaya (*pers. comm.*) from a section of the laterally equivalent Barcaliente Limestone at La Lastra village, corresponding to the first thrust slice North of the Carrionas/Ruesga fault trace, where succes-

sive conodont faunas show ages ranging from Serpukhovian to Early Bashkirian, the latter only in the top part of the c. 80 m thick limestone section. The thicker Peña Formation, as developed in thrust slices North of La Lastra, is clearly a time equivalent of the Barcaliente Formation. An irregular erosional contact (presumed palaeokarst) is present between the Barcaliente and Perapertú formations at La Lastra village. No Perapertú Formation has been found in the thrust slice represented at Peña Santa Lucía, where the Peña Formation is the highest stratigraphic unit recognised.

A small goniatite fauna collected from locality N° 9795 at 14 m above the base of the Perapertú Formation at c. 500 m North of San Martín de los Herreros (Figs 3 to 5), where an erosional contact is observed with underlying Barcaliente/Peña Formation, is most likely Late Bashkirian in age on the basis of *Branneroceras* being present. This genus also characterises the Bloyd (upper Morrow) in the Ozark Uplift of Arkansas/Oklahoma (McCaleb, 1968). Another small goniatite fauna was described by Wagner-Gentis (1985) from just below the Piedrasluengas Limestone, a 300 m thick unit of platform limestone at the top of the Perapertú Formation. A revision of the original material, kept in the Senckenberg Museum in Frankfurt-am-Main, resulted in the following list (J.K. det.): *Boesites* sp., *Diaboloceras* sp., *Phaneroceras gandli* Wagner-Gentis, 1985, *Phaneroceras?* sp., *Proshumardites?* sp. vel *Deleshumardites?* sp. This is an assemblage belonging to the *Diaboloceras-Winslowoceras* Genozone, of Early Moscovian age (also Atokan in the American chronostratigraphic terminology). It thus appears that the Perapertú Formation spans both the *Branneroceras* and *Diaboloceras-Winslowoceras* zones, and ranges in age from Late Bashkirian to Early Moscovian.

The foraminiferal faunas identified by S.Z. Rumyantseva (*in* Wagner & Bowman, 1983) from limestones in the Perapertú Formation near San Martín de Perapertú have been attributed to the Lower Moscovian Vereisky Horizon (with one locality suggesting Kashirsky), a conclusion which agrees with the dating of the Piedrasluengas Limestone, exposed more to the North in the same province of Palencia. The full thickness of the Perapertú Formation has not been ascertained, but it is probably in excess of 500 m.

The 300 m thick Piedrasluengas Limestone (Brouwer & van Ginkel, 1964; van de Graaff, 1971), in the top part of the Perapertú Formation, is overlain by mudstones with conglomerate lenses in the area South of the Piedrasluengas mountain pass. These overlying deposits are ascribed to the Carmen Formation, the highest stratigraphic unit in the pre-Curavacas succession. This formation, with an recorded thickness of at least 1,100 m in northern Palencia (Wagner *et al.*, 1984), comprises shales alternating with generally turbiditic sandstone beds and also contains quartzite conglomerate lenses representing coastal material

which has been slid into the marine basin. The Piedrasluengas Limestone passes northwestwards from the province of Palencia (Castilla) into neighbouring Cantabria (formerly Santander province) where the overlying conglomeratic deposits of the Carmen Formation continue in the direction of Dobres (Fig. 1). These were assumed to have yielded the floral remains reported by Wagner (1959, 1962) and Wagner & Álvarez-Vázquez (1995), but recent work has shown that these plant impressions of Langsettian age originated from the Curavacas Formation. This post-orogenic formation, belonging to a later episode in the tectono-stratigraphic history of the region, overlies the structures involving the Carmen Formation with total unconformity.

This leaves the Carmen Formation with less direct evidence of stratigraphic age. The palaeontological information in this respect is as follows. The bivalve *Pterinopecton rhythmicus* Jackson, 1927 was recorded by Kanis (1956) from a locality at 1 km West of Valsadornín (Palencia). According to the geological map published by Wagner *et al.* (1984), this locality lies in the Carmen Formation. Kanis (1956), who did not figure the specimen in question, suggested that it indicated a mid-Namurian age. Kanis also collected a drifted plant remain from strata of the same formation at 500 m NW of Cervera de Pisuerga, also in northern Palencia. This specimen was figured and described by Wagner (1962: pl. 29, figs 1, 1a) as *Sphenopteris stockmansii*. Although assumed to be of early to mid-Namurian age (*op. cit.*), the total range of this species may be more extensive. Another palaeobotanical record, *Calamites vandergrachtii* Kidston & Jongmans, 1915 (Wagner *et al.*, 1984: 33) is devoid of stratigraphic interest. Likewise, a specimen of *Lepidophloios laricinus* Sternberg, 1825 found in turbiditic sandstone of the Carmen Formation immediately North of the Ruesga Fault, North of the Ruesga Dam, is lacking in stratigraphic importance. More relevant is the find of a pinnule of *Linopteris* in fine-grained sandstone of the Carmen Formation overlying limestone of the Genicera Formation in the head of the Revilla Nappe near Barruelo de Santullán (Wagner, 1971: 443). This genus does not seem to occur below the Westphalian in Europe. Even more important is the record of a Westphalian A (Langsettian) microflora from the upper part of the Carmen Formation in its type section near Vallespinoso de Cervera (Dorning *in* Wagner *et al.*, 1984: 33).

A Langsettian age for the entire Carmen Formation, a turbiditic unit of at least a thousand metres thickness should probably be interpreted more specifically as early Langsettian, in view of the (late?) Langsettian age of the overlying Curavacas Formation. Wagner & Álvarez-Vázquez (1995) accepted that the basal portion of the Curavacas Conglomerate Formation belonged to the (highest?) Langsettian, as Stockmans & Willièrè (1965) had determined previously. Recent work in the vicinity

of Dobres-Cucayo (Liébana region of Cantabria) strongly supports a Langsettian age for the lowermost part of the Curavacas Formation.

An early Langsettian age for the Carmen Formation suggests that the underlying Perapertú Formation probably straddles the Namurian-Westphalian boundary.

The mainly Lower Moscovian Perapertú Formation may thus be regarded as belonging to either the upper Namurian (Yeadonian) or lowermost Langsettian. This correlation which was suggested already by Wagner & Bowman (1983) is not that which is commonly accepted in the literature. In fact, the authors usually place the base of the Moscovian at a level corresponding to upper Langsettian or even lower Duckmantian, if not higher (see the correlation table in Heckel, 2004, where the base of the Moscovian is placed quite high in the Westphalian). This will be discussed in the next chapter.

MARINE-TERRESTRIAL CORRELATIONS

(R.H. Wagner, C.F. Winkler Prins & J. Kullmann)

The higher Carboniferous (Pennsylvanian) of the Cantabrian Mountains is predominantly marine with a Palaeotethyan connection which allows direct correlation with Russia and the Ukraine. Marine faunas of the American Midcontinent are comparable but not wholly identical, whilst the occasional marine bands present as marine incursions in the area of the Paralic Coal Belt of northern Europe and the Appalachians in North America show more limited faunal compositions. Oddly enough, the Bashkirian/Moscovian ammonoids (Nassichuk, 1975) and brachiopods (Martínez Chacón & Bahamonde, *in press*; Winkler Prins, *in press*) show very close resemblances with those of Ellesmere Island in Arctic Canada.

The North European area has relied to a large extent on a succession of eustatic transgressions for long-distance correlation (with individual faunas marking the transgressions) as well as on terrestrial floral zonation. Eustatic transgressions are difficult to recognise in the tectonically much more mobile setting of the Pennsylvanian sediments in the Cantabric-Asturian arcuate fold belt of NW Spain, but marine faunal zones and terrestrial floral zones can both be distinguished due to the abundant fossil remains found in this region.

In northern Palencia, the total unconformity between post-orogenic deposits of the Curavacas Conglomerate Formation and the various formations involved in thrust slices and high-level nappe structures underlying this conglomerate formation provides a ceiling to the ages of the underlying formations. This includes the Perapertú Formation, which is therefore earlier in age than the (late) Langsettian as determined for the lowermost deposits of the Curavacas Formation on the basis of floral assemblages. Turbiditic and deltaic deposits overlying the Cura-

vacas Formation range up into lower to mid-Westphalian D (= Asturian Substage). The formations below the Curavacas Formation, i.e. the Barcaliente/Peña, Perapertú and Carmen formations are highly significant for the international correlation between the East European Tethyan area and the West European region. This matter was addressed already by Wagner & Bowman (1983), but further precision in the determination of floral remains in Wagner & Álvarez-Vázquez (1995) (partly based on new material) and the finds of small goniatite faunas as reported here, provide additional information to the foraminiferal and conodont faunas mentioned in 1983.

International correlations involving different faunas from Russia/Ukraine and North America as published most recently, need to be referred to, albeit briefly. Groves (1988: fig. 3) correlated the Late Bashkirian and Early Moscovian with the late Atokan on fusulinacean faunas, but later (Groves *et al.*, 1999) considered the top Bashkirian to correlate with the lower Atokan. Nemyrovskaya & Alekseev (1995: 116), discussing conodont and foraminiferal evidence, stated that the upper boundary of the Bashkirian did not seem to be very clear. Indeed, these authors correlated the highest Bashkirian (Asatausky) in the Urals with the Vereisky of the Moscow Syncline on conodont evidence, thus lowering the base of the Moscovian in the Donets Basin to the base of limestone I₂. Vachard & Maslo (1996: 367-369), stated that at least limestones K₁ and K₂ should be included in the Moscovian, but that the Asatausky (uppermost Bashkirian) would seem to correspond to the Vereisky (lowermost Moscovian), as Nemyrovskaya & Alekseev (1995) had suggested, thus placing the boundary at the base of Limestone I₂ of the Donbass. Since the basal part of the Vereisky in the Moscow Syncline is non-marine (Einor, 1996), and thus without foraminiferal faunas, the actual base of the Moscovian may be situated even lower in the Upper Bashkirian. These non-marine deposits were used to explain the apparently anomalous mixed Bashkirian-Moscovian foraminiferal fauna which was described by Granados *et al.* (1985) from the Central Asturian Coalfield in NW Spain (compare Villa *et al.*, 2001: 82). A megafloreal analysis by Fissunenکو & Laveine (1984) suggested that the base of the Moscovian would most likely correspond to the Westphalian A/B (= Langsettian/Duckmantian) boundary, and the ranges of floral elements in the Donbass (chart published by Fissunenکو in "The Carboniferous of the World" vol. III – Einor, 1996: fig. 28) seem to support this assertion. Fissunenکو & Laveine (1984: 98, table 3) placed the Westphalian B/C (= Duckmantian/Bolsovian) boundary higher in the Donbass succession, viz. somewhere between limestones K₃ and K₇, most likely at the base of limestone K₇, when taking also the palynological evidence into account. The correlation of the Bashkirian/Moscovian boundary according to Vachard & Maslo (1996) and Fissunenکو & Laveine (1984) does not tie in exactly with our data. More exhaustive information

on the Donbass would be useful, with particular regard to the plant megafossils which are in need of a modern revision. It is noted that in recent papers, Nemyrovskaya (1999: 49) and Alekseev *et al.* (2004: fig. 1) revert to a now obsolete correlation of the Bashkirian/Moscovian boundary with that between Duckmantian and Bolsovian, as suggested by Stepanov *et al.* (1962). They placed it, respectively, at the base of Limestone K₃ and of Limestone K₂. Finally, it is observed that Izart *et al.* (1996: 192, table 1) placed the Bashkirian/Moscovian boundary as determined in the Donets Basin, in the upper Duckmantian Substage using foraminiferal and palynological evidence. However, they position the boundary at the base of their Unit SM1, i.e. between limestones K₁ and I₄. All these different opinions leave considerable latitude for discussion. Part of the problem, of course, seems to lie with the likelihood that an overlap exists between the Upper Bashkirian and the Lower Moscovian in their respective stratotypes.

EARLY PENNSYLVANIAN AMMONOID FAUNAS AS RECORDED IN THE CANTABRIAN MOUNTAINS

(J. Kullmann)

Lower Pennsylvanian deposits are widespread in the Cantabric-Asturian arcuate fold belt and some outcrops have yielded ammonoids. In most cases they are poorly preserved, without visible suture lines. The fragmentary state of the shells usually precludes a conclusive determination.

Ammonoid faunas with *Proshumardites* Rauser-Chernousova, 1928, *Phillipsocheras* Ruzhentsev & Bogoslovskaya, 1975 (= *Reticuloceras* Bisat, 1924) and *Ramosites* Ruzhentsev & Bogoslovskaya, 1969 indicate undoubtedly an earliest Bashkirian age (Kullmann, 1973, 1979). These occur in shaly beds overlying the Barcaliente Limestone Formation, at Santa Olaja de la Varga (León province), and at the Porma Reservoir near Boñar (León). Similar small faunas have been described from a higher level, also in the province of León, by Wagner-Gentis (*in* Moore *et al.*, 1971). She originally recorded *Retites* McCaleb, 1964, an identification which was changed later to *Branneroceras* Plummer & Scott, 1937 (Wagner-Gentis *in* Wagner & Bowman, 1983: 141). These were obtained from strata of Marsdenian age as determined by palynology (Neves *in* Moore *et al.*, 1971). *Branneroceras* was also recorded from overlying sediments of early Westphalian A (= Langsettian) age (Wagner-Gentis *in* Moore *et al.*, 1971). This age, based on palynology (*op. cit.*), was later confirmed by Horvath (*in* Villa *et al.*, 1988). The same strata also yielded Upper Bashkirian foraminifera (*op. cit.*). A direct correlation between early Langsettian and Late Bashkirian is therefore suggested. Schmidt (1955) fig-

ured and described a *Paralegoceras percostatum* Schmidt, 1955 from a succession of Langsettian coal-bearing strata at La Camocha, near Gijón, Asturias (Wagner & Álvarez-Vázquez, 1995). This species was later referred tentatively to *Axinolobus* by McCaleb (1968). Comparison was made with the Atokan of North America and with Westphalian faunal elements in Algeria.

A goniatite find in mudstones overlying the Valdeteja Limestone Formation was mentioned but not figured, as *Proshumardites morrowanus* Gordon, 1964, from a locality North of Villafría on the southern flank of the Sierra del Brezo (Palencia) (C.H.T. Gentis in Wagner & Winkler Prins, 2000: 388). This unfigured specimen seems to have been lost. Additional remains from this locality, lodged in the collections of the Geology Department at Oviedo University, are heavily crushed shells which might belong to *Proshumardites* or *Deleshumardites?* sp. indet., suggesting either Late Bashkirian or Early Moscovian.

The small fauna from North of the Ruesga Fault, at c. 500 m North of San Martín de los Herreros, from beds low in the Perapertú Formation (loc. 9795 – see Figs 3 to 5), seems to be slightly older than the Piedrasluengas fauna higher in this formation, because it contains *Branneroceras* which starts in the Late Bashkirian and disappears in the Early Moscovian (N.B. these are probably partly equivalent ages.). Representatives of *Branneroceras* are regarded in North America as index fossils of the lower Bloyd of the Ozark Uplift (McCaleb, 1968). *Deleshumardites* and related forms are longer ranging; being known from Arnsbergian (Upper Serpukhovian, Mississippian Subsystem) until at least Langsettian (Pennsylvanian Subsystem) in Europe and Asia, and Atokan (Pennsylvanian) in North America. Both faunal elements, *Deleshumardites* and *Branneroceras*, were globally distributed in early Pennsylvanian times and document the close connection of marine habitats during Late Bashkirian/Early Moscovian (Langsettian) and Bloydian (late Morrowan) times.

CONCLUSIONS

(J. Kullmann, R.H. Wagner & C.F. Winkler Prins)

A newly discovered ammonoid fauna at 14 m above the base of the Perapertú Formation in the Palentian facies and structural domain in northern Palencia shows that the Upper Bashkirian may be involved in the lowermost part of this formation. Most of the Perapertú Formation corresponds to Lower Moscovian Vereisky Horizon however (which overlaps with the highest Bashkirian of Bashkiria, South Urals). This correlates with lowermost Langsettian and/or upper Yeadonian of the West-European chronostratigraphic classification, on the evidence presented. The base of the Moscovian Stage would thus seem to coincide approximately with the base of the Westphalian regional Stage, or even a little below, reaching into highest Namurian.

SYSTEMATIC DESCRIPTION OF AMMONOIDS (Figs 6-8)

(J. Kullmann)

Locality at c. 500 m North of San Martín de los Herreros (Palencia)

The ammonoids in this locality (Nº 9795) low in the Perapertú Formation (Fig. 5) are, on the whole, poorly preserved. They were imbedded in shales with fine-grained siliciclastic material and occur as crushed shells which only rarely display the suture lines. Precise measurement of the shell dimensions is impossible, and the ornamentation is difficult to observe. Nevertheless, the preservation allows an indication of age and facies conditions, and this permits a comparison with the stratigraphic age of the locality below the Piedrasluengas Limestone higher in the Perapertú Formation, further North in the same province of Palencia.

The specimens are deposited in the “Nationaal Natuurhistorisch Museum” (National Museum of Natural History) in Leiden (The Netherlands). The prefix RGM refers to the former “Rijksmuseum van Geologie en Mineralogie”. Conventional abbreviations are: D = diameter, Wh = whorl height, Ww = whorl width, U = umbilicus.

Tolibia de Abajo (León province); Genicera (= Alba) Limestone Formation

One new species is described primarily from this locality in northern León, at Tolibia de Abajo, with a different age (Late Mississippian). Specimens are lodged in the Geology Departments of the universities at Tübingen and Münster, Germany.

Order GONIATITIDA Hyatt, 1884
Superfamily **Goniatitoidea** Hyatt, 1884

Family **Delepinoceratidae** Ruzhentsev, 1957

A close relationship exists between the delepinoceratids with a tendency towards trifurcate ventral and adventitious lobes (i.e. subfamily Delepinoceratinae Ruzhentsev, 1957), and the dombaritids with only the adventitious lobe being trifurcate (subfamily Dombaritinae subfam. nov.). Representatives of both subfamilies occur jointly in Late Viséan and Early Serpukhovian faunas. The Dombaritinae are traditionally regarded as the source group of the Agathiceratoidea Arthaber, 1911, which are clearly distinguished by the threefold subdivided adventitious lobe with three long and independent parts. The Agathiceratoidea show in addition the tendency to develop a retrochoanitic siphuncle, whereas the Goniatitoidea display usually rather short septal necks.

Subfamily **Dombaritinae** Kullmann, subfam.

nov.

Diagnosis: Delepinoceratidae with a tendency towards trifurcation of the adventitious lobe only.

Constituent genera: *Dombarites* Librovitch, 1957; *Proshumardites* Rauser-Chernousova, 1928; *Deleshumardites* Kullmann, gen. nov.

Range: Mississippian (Late Viséan-Serpukhovian, Chesterian), Pennsylvanian (Bashkirian, ?Moscovian, Morrowan-Atokan) in Europe, Asia, North Africa, North America.

Deleshumardites Kullmann, gen. nov.

Type-species: *Proshumardites delepinei* Schindewolf, 1939: 429.

1937 *Proshumardites* Rauser-Chernousova; Delépine & Menchikoff, 78.

1939 *Proshumardites* Rauser; Schindewolf, 429.

pars 1962 *Proshumardites* (*Proshumardites*) Rauser-Chernousova; Kullmann, 68.

pars 1971 *Pericleites* Renz; Ruzhentsev & Bogoslovskaya, 236.

pars 1971 *Proshumardites* Rauser-Chernousova; Ruzhentsev & Bogoslovskaya, 240.

Derivatio nominis: Named in honour of Monseigneur Gaston Delépine, who described and figured the group under consideration for the first time (Delépine & Menchikoff, 1937: 78, i.e. *Proshumardites Karpinskyi*, text-fig. 4, pl. 5, figs 2-3).

Additional species: *Deleshumardites cantabricus* sp. nov., *Proshumardites aequalis* Nassichuk, 1975, *Pr. morrowanus* Gordon, 1964, *Pr. primus* Plummer & Scott, 1937, and *Shumardites Keideli* Leuchs, 1919.

Diagnosis: Dombaritinae with thick discoidal conch and narrow umbilicus. No triangular inner whorls. Ornamentation consists of fine growth lines and usually also prominent lirae. Ventral lobe relatively wide, median saddle at least half the height. Ventrolateral saddle acute, subacute or narrowly rounded. Adventitious lobe very wide, subdivided into three small lobes, the middle lobe being longer and acute, the outer ones smaller and acute or narrowly rounded. **Sutural formula:** ($E_1E_mE_1$) ($A_vA_mA_d$): UI or (V_1V_1) $L_2L_1L_2$: ID.

Comparisons: The new genus is distinguished from *Proshumardites* by the wide adventitious lobe and its three comparatively wide and long subdivided parts; especially the lateral parts are considerably larger in *Deleshumardites* gen. nov. *Agathiceras* Gemmellaro, 1887 displays three equally long parts of the adventitious lobe and possesses usually a retrochoanitic siphuncle. The tridentate adventitious lobe of *Proshumardites* (see *P. karpinskii*, Rauser-Chernousova, 1928 (Fig. 6b, 8a), *P. principalis* Ruzhentsev & Bogoslovskaya, 1971 (Fig. 6a), *P. uralicus* Librovitch, 1941 [= ?*Pericleites pilatus* Ruan, 1981; = *P. woeklumerioides* Kullmann, 1962] (Fig. 6c) shows a rather long and

acute middle part; the lateral parts are small and short, with acute, hook-like tips.

Occurrence: Arnsbergian (Upper Serpukhovian, Mississippian)-Langsettian, ?Bolsovia (Upper Bashkirian, Moscovian), Bloydian (upper Morrow)-Atokan (Pennsylvanian). Algeria, Canada (Arctic Archipelago), Iran, Japan, Kazakhstan (South Urals, Tian Shan), Russian Federation (South Urals, Novaya Zemlya), Tajikistan, Uzbekistan, USA (Arkansas, Nevada, Oklahoma, Texas).

Deleshumardites cantabricus Kullmann, sp. nov.

Figs 7b, c, 8b-f

1958 *Proshumardites* aff. *delepinei* Schindewolf; Schindewolf & Kullmann, 51.

1962 *Proshumardites* (*Proshumardites*) *delepinei* Schindewolf; Kullmann, 70, text-fig. 11 b-c, pl. 5, figs 1-5.

Holotype: GPIT Tübingen, No. Ce1206/258 (Figs 7c, 8c-d).

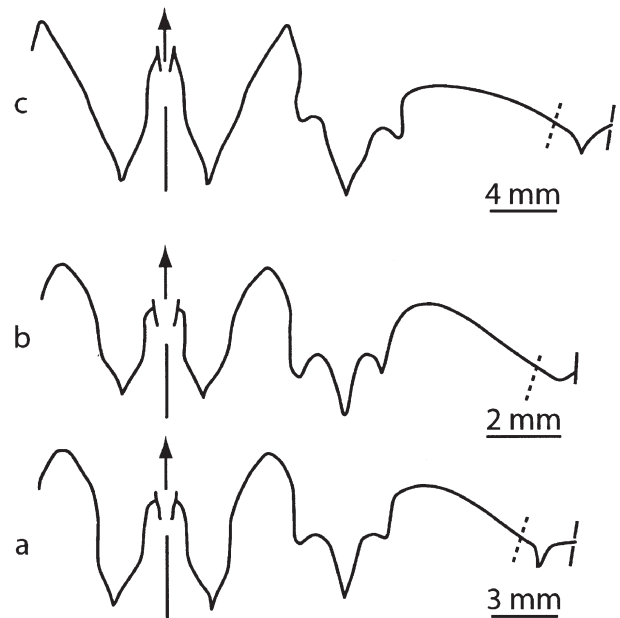


Figure 6. Suture lines of *Proshumardites* Rauser-Chernousova, 1928 (J.K.) **a:** *Proshumardites principalis* Ruzhentsev & Bogoslovskaya, 1971, PIN 455/28196, paratype, South Urals, Bashkortostan, upper *Eumorphoceras* Zone, E_2 , Arnsbergian, Mississippian (from Ruzhentsev & Bogoslovskaya, 1971, text-fig. 53b), x 3. **b:** *Proshumardites karpinskii* Rauser-Chernousova, 1928, PIN 455/28786, South Urals, Bashkortostan, lower Bashkirian, Pennsylvanian (after Ruzhentsev & Bogoslovskaya, 1978, text-fig. 12b), x 5. **c:** *Proshumardites uralicus* Librovich, 1941, PIN 455/228051, South Urals, Bashkortostan, upper *Eumorphoceras* Zone, E_2 , Arnsbergian, Mississippian (after Ruzhentsev & Bogoslovskaya, 1971, text-fig. 53b), x 2.

Locus typicus/Stratum typicum: Tolibia de Abajo, province of León, uppermost Genicera (= Alba) Formation, upper *Eumorphoceras* Zone (E_2), Arnsbergian (Upper Serpukhovian, Mississippian).

Material: Holotype and about 20 specimens of the GPIT Tübingen 1206/119, 187, 189, 257-58, 262-63, 266, 270, D = 13-56 mm, 3 specimens of the GPI Münster L4016, L4018-19, L4035, D = 9-19 mm, 1 specimen RGM 343010, D = 13 mm.

Diagnosis: *Deleshumardites* with strongly sinuous sides of the ventral and adventitious lobes, acute saddle in between. Median lobe exceeds slightly half the height of entire ventral lobe. No constrictions in adult stages. About 70-80 spiral lirae, stronger than growth lines.

Description: The outline of the bigger specimens is oval with a rather small umbilicus. The flanks are roundedly arched and pass continuously into the ventral side (Fig. 8c-f). The living chamber comprises about one whorl. There are four constrictions on parts corresponding to early stages. Growth lines can be observed only partly. The spiral ornamentation is slightly stronger than the growth lines. The tridentate adventitious lobe displays sinuously rounded sides. Its three portions are long, comparatively wide and acute.

The relationship of the new species to the type species is very close. The holotype of the latter which was described as *Proshumardites Karpinskyi* by Delépine & Menchikoff (1937: 78, text-fig. 4, pl. 5, figs 2, 3) seems to have less sinuous sides of the ventral lobe (see Fig. 7d, e). The Uralian form described by Ruzhentsev & Bogoslovskaya (1971, text-fig. 52b) as *Pericleites atticus* seems to be identical with regard to the reconstructed suture line of the type species (Fig. 7d, e). The specimen figured and described as *Proshumardites delepinei* by Ruzhentsev & Bogoslovskaya (1971, text-fig. 53g; see Fig. 7f) shows a highly elevated median saddle, a subacute ventrolateral saddle and less sinuous sides of the adventitious lobe; it is presently regarded as a new species (*Deleshumardites* sp. nov. Kullmann). *Deleshumardites morrowanus* (Gordon, 1964) of the Boyd in North America is also closely related. It can be distinguished from *Deleshumardites cantabricus* by the relatively wide and partly pouched prongs of its ventral lobe.

Occurrence: Tolibia de Abajo, province León, Playa de Carranques and Perlora (province Oviedo, Asturias), from

grey or yellowish marly limestones or marls of the uppermost layers of the Genicera (= Alba) Formation, upper *Eumorphoceras* Zone (E_2), Mississippian; Perapertú Formation (lower part), at c. 500 m North of San Martín de los Herreros (province Palencia), Upper Bashkirian (either Yeadonian or lowermost Langsettian).

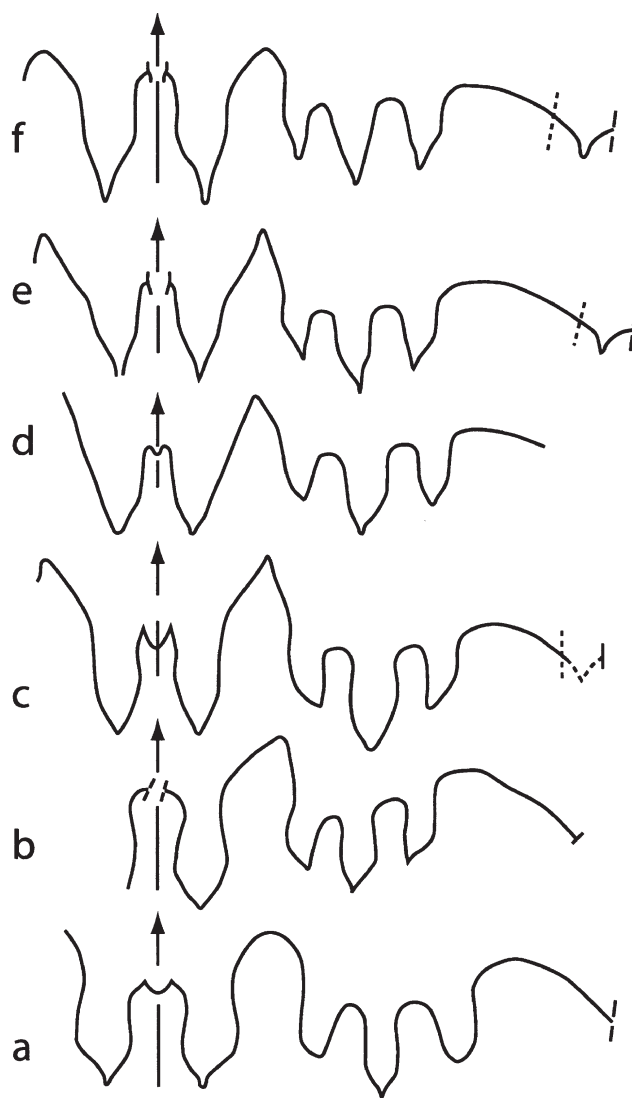


Figure 7. Suture lines of *Deleshumardites* Kullmann, gen. nov. (J.K.) **a:** *Deleshumardites morrowensis* (Gordon, 1964), hypotype, SUI 11675, Arkansas (USA), Boyd Formation, Greens Ferry Dam, 3 miles NE of Heber Springs, Arkansas, Bloydian, late Morrowan, Pennsylvanian (after McCaleb, 1968, text-fig. 5A), x 4.1. **b-c:** *Deleshumardites cantabricus* Kullmann, sp. nov.; **b**, RGM 343010, Cantabrian Mountains, NW Spain, loc. 9795: c. 500 m South of San Martín de los Herreros (Palencia), Yeadonian or lowermost Langsettian, Pennsylvanian, x 6.6; **c**, holotype, GPIT Ce 1206/258, Cantabrian Mountains, NW Spain, Tolibia de Abajo (León), uppermost layers of the Genicera Formation, upper *Eumorphoceras* Zone (E_2), Mississippian (after Kullmann, 1962, text-fig. 11c), x 3. **d-e:** *Deleshumardites delepinei* (Schindewolf, 1939); **d**, holotype (reconstructed in Schindewolf, 1939, text-fig. 2 after Delépine in Delépine & Menchikoff, 1937, pl. 5, figs 1-5), Hacı-Diab, Algerian-Moroccan border region, upper *Eumorphoceras* Zone, Arnsbergian, Mississippian, enlarged; **e**, PIN 455/28131, Verkhni-aia Kardailovka, horizon 4, upper *Eumorphoceras* Zone, Arnsbergian, Mississippian (after Ruzhentsev & Bogoslovskaya, 1971, described as "*Pericleites atticus*", text-fig. 52b), x 2.4. **f:** *Deleshumardites* sp. nov. Kullmann, PIN 455/28510, NE Krasno-Sakmarsk, South Urals, Orenburg County, upper *Eumorphoceras* Zone, Arnsbergian, Mississippian (after Ruzhentsev & Bogoslovskaya, 1971, described as "*Proshumardites delepinei*", text-fig. 53g), x 2.

Deleshumardites sp.

Material: Two fragmentary specimens, RGM 343011, D = c. 20 mm, and RGM 343012, D = c. 10 mm.

Description: The bigger specimen is a totally crushed shell that

shows part of the spiral ornamentation and only a very small part of the suture line. The tridentate adventitious lobe has a comparatively big ventral lobelet, which is typical for *Deleshumardites* gen. nov.

The smaller specimen also shows a portion of the tridentate lobe of *Deleshumardites* gen. nov.

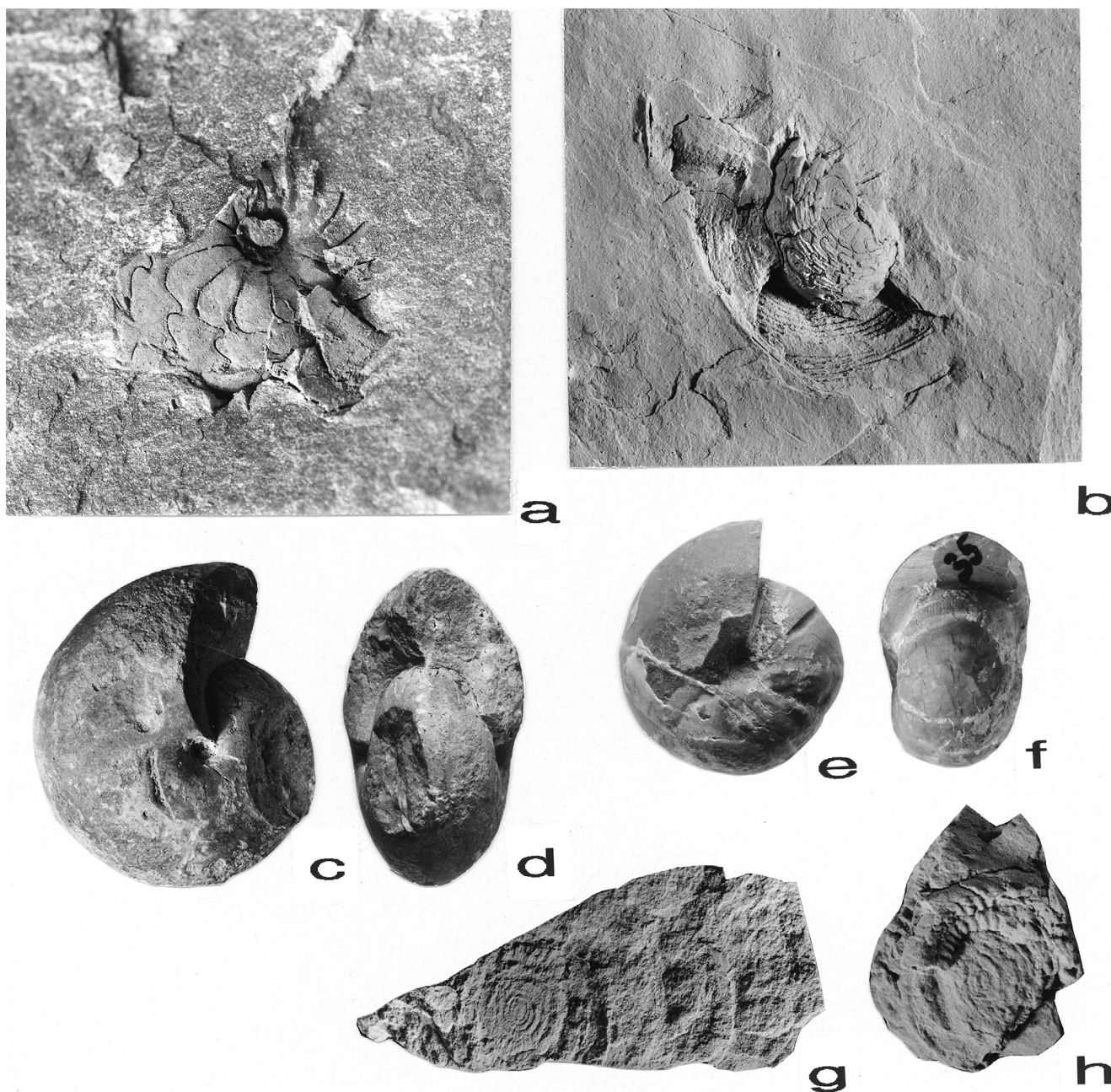


Figure 8. Photographic illustrations. (J.K.) **a:** *Proshumardites karpinskii* Rauser-Chernousova, 1928, GPIT 1432/1077, Asturreta, North of Eugui, Navarra, Spanish Pyrenees, Kinderscoutian, lower Bashkirian, Pennsylvanian (after Kullmann, 1973: pl. I, fig. 4), x 5. **b-f:** *Deleshumardites cantabricus* Kullmann, sp. nov.; **b**, RGM 343010, loc. 9795, c. 500 m South of San Martín de los Herreros (Palencia), uppermost Bashkirian (Yeadonian or lowermost Langsetian), Pennsylvanian, x 2; **c-d**, Holotype, GPIT Ce 1206258, Tolibia de Abajo (León), uppermost layers of the Genicera Formation, upper *Eumorphoceras* Zone (E_2), Mississippian; **c**, Side view; **d**, Front view, x 1; **e-f**, GPI Münster L 4035, Playa de Carranques, Perlora (Asturias), Genicera Formation, upper *Eumorphoceras* Zone (E_2), Mississippian; **e**, Side view; **f**, Front view, x 2. **g-h:** *Braneroceras*(?) sp.; **g**, RGM 343014; **h**, RGM 343013, external moulds, loc. 9795, c. 500 m South of San Martín de los Herreros (Palencia), uppermost Bashkirian (Yeadonian or lowermost Langsetian), Pennsylvanian, x 2.

Occurrence: Perapertú Formation at c. 500 m North of San Martín de los Herreros (Palencia), Upper Bashkirian (either Yeadonian or lowermost Langsettian).

Superfamily **Schistoceratoidea** Schmidt, 1929

Family **Schistoceratidae** Schmidt, 1929

Branneroceras Plummer & Scott, 1937

Branneroceras (?) sp.

Figs 8g-h

Material: Four fragments, RGM 343013-16, D = c. 11-15 mm.

Description: Four small fragments may be assigned with some reservation to the genus *Branneroceras*. Three small specimens display well developed riblets at the umbilical portion of the flanks, disappearing ventrolaterally. The umbilical width of the better preserved specimens seems to have been at D = 13.5 mm c. 8 mm and at D = 12 mm 6.5 mm. A larger, fourth specimen shows a reticulate ornamentation without ribs. None display suture lines, and the tentative assignment to *Branneroceras* is based mainly on the kind of riblets and ornamentation common among branneroceratids. The early whorls can be observed in specimen RGM 343014 (Fig. 8g) which displays a rounded or slightly polygonal outline of the innermost whorls, which characterises *Branneroceras*, and which differs from the triangular early whorls of *Diaboloceras*.

Occurrence: Perapertú Formation, at c. 500 m North of San Martín de los Herreros (Palencia), Upper Bashkirian (either Yeadonian or lowermost Langsettian).

ACKNOWLEDGEMENTS

Mr S.B. Blankevoort (Nationaal Natuurhistorisch Museum Naturalis) is thanked for drawing figures 1-5. The third author (CFWP) gratefully acknowledges the A. Buitendijk Foundation for contributing to his travelling costs to Spain in order to finish fieldwork with the second author (RHW). The authors are also grateful for useful comments by the Referees, Drs L. Sánchez de Posada and J.L. Alonso. The pertinent remarks by Dr Sánchez de Posada are particularly appreciated. Dr. E. Villa is thanked for expert advice on foraminiferal faunas, and Dr. C. Álvarez-Vázquez for aid with the physical production of this paper. Helpful suggestions by the Editor, Dr. R. Gozalo, are also gratefully acknowledged.

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Manuscrito recibido: 15 de Septiembre, 2006

Manuscrito aceptado: 25 de Junio, 2007