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Fusulines from the Central Asturian Coalfield (Pennsylvanian, Cantabrian Zone, Spain) and their significance for biostratigraphic correlation

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ABSTRACT

The Central Asturian Coalfield of the Cantabrian Zone (NW Spain) exposes a Moscovian (Middle Pennsylvanian) succession, up to 5000-m thick, which records stratigraphically significant terrestrial and marine fossils such as fossil flora and fusulines. The present paper focuses on the fusuline-bearing limestones of this succession, which cover a time span ranging from latest Bashkirian to early Myachkovian. 36 fusuline species are described and illustrated, among them the new species *Schubertella luisorum* Villa. This study reveals that the composition of the Kashirian to early Myachkovian fusuline assemblages is similar to that of the *Beedeina*-dominated assemblages of the Donets Basin, which were interpreted by Khodjanyazova *et al.* (2014) as occurring during early high-stands. In parallel with this, the absence of species representing the *Fusulinella*-dominated assemblages of the later authors is observed, while their *Hemifusulina*-dominated assemblages are replaced in the Central Asturian Coalfield by monospecific associations of *Hemifusulina*. Biostratigraphic data inferred from these microfaunas allowed us to assign an age to several informal stratigraphic intervals known as 'mining stratal packages' and to propose a tentative correlation with some relevant horizons of the Donets Basin: 1) The Levinco package seems to correlate with the K interval

RESUMEN

La Cuenca Carbonífera Central de Asturias (NW de España) contiene una potente sucesión del Moscoviense (Pensilvánico medio) (5000 metros de espesor) en la que alternan capas con fósiles marinos, como las fusulinas, y capas con flora continental. Este trabajo se ocupa del estudio de las fusulinas que aparecen en las distintas calizas de la sucesión, cuya edad abarca desde el Bashkiriense final hasta el Myachkoviense inferior. Se describen 36 especies de fusulinas y entre ellas *Schubertella luisorum* Villa sp. nov. Las composición de las asociaciones es similar al tipo denominado '*Beedeina*-dominated assemblage' que Khodjanyazova *et al.* (2014) describieron en la Cuenca del Donets, interpretado por estos autores como propio de los momentos iniciales de *high-stand*. Por el contrario, en la Cuenca Asturiana las asociaciones comparables al tipo denominado '*Fusulinella*-dominated assemblage' están ausentes, mientras que las descritas como '*Hemifusulina*-dominated assemblage' han sido reemplazadas por asociaciones monoespecíficas de *Hemifusulina*. Los datos bioestratigráficos proporcionados por estas microfaunas nos han permitido asignar edades a los 'paquetes mineros', unidades estratigráficas informales de uso extendido entre mineros y geólogos, y proponer una correlación de los mismos con horizontes relevantes de la Cuenca del Donets:

and the lower part of the L interval; 2) the Tendeyon package fusulines are best compared with those of the upper L and lowermost M intervals; 3) the Caleras package is probably equivalent to the lower part of the M suite; and 4) the Entrerregueras Limestone (Entrerregueras package) could be roughly equivalent to or slightly older than the N1 limestone.

Keywords: Fusulines, Central Asturian Coalfield, Cantabrian Zone, Pennsylvanian correlation.

1) el paquete Levinco podría equivaler a la suite K y quizá llegar a la parte inferior de la L; 2) las fusulinas del paquete Tendeyón son comparables a las de la parte superior de la suite L upper y la más baja de la M; 3) el paquete Caleras probablemente equivale a la parte inferior de la suite M; 4) la caliza Entrerregueras del paquete del mismo nombre podría ser aproximadamente equivalente o ligeramente más antigua que la caliza N1.

Palabras clave: Fusulinas, Cuenca Central Asturiana, Zona Cantábrica, correlación del Pensilvánico.

1. INTRODUCTION

Continental, paralic and marine Pennsylvanian successions may be found across Europe. Generally speaking, continental and paralic basins yielding abundant fossil flora are mainly represented in large areas of Central and Western Europe, whereas shallow marine rocks, containing diverse assemblages of marine invertebrates, occur extensively in the Russian Platform. Traditionally, fossil megaflora has been used to establish the stratigraphy of the continental and paralic Pennsylvanian successions (except for a few marine horizons providing ammonoids and conodonts) and fusuline foraminifera are the most relevant markers that make it possible to separate stratigraphic units in the marine basin of the Russian Platform. As a result, two different stratigraphic scales were built (one referrred to western Europe and the other to Eastern Europe), the correlation of which has challenged the Carboniferous stratigraphers for decades. Clues to solve this stratigraphic problem must be obtained from Carboniferous areas exposing an alternation of carbonate beds that yield abundant marine fossils, particularly fusulines, and siliciclastic beds consisting of continent-derived sediments embedding micro- and macroflora remains.

Such a type of Carboniferous succession exists in the Donets Basin and in the Cantabrian Zone, in which the marine and terrestrial fossils have been studied for a long time (for the Donets, see Aisenverg *et al.*, 1979; Fissunenko & Laveine, 1984; Izart *et al*., 1996, 1998; Ueno & Nemyrovska, 2008; Khodjanyazova & Davydov, 2013; Khodjanyazova *et al*., 2014; and for the Cantabrian Zone, see van Ginkel, 1965, 1971, 1973, 1987; van Ginkel & Villa, 1996; Villa, 1995; Villa *et al*., 2015; Villa & Merino-Tomé, 2016; Wagner & Winkler Prins, 1985a, 1985b; Wagner *et al*., 2002; Wagner & Álvarez-Vázquez, 2010). However, the correlation of the marine and terrestrial biostratigraphic units from both areas is a problematic issue. Discrepancies are particularly important with respect to the correlation of the Bashkrian and Moscovian marine stages (now recognized as global units) with the regional units of the Western Europe scale (e.g. Wagner & Winker Prins, 1994, 1997, 2016). The main problem refers to the correlation of the base of the Moscovian stage, since in the Donets Basin the fusulines around this boundary seem to be coetaneous with Westpahlian C (= Bolsovian) flora whereas, in the Cantabrian Zone, similar fusulines occur in beds intercalated with Westphalian A (= Langsettian) flora. The study of the fusulines described below has been undertaken with the aim to contibute to solve this stratigraphic problem yielding data referred to the marine scale.

2. THE PENNSYLVANIAN SUCCESSION OF THE CENTRAL ASTURIAN COALFIELD

The Cantabrian Zone (NW of Spain) (Fig. 1) corresponds to the foreland thrust and fold belt of the Variscan Orogen in the NW Iberian Peninsula (Lotze, 1945), in which a very thick Carboniferous sedimentary pile accumulated in a broad marine foreland basin developed during the Variscan Orogeny (Julivert, 1978; Marcos & Pulgar, 1982; Águeda *et al*., 1991; Bahamonde *et al*., 2015). Upper Bashkirian to uppermost Moscovian successions showing an alternation of flora- and fusuline-rich strata occur in the Somiedo and Bodón-Ponga units (Alonso *et al*., 2009), e.g. in the Santo Firme and La Camocha areas of the former and Teverga, Quirós, San Emiliano, Central Asturian Coalfied and Ponga áreas of the latter. The Moscovian strata of the Central Asturian Coalfield succession are particularly relevant as they reach up to 5000 m in total thickness and record both terrestrial (mega- and microflora) and marine fossils (among them, brachiopods and the stratigraphically significant fusulines and conodonts). Therefore, the Moscovian strata of the Central Asturian Coalfield have a great potential for the correlation of the chronostratigraphic units of western and eastern Europe (Sánchez de Posada *et al*., 2002; Villa & Merino-Tomé, 2016; Merino-Tomé *et al*., 2017).

Pioneer studies of the stratigraphy of the Carboniferous of the Cantabrian Zone (Barrois, 1882) subdivided the

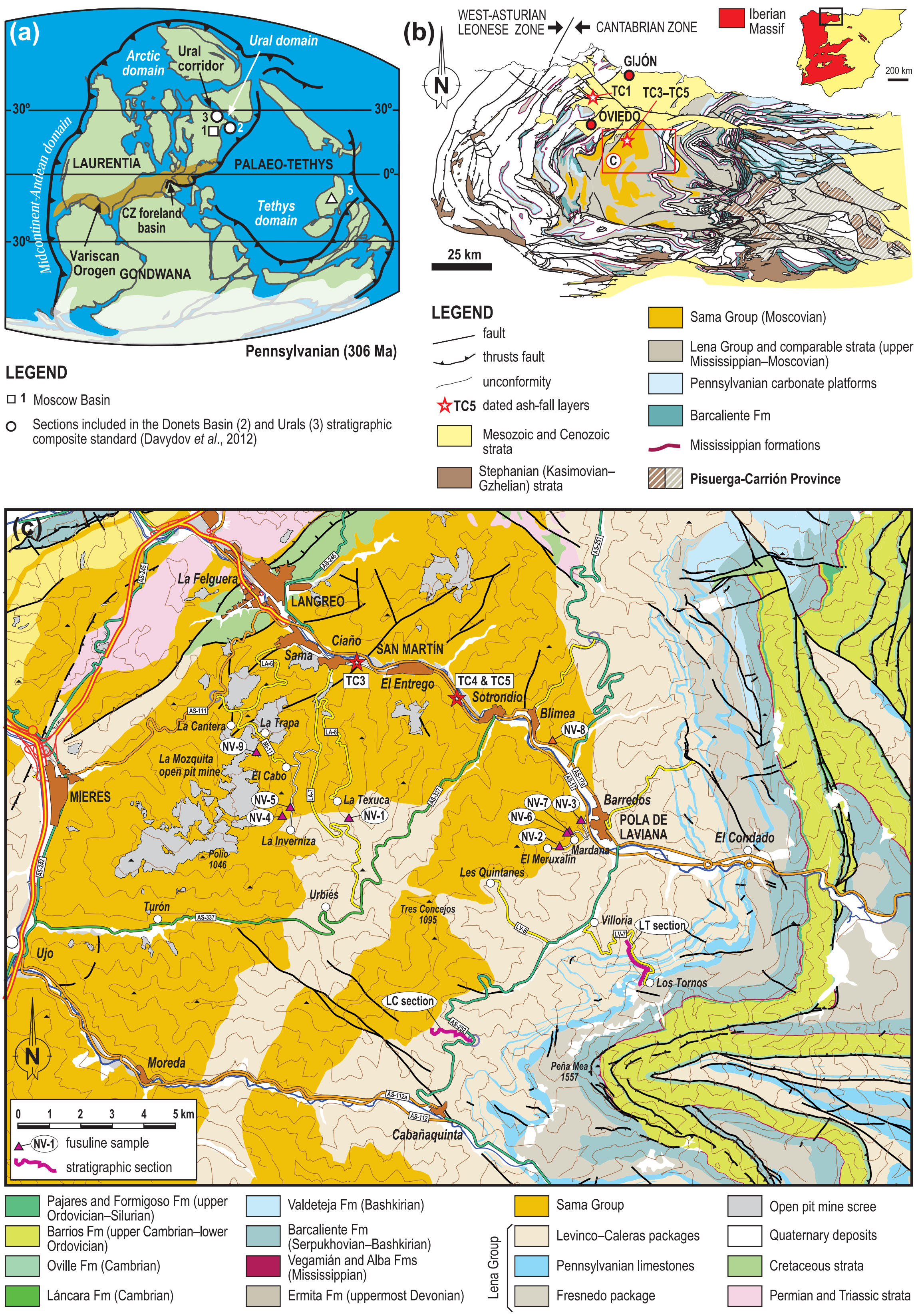

Figure 1. a) Palaeogeography of Pangea during Pennsylvanian time with the location of the Variscan orogen and the foreland basin of the CZ (Scotese, 2001, modified; Golonka, 2002). Palaeobiogeographic domains after Lin *et al*. (1991). **b)** Schematic geological map of the CZ showing the location of the Pennsylvanian ash-fall samples dated by Merino-Tomé *et al.* (2017) and the area enlarged below. **c)** Synthethic geological map of the northern part of the Central Asturian Coalfield showing the location of the stratigraphic sections and samples referred to in the text.

thick stratigraphic succession of the Central Asturian Coalfield (excluding the Mississippian Vegamián and Alba formations) into three informal stratigraphic units designated, from base to top, Calcaire des Cañons, Assise de Lena and Assisse de Sama, the last two generally referred to as the Lena and Sama Groups after de Sitter (1949). García Loygorri *et al.* (1971) subdivided these groups into a number of informal stratigraphic units called "paquetes mineros" (= mining stratal packages) (Fig. 2), usually hundreds of meters thick, which were subsequently fully-adopted by geologists (e.g. Truyols, 1983; Leyva *et al.,* 1985; Luque *et al*., 1985; Wagner & Álvarez-Vázquez, 1991, 2010; Sáenz de Santa María *et al*., 1985; Salvador, 1993; Barba & Colmenero, 1994; Colmenero *et al*., 2002; Fernández *et al*., 2004). Despite their informal character, these units maintain their usefulness for regional studies. However, although the package names derive from traditional coal-mining terminology and from Bless (1967, 1968), it must be noted that their present vertical extension is different, since the boundaries proposed by Bless were modified by García Loygorri *et al.* (1971).

The Central Asturian Coalfield succession overlying the Barcaliente Formation consists of 500-700 m-thick siliciclastic strata deposited in clay-dominated slopes and prodeltaic wedges (Fresnedo package). This package is followed by a 160 m-thick carbonate unit (Peña Redonda Limestone) and shallow-water to alluvial siliciclastic strata (generally arranged in 10's to 100's m-thick cyclothems) that contain coal seams as well as limestones deposited during marine transgressions (Levinco to Oscura packages). Limestone intercalations are more abundant and thicker in the Levinco, Tendeyón and Caleras packages (the latter forming the top of the Lena Group), becoming thinner and very scarce from the Generalas stratal package (base of the Sama Group) upwards. By contrast, coal seams occur more commonly in this upper part of the succession. Thick fan-deltaic deposits (Mieres and Olloniego formations), laterally equivalent to the Sama Group packages, occur in the western part of the basin. Therefore, in general terms, the Central Asturian Coalfield displays a shallowing and coarsening upward trend (Salvador, 1993; Barba & Colmenero, 1994; Colmenero *et al*., 2002; Fernández *et al*., 2004).

3. THE FUSULINES FROM THE CENTRAL ASTURIAN COALFIELD

The existence in the Central Asturian Coalfield of fusuline-bearing beds was already detected by Barrois (1882), who was already aware of their stratigraphic value. In spite of this interest, a comprehensive study of the fusulines from the Central Asturian Coalfield has never been carried out. Some papers (Martínez Díaz, 1970a, 1970b) contain preliminary information and others have focused on sections exposing only parts of the potentially fusuline-productive succession (Leyva *et al*., 1985; Villa, 1995; Villa & Merino Tomé, 2016). Also relevant is the publication by van Ginkel (1973) who studied *Hemifusulina* species recovered from siliciclastic beds lying at different levels throughout the upper part of the Central Asturian Coalfield succession.

The study by van Ginkel (1973) was a unique research, for it was devoted to a stratigraphic interval (Sama Group) whose fusulines were hitherto unknown. Moreover, this paper is the only one so far published that is devoted to Cantabrian Zone fusulines yielded by non-carbonate strata. Van Ginkel showed the stratigraphic location of his samples on the stratal packages subdivision proposed by Bless (1967, 1968), whereas, in the present paper, the position of van Ginkel's samples is represented on the scheme by García-Loygorri *et al*. (1971, fig. 2). Van Ginkel (1973) concluded an age for the whole interval ranging from the late Kashirian/early Podolian to the late Podolian/Myachkovian. However, as this author himself pointed out, *Hemifusulina* species appear to be largely facies controlled, and, therefore, in the absence of other fusuline genera, ages inferred are merely tentative or approximate.

A relevant contribution to the knowledge of the Central Asturian Coalfield fusulines and age was given by Leyva *et al.* (1985), who studied the Lena Group at the Los Tornos and La Collaona sections (Figs 3-4). A number of fusuline productive beds were found by these authors, allowing them to establish that the stratigraphic interval from the base of the Levinco to the top of the Tendeyón stratal packages ranges in age from the Bashkirian/Moscovian transition to the Podolian. Particular attention was given to the Peña Redonda Limestone (base of the Levinco stratal package), in which the Bashkirian/Moscovian transition contains a fusuline assemblage unknown in the Moscow Basin stratotype.

The Bashkirian/Moscovian transition was also the main focus of interest in Villa & Merino-Tomé (2016), a paper analyzing the fusulines from the Los Tornos section and other Cantabrian Zone areas. It provided the first detailed description and illustration of the fusulines yielded by the Levinco stratal package, excluding its uppermost part. This interval was considered to have an age ranging from the Bashkirian/Moscovian transition in the Peña Redonda Limestone to the Vereian (lowermost Moscovian) in the middle part of the Levinco stratal package.

3.1. Age and correlation of the fusuline-bearing strata of the Central Asturian Coalfield

This paper presents more recent studies, which were focused on fusuline-bearing limestones younger than those studied by Villa & Merino-Tomé (2016). These

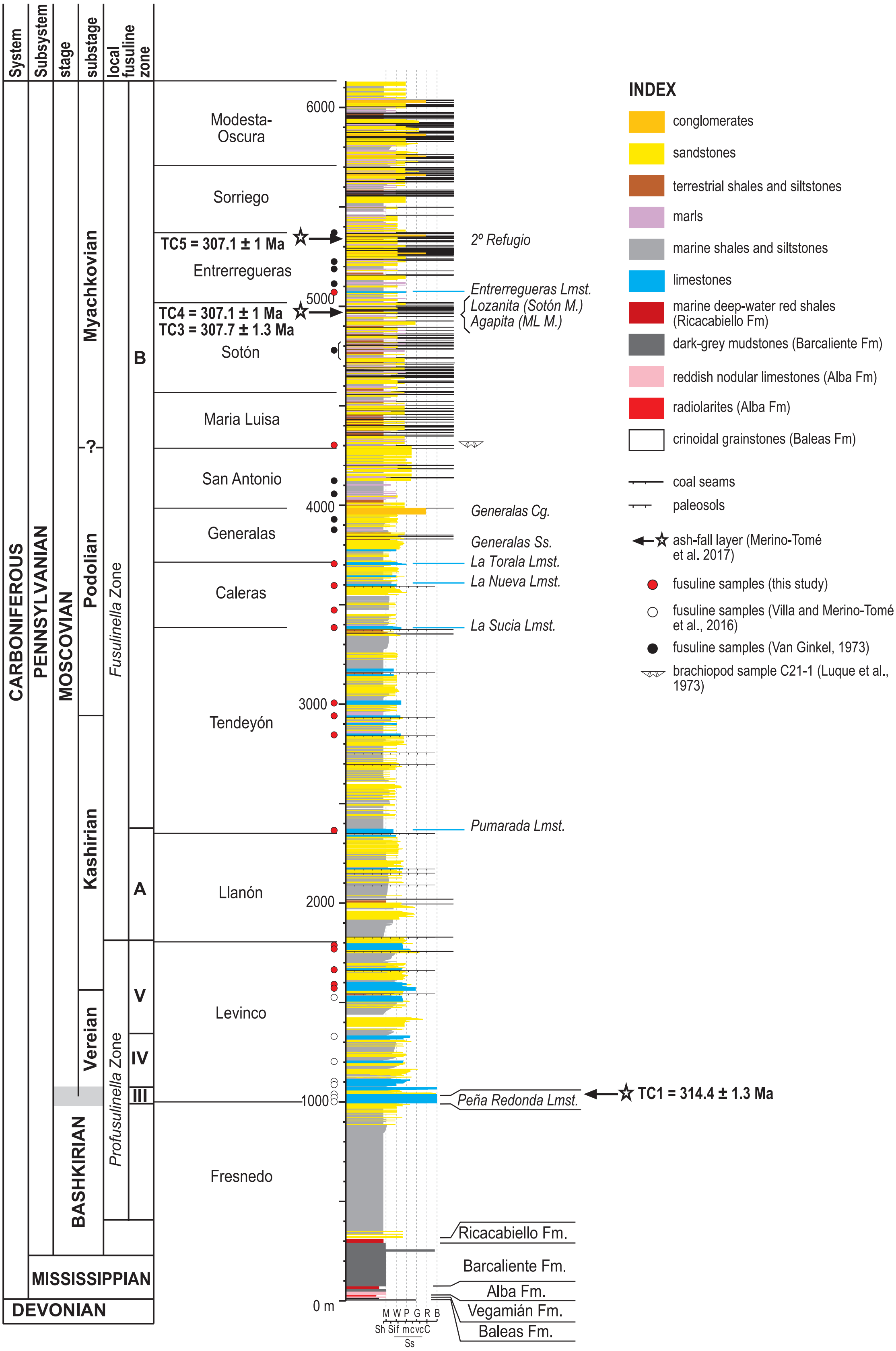

Figure 2. Synthetic stratigraphic section of the Central Asturian Coalfield established after data from Barba (1991), Salvador (1989, 1993) and Hunosa Mining Company. The location of fusuline samples (van Ginkel, 1973; Villa & Merino-Tomé, 2016; this study), a brachiopod sample (Luque *et al.*, 1985), and tonstein beds (Merino-Tomé *et al.*, 2017) is indicated. Fusuline zones are based on van Ginkel (1965, 1973) and Villa & Merino-Tomé (2016).

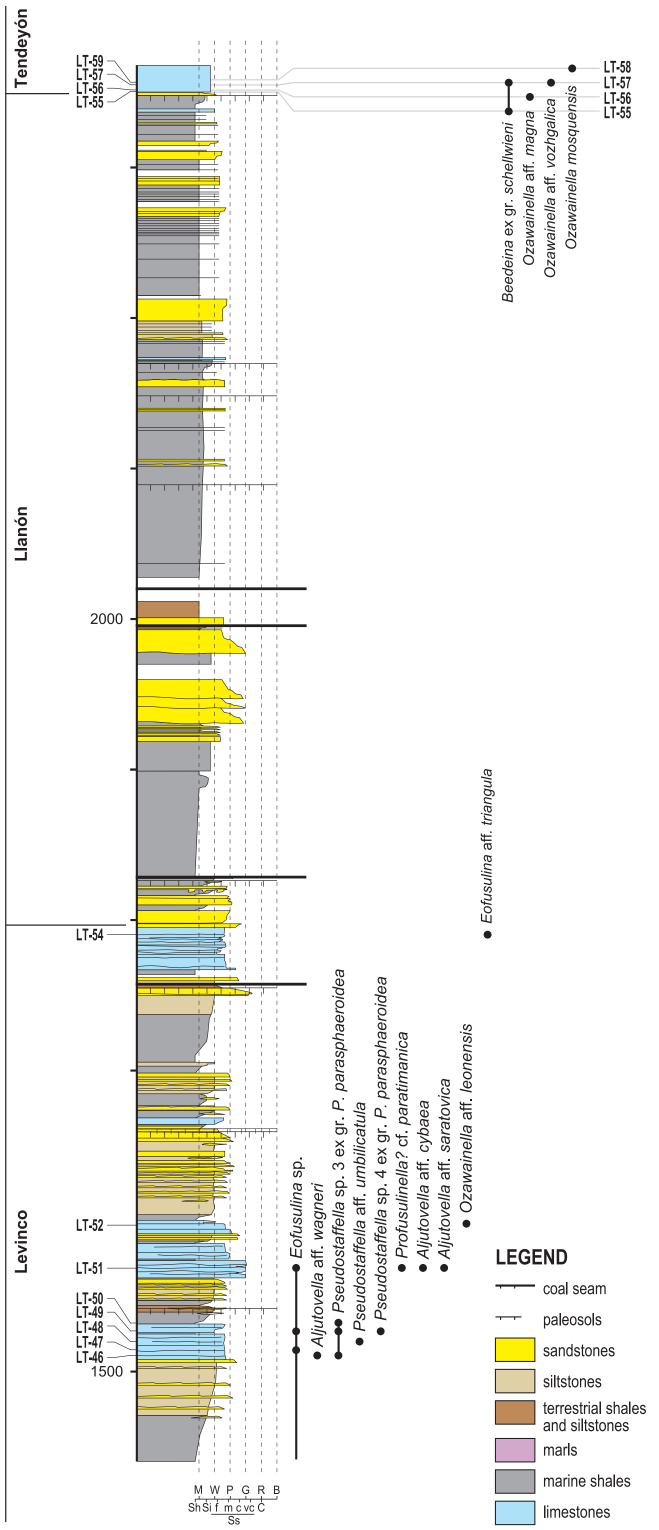

Figure 3. Distribution of fusuline species in the Los Tornos section. Stratigraphic data based on Salvador (1989) and Leyva *et al.* (1985).

microfossils were recovered from three sections: a) the Los Tornos section (upper part of the Levinco stratal package and base of the Tendeyón); b) the La Collaona section (Tendeyón stratal package); and c) the Nalón Valley área (Caleras, Generalas, María Luisa, and Entrerregueras stratal packages).

The correlation of the Central Asturian Coalfield by means of fusulines is hampered by the fact that most of the sedimentary record of this coalfield consists of siliciclastics, limestone beds being rather scarce (except for the Levinco and Caleras stratal packages). This characteristic, coupled with the great thickness of the Moscovian succession (more than 5000 m), makes the location of chronostratigraphic boundaries uncertain.

Facies differences among areas also hamper correlation as they have an influence on the composition of the fusuline assemblages. In the Central Asturian Coalfield, *Beedeina, Ozawainella, Taitzehoella, Putrella*, and *Pseudostaffella* species are the most common elements of the fusuline assemblages, and, in this respect, the Kashirian and Podolian assemblages seem to be comparable to the *Beedeina*-dominated assemblages of the Donets Basin, interpreted by Khodjanyazova *et al.* (2014) as occurring during early high-stands. On the other hand, there is notable absence in the Central Asturian Coalfield of species representing the *Fusulinella*-dominated assemblages of the Donets Basin, which according to Khodjanyazova *et al.* (2014) characterize the late high-stands and play an important role in the correlation of the Moscovian strata. The absence of *Fusulinella* species, which are very abundant in the carbonate platform strata of other areas of the Cantabrian Zone (e.g., Ponga area), could be a consequence of a more near-shore position of the Central Asturian Coalfield compared to the Donets Basin, for this position resulted in late highstand deposits consisting of siliciclastic sediments. The near-shore location could also be the reason why the *Hemifusulina*-dominated assemblages of Khodjanyazova *et al.* (2014) do not appear in the Central Asturian Coalfield, where they are replaced by monospecific *Hemifusulina* associations (van Ginkel, 1973) occurring in coastal shales.

Next paragraphs summarize the fusuline species occurring in these stratigraphic intervals. Authors of these species are indicated in the chapter devoted to taxonomy.

3.1.1. Levinco Stratal Package (Bashkirian/ Moscovian transition to Kashirian)

For a detailed description of the fusulines from the lower and middle part of this package (Fig. 3), readers are referred to Villa & Merino-Tomé (2016), a paper illustrating that a mixture of fusuline fauna with Bashkirian or Moscovian features occurs at the Peña Redonda Limestone, the base

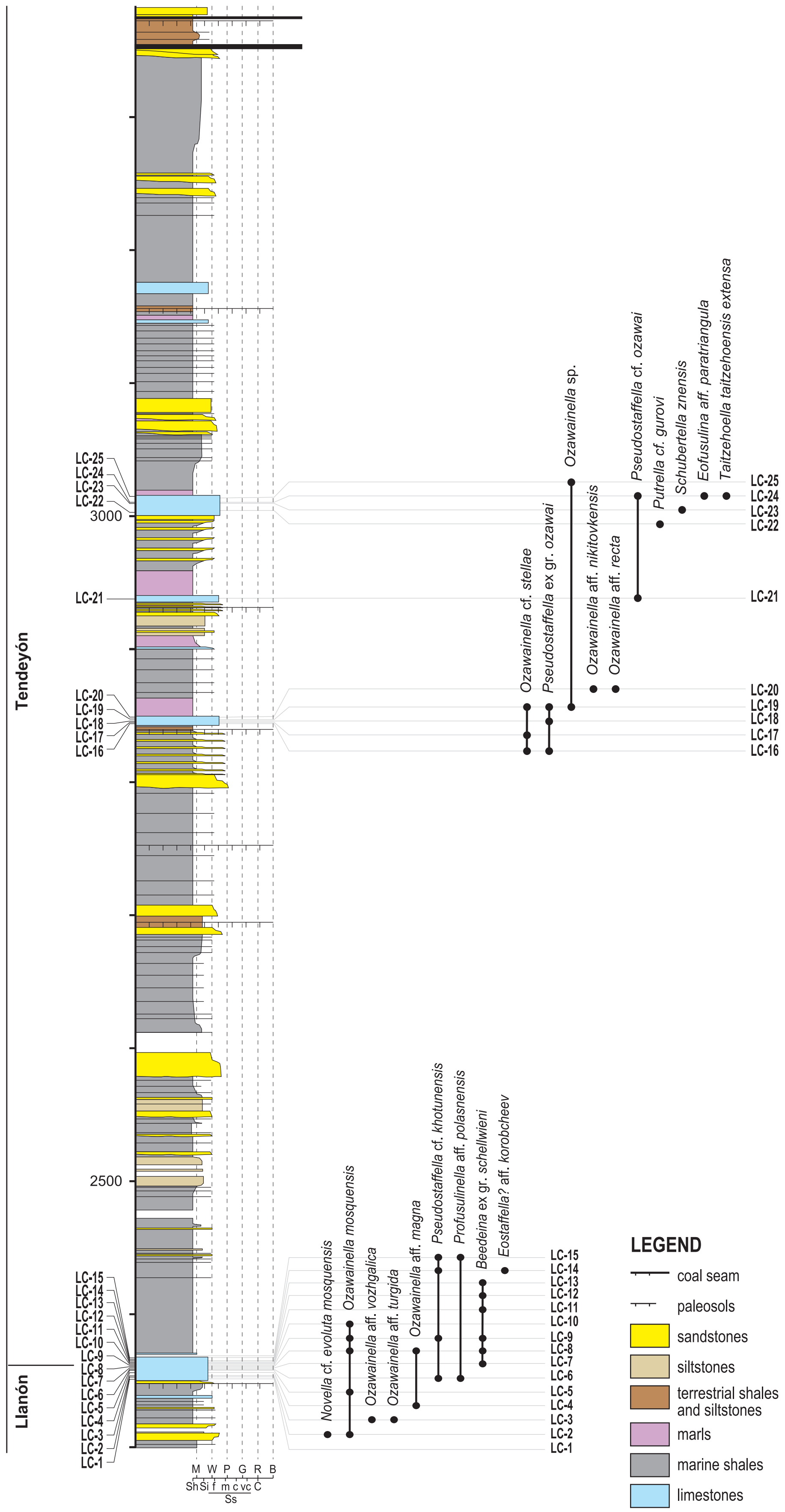

Figure 4. Distribution of fusuline species in the La Collaona section. Stratigraphic data based on Barba (1991) and Leyva *et al.* (1985).

of the Levinco strata. In this respect, one of the most striking aspects is the presence of Bashkirian microfauna (abundant archaediscids and fusulines such as *Aljutovella* cf. *porrecta*), occurring along with large *Aljutovella* with intensive plication of septa (*Aljutovella asturiensis*, *Aljutovella* aff. *postaljutovica*, etc.) resembling typical Moscovian forms. The upper part of the Levinco stratal package yielded a species (*Eofusulina* aff. *triangula*; this paper) of early Moscovian age. However, according to the species recovered by Leyva *et al.* (1983) (*Profusulinella paratimanica*, *Aljutovella* aff. *saratovica*, *Neostaffella larionovae*, etc.) from these same beds, the age of the upper part of the Levinco stratal package can be more precisely specified as Kashirian.

Compared to the fusuline data from the Donets Basin (Aisenverg *et al*., 1979; Ueno *in* Fohrer *et al*., 2007; Davydov, 2009), the Levinco package seems to correlate with the K interval and perhaps the lower part of the L interval.

3.1.2. Tendeyón Stratal Package (upper Kashirian to lower Podolian)

This package has been studied in the Los Tornos and La Collaona sections (Figs 3-4). Its base consists of limestone strata referred to as the Pumarada Limestone. In the Los Tornos section, *Novella* cf. *evoluta mosquensis* occurs at the very base of this limestone, suggesting an age not younger than Kashirian for this level. As a whole, the Pumarada Limestone assemblages are dominated by three genera, *Ozawainella, Beedeina* and *Pseudostaffella*; of special note is the abundance throughout this limestone of specimens belonging to the *Beedeina schellwieni* species group, typical for the upper Kashirian/lower Podolian. Other relevant elements are *Pseudostaffella* cf. *khotunensis* and *Profusulinella* aff. *polasnensis* (samples LC-6 and LC-15), species very close to forms described from the upper Kashirian/lowermost Podolian of the Russian Platform (Rauzer-Chernousova *et al.*, 1951).

Higher up in the La Collaona section (samples LC-16 to LC-19), *Ozawainella* cf. *stellae* occurs, a species indicating an earliest Podolian age. The same age is also suggested by the presence of *Putrella* cf. *gurovi* in LC-22. Finally, the youngest limestone intercalation of the Tendeyón package yielded *Pseudostaffella* cf. *ozawai*, *Taitzehoella taitzehoensis extensa* and *Eofusulina* aff. *paratriangula* (LC-24), an assemblage considered also to be of early Podolian age.

Eofusulina aff. *paratriangula* is a species very close to the form originally described from the L6 limestone of the Donets Basin (Putrya, 1939), whereas *Ozawainella* cf. *stellae* is probably conspecific with the *O. stellae* individuals described by Ueno (in Fohrer *et al*., 2007) from the M1 limestone. In general, the Tendeyón package fusulines are best compared with those of the upper L and lowermost M intervals of the Donets Basin.

3.1.3. Caleras Stratal Package (Podolian)

Five distinct fusuline-bearing limestones are intercalated in this package (Figs 2 and 5). *Pseudostaffella umbilicata*, *Beedeina truyolsi*, and *Putrella* aff. *persica*, among others, are significant forms. *Beedeina truyolsi* has never been recorded in beds younger than the lower Podolian; *Putrella persica*, was described from the lower part of the upper Moscovian (Leven *et al*., 2006) [from their figure 2, however, some doubt arises with regard to a possible upper Kashrian location of the samples]; and *Pseudostaffella umbilicata* occurs in the M5 limestone from the Donets Basin (Khodjanyazova *et al*., 2014). From this set of data, a Podolian age, though not the latest, is clearly inferred, probably equivalent to the lower part of the M suite of the Donets Basin.

3.1.4. Maria Luisa Stratal Package (upper Podolian or lower Myachkovian)

The poor assemblage recovered from the La Escribana Limestone of the Maria Luisa package (Fig. 5) makes it difficult to assign an accurate age to this stratal interval. The generic identification of the two fusuline specimens recovered is doubtful, one being questionably assigned to *Dagmarella*? and the other to *Putrella*? Considering the age and fusulines of the underlying stratal packages, the maximum age of this interval cannot be older than Podolian (and probably not older than late Podolian). Therefore, a latest Podolian/earliest Myachkovian age is considered most probable. In this regard, it is important to point out that *Putrella*? sp. exhibits a size and number of volutions considerably larger for this genus, therefore suggesting a remarkably advanced evolutionary step. This poor assemblage hampers any comparison with Donets Basin fusulines.

In this connection, it must be pointed out that Myachkovian brachiopods have been recorded as occurring nearly 20 m above this stratigraphic level (Martínez-Chacón *in* Luque *et al.*, 1985).

3.1.5. Entrerregueras Stratal Package (lower Myachkovian)

The fusuline assemblage yielded by the only limestone so far detected in the Entrerregueras Stratal Package consists of *Pseudostaffell*a ex gr. *sphaeroidea*, *Taitzehoella* cf. *librovitchi*, *Fusulina cotarazoe*, and *Hemifusulina* ex gr. *bocki,* an association compatible with an early Myachkovian age (Fig. 5). *Hemifusulina* sp. is significant as is reminiscent of species of the *H. bocki* species group, which is restricted

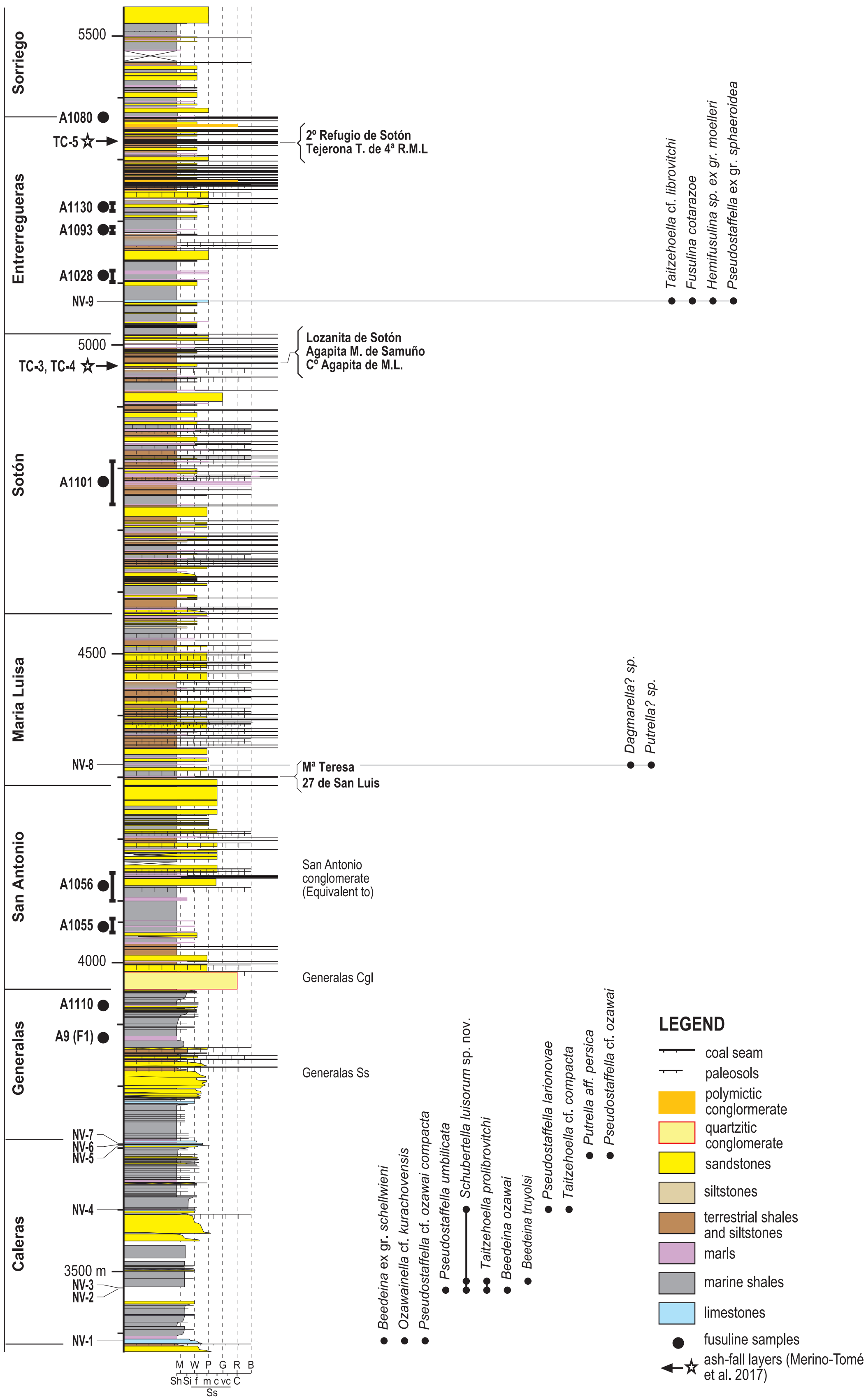

Figure 5. Distribution of fusuline species (van Ginkel, 1973, and this paper) in the Caleras to Entrerregueras stratal packages. Stratigraphic data according to Barba (1991) and Hunosa Mining Company. The location and age of tonstein samples TC-3, TC-4 and TC-5, dated by means of LA-ICP-MS U-Pb (Merino-Tomé *et al.*, 2017), is indicated.

to the Myachkovian. Some of the specimens of *Taitzehoella* cf. *librovitchi* show the large size and number of volutions that are typical of the Myachkovian subspecies *T. librovitchi perseverata* (Safonova *in* Rauzer-Chernousova *et al*., 1951). Also significant is *Fusulina cotarazoe,* which occurs abundantly in lower Myachkovian strata throughout the Cantabrian Zone. Compared to the Donets Basin, the Entrerregueras Limestone could be roughly equivalent to or slightly older than the N1 limestone, where Khodjanyazova & Davydov (2013) established the *Hemifusulina graciosa-Fusiella spatiosa* Zone.

3.1.6. Equivalence with the ages obtained by van Ginkel (1973)

The ages summarized above are slightly younger than those assigned by van Ginkel (1973) on the basis of the *Hemifusulina* species occurring in shales at different levels of the Central Asturian Coalfield succession.

Van Ginkel (1973) estimated a late Kashirian or early Podolian age for the Caleras and María Luisa stratal packages (sense of García Loygorri *et al*., 1971), which in this paper are assigned to the Podolian and to the late Podolian/early Myachkovian, respectively. As for the Entrerregueras stratal package, we assign it to the early Myachkovian, ruling out the possible late Podolian age suggested by van Ginkel.

4. SYSTEMATIC PALAEONTOLOGY

Family **Ozawainellidae** Thompson & Foster, 1937

Genus *Eostaffella* Rauzer-Chernousova, 1948

Type species *Staffella (Eostaffella) parastruvei* Rauzer-Chernousova, 1948

Eostaffella? aff. *korobcheevi* Rauzer-Chernousova *in* Rauzer-Chernousova *et al*.,1951
(Figs 6a-6b)

Measurements. L = 0.11-0.12 mm; D = 0.33-0.40 mm; L/D = 0.30-0.33; n = 3-4; wth = 5 µm.

Remarks. These two specimens resemble *E. korobcheevi* Rauzer-Chernousova *in* Rauzer-Chernousova *et al*., 1951, in size, angular median region of the test, number of volutions, and large proloculus. However, they exhibit deeper umbilici and a more compressed test, resulting in a smaller L/D ratio than that of the Rauzer-Chernousova material; moreover, evolute outer volutions (not mentioned in the original diagnosis of *E. korobcheevi*) cannot be excluded in our material.

It must be noted that *E. korobcheevi* belongs to the *E. acuta* and *E. mutabilis* group of Rauzer-Chernousova *et al*. (1951). Van Ginkel (2010) assigned this species group to *Paramillerella (Acutella)*; he stated that evolute coiling might occasionally occur in the final one to two volutions [Vachard *et al*. (2013) considered *Paramillerella (Acutella)* a pre-occupied name that must be replaced by their new genus *Pseudoacutella*]. In this respect, some of the specimens of *E. korobcheevi* from the Moscow Basin illustrated by Baranova *et al*. (2014) (e.g., pl. 1, figs 8, 10) are closer to the Cantabrian form than to that of the type material.

Stratigraphic data and age. Sample LC-14, La Collaona section; Pumarada Limestone of the Tendeyón Stratal Package, Lena Group. Moscovian (upper Kashirian).

Genus *Novella* Grozdilova & Lebedeva, 1950

Type species *Novella evoluta* Grozdilova & Lebedeva, 1950

Novella cf. *evoluta mosquensis* Rauzer-Chernousova *in* Rauzer-Chernousova *et al*., 1951
(Fig. 6c)

Measurements. L = 0.07 mm; D = 0.53 mm; L/D = 0.12; n = 7(?); d = 40-55 µm; wth = 5 µm.

Remarks. Test discoidal, evolute in all or almost all volutions. The axis of coiling is slightly curved. The spire expands rapidly in the last two volutions. The median region of the last whorls is bluntly angular, giving the chambers a linguiform shape in cross-section. Supplementary deposits (chomata?) occur at least in the last volutions. The wall is thin, dark-microgranular, undifferentiated. These characteristics closely match those of *N. evoluta mosquensis* Rauzer-Chernousova described from the Moscow Basin.

Stratigraphic data and age. Sample LC-2, La Collaona section; Pumarada Limestone of the Tendeyón Stratal Package, Lena Group. Moscovian (upper Kashirian).

Genus *Ozawainella* Thompson, 1935

Type species *Fusulinella angulata* Colani, 1924

Descriptive note. The wall of the *Ozawainella* species described below consists of at least two layers: tectum and primatheca. However, in the majority of the specimens it is difficult to document whether an outer tectorium exists since the ribbon-like chomata might mask that layer even in the tunnel region. In a few cases, it was posible to observe this region, the wall usually appearing to be formed by only two layers (more rarely by three).

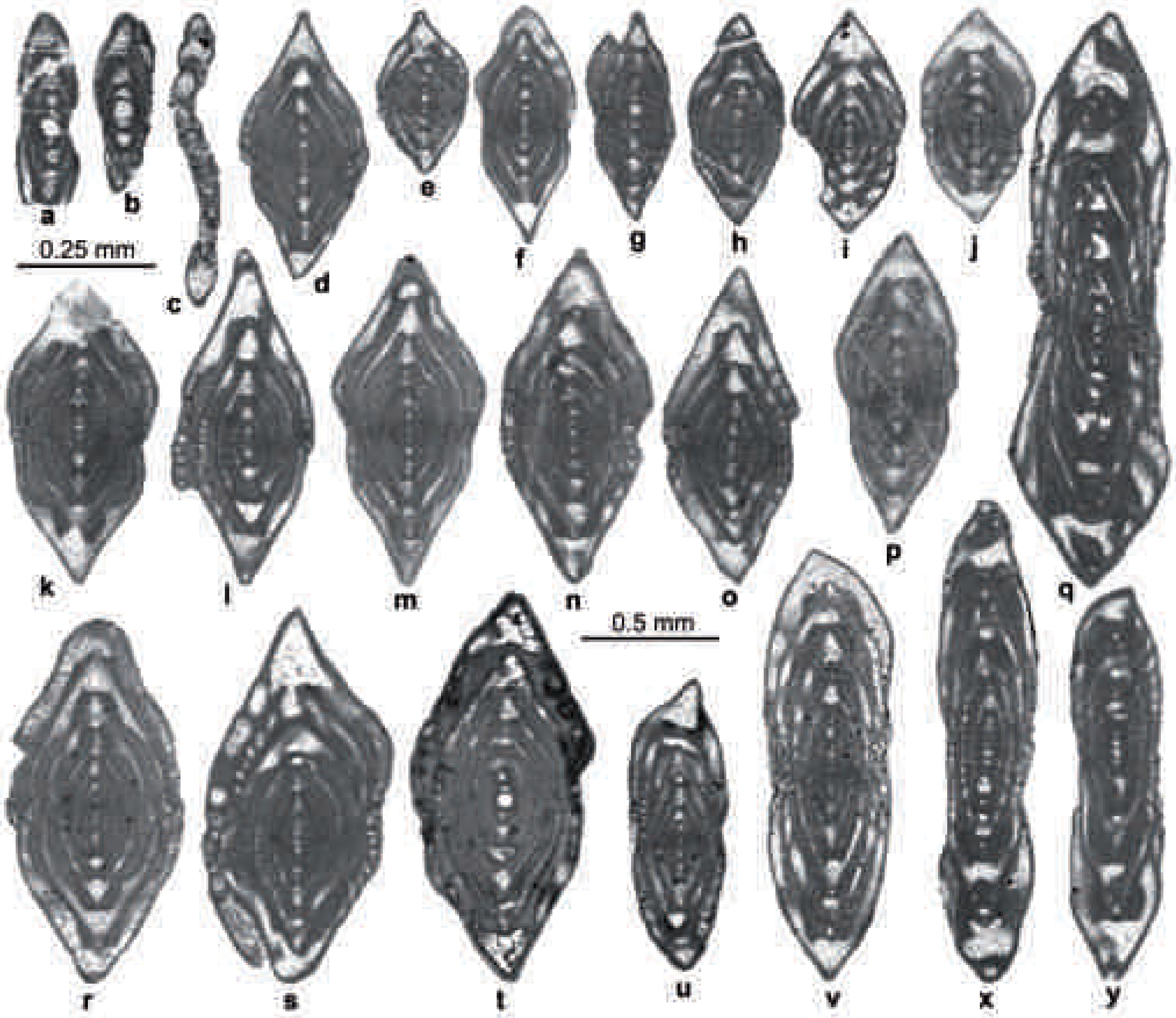

Figure 6. a-b) *Eostaffella*? aff. *korobcheevi* Rauzer-Chernousova *in* Rauzer-Chernousova *et al*., 1951. **(a)** LC14/1a; **(b)** LC14/1b. **c)** *Novella* cf. *evoluta mosquensis* Rauzer-Chernousova *in* Rauzer-Chernousova *et al.*, 1951, LC2/2. **d)** *Ozawainella* aff. *turgida* Sheng, 1958, LC3/1a. **e)** *Ozawainella* aff. *leonensis* van Ginkel, 1965, LT52/1. **f-h)** *Ozawainella* aff. *vozghalica* Safonova *in* Rauzer-Chernousova *et al*., 1951. **(f)** LC3/1b; **(g)** LT57/1; **(h)** LT57/2b. **i-j)** *Ozawainella* sp. **(i)** LC19/3; **(j)** LC25/2. **k-o)** *Ozawainella mosquensis* Rauzer-Chernousova *in* Rauzer-Chernousova *et al*., 1951. **(k)** LC9/2; **(l)** LC8/1b; **(m)** LC2/3; **(n)** LT59/5; **(o)** LC5/3. **p)** *Ozawainella* cf. *kurachovensis* Manukalova, 1950, NV1/2. **q**, **x-y)** *Ozawainella* cf. *stellae* Manukalova, 1950. **(q)** LC17/1; **(x)** LC19/2; **(y)** LC16/3. **r-t)** *Ozawainella* aff. *magna* Sheng, 1958. **(r)** LT56/2; **(s)** LC4/1; **(t)** LC8/3. **u)** *Ozawainella* aff. *nikitovkensis* (Brazhnikova, 1939), LC20/2. **v)** *Ozawainella* aff. *recta* Pogrebnyak, 1975, LC20/1.

Ozawainella aff. *leonensis* van Ginkel, 1965
(Fig. 6e)

Measurements. L = 0.34 mm; D = 0.59 mm; L/D = 0.58; n = 5.5; D_{IV} = 0.33 mm; d = 35 µm; wth = 12 µm.

Remarks. The most distinctive features of this single specimen are its rather broad test for an *Ozawainella* species, flat or slightly convex umbilici, and an acute keel in the last volution. Ribbon-like chomata reach approximately half the lumen height.

Of special note is the similarity of this specimen to one of the individuals of *O. leonensis* illustrated by van Ginkel, 1965 (pl. 15, fig. 55). However, the scarcity of the present material make it difficult to assign it with confidence to *O. leonenis*, species that has been described from older (upper Bashkirian) strata.

Stratigraphic data and age. Sample LT-52, Los Tornos section, Levinco Stratal Package, Lena Group. Moscovian (Kashirian).

Ozawainella aff. *vozhgalica* Safonova *in* Rauzer-Chernousova *et al*., 1951
(Figs 6f-6h)

Measurements. L = 0.36-0.38 mm; D = 0.78-0.87 mm; L/D = 0.44-0.44; n = 5-6; d = 30-60 µm; D_{IV} = 0.42-0.61 mm; wth = 25 µm.

Remarks. The species is reminiscent of several forms of the *O. mosquensis* species group (particularly *O. vozghalica* and *O. mosquensis*) in having concave-convex lateral sides (concavities are weakly developed), shallow umbilical depressions, and a keel in the outer volutions. However, *O.* aff. *vozhgalica* differs in having a smaller size.

Stratigraphic data and age. Sample LT-57, Los Tornos section, and sample LC-3, La Collaona section. The two samples are from the Pumarada Limestone of the Tendeyón Stratal Package, Lena Group. Moscovian (upper Kashirian).

Ozawainella aff. *turgida* Sheng, 1958
(Fig. 6d)

Measurements. L = 0.48 mm; D = 0.98 mm; L/D = 0.49; n = 5.5; D_{IV} = 0.38 mm; d = 30 µm.

Remarks. Test inflated lenticular, with slightly concave lateral sides, convex umbilical regions, and acute median region that forms a pronounced keel in the last volution. Chomata massive, ribbon-like, their height exceeding half the chamber height. In its outer shape, this specimen resembles the Chinese species *O. turgida* Sheng, from which it differs in having tighter inner volutions.

Stratigraphic data and age. Sample LC-3, La Collaona section; Pumarada Limestone of the Tendeyón Stratal Package, Lena Group. Moscovian (upper Kashirian).

Ozawainella mosquensis Rauzer-Chernousova *in* Rauzer-Chernousova *et al*., 1951
(Figs 6k-6o)

Measurements. L = 0.50-0.60 mm; D = 1.15-1.41 mm; L/D = 0.39-0.49; D_{IV} = 0.51-0.66 mm; d = 30-50µm; n = 5-6; wth = 15-40 µm.

Remarks. Our collection includes specimens showing a rhombic shell with slightly concave lateral sides (concavities are weakly developed), shallow umbilical depressions, and a moderate keel in the outermost volutions. Nevertheless, these characteristics are rather variable and, thus, it is possible to find specimens showing almost straight lateral sides (specimen LC5/1) and others having a relatively more pronounced keel (specimen LC8/1b). This variability, as well as the size of the shell, diameter of the 4th whorl, and type of chomata, closely match the characteristics of the original material described by Rauzer-Chernousova, 1951. Other very similar forms are *O. vozghalica* Safonova, *O. kumpani* Rauzer-Chernousova (both *in* Rauzer-Chernousova *et al.*, 1951), and *O. pseudoangulata* (Putrya, 1939). Apparently, *O. vozghalica* differs in exhibiting deeper umbilical depressions whereas *O. kumpani* and *O. pseudoangulata* have a less pronounced keel.

Stratigraphic data and age. Sample LT-59, from the Los Tornos section, and samples LC-2, LC-5, LC-8, LC-9, LC-10, from the La Collaona section. All samples collected from the Pumarada Limestone, base of the Tendeyón Stratal Package, Lena Group. Moscovian (upper Kashirian).

Ozawainella aff. *magna* Sheng, 1958
(Figs 6r-6t)

Measurements. L = 0.67-0.70 mm; D = 1.35-1.45 mm; L/D = 0.47-0.53; D_{IV} = 0.53-0.64 mm; d = 30-80 µm; n = 6.5-7; wth = 15-30 µm.

Remarks. The large size, nearly flat umbilici and moderately stretched keel of the present material conform quite well with the features of *O. magna* Sheng. However, *O.* aff. *magna* differs from the Chinese species in having a wider shell, which results in a larger L/D ratio (0.47-0.53) in the Central Asturian Coalfield specimens against 0.375 in the Sheng materials).

Stratigraphic data and age. Sample LT-56, from the Los Tornos section, and samples LC-4, LC-8, from the La Collaona section. All collected from the Pumarada Limestone, base of the Tendeyón Stratal Package, Lena Group. Moscovian (upper Kashirian).

Ozawainella cf. *stellae* Manukalova, 1950
(Figs 6q, 6x-6y)

Measurements. L = 0.34-0.58 mm; D = 1.45-2.06 mm; L/D = 0.21-0.28; n = 5.5-6; d = 50 µm (specimen LC17/1); D_{IV} = 0.76-0.86 mm.

Remarks. Species showing a very slender test and one of the largest sizes for the genus *Ozawainella*. It is very close to *O. stellae* Manukalova in having a strong lateral compression of the shell, an evolute or nearly evolute last volution, and very high chomata near the aperture rapidly thinning towards the polar region. One specimen (LC17/1) differs from the only specimen illustrated by Manukalova in having a larger size and more convex lateral sides in the upper part of the last volution. It also exhibits a less stretched median region, more rounded keel and deeper umbilici than the other two specimens and, in this respect, it somewhat resembles *O. praestellae* Rauzer-Chernousova (*in* Rauzer-Chernousova *et al.*, 1951). These differences are tentatively considered as being due to intraspecific variability of *O.* cf. *stellae*. However, larger collections of both the Donets and the Asturian materials are necessary to confirm this possibility.

The presence in these strata of a form very close or identical to *O. stellae* is stratigraphically significant, for this species is considered in the Russian Platform to be restricted to the lower Podolian (Rauzer-Chernousova *et al.*, 1951).

Stratigraphic data and age. Samples LC-16, LC-17, LC-19, La Collaona section, Tendeyón Stratal Package, Lena Group. Moscovian (lower Podolian).

Ozawainella sp.
(Figs 6i-6j)

Measurements. L = 0.41-0.42 mm; D = 0.78-0.81 mm; L/D = 0.51-0.54; n = 5.5; D_{IV} = 0.41 mm; d = 15 µm.

Remarks. Test small, lenticular, with shallow umbilical depressions and a moderately stretched and acute keel in the last volution. Chomata massive, ribbon-like, sometimes increasing sharply in height near the tunnel. These elevations are seen in section as distinct nodes (Fig. 6 i); in the penultimate volution, the height of the chomata reaches approximately half the chamber height.

The characteristics of this species do not fit any known *Ozawainella* form. It somewhat resembles two specimens from the Gissar Range (Central Asia) assigned to *O. paratingi* by Orlov-Labkovsky & Bensh (2015, pl. 34, figs 3-4). (Orlov-Labkovsky & Bensh assigned these specimens to *O. paratingi* Manukalova, 1950; however, they differ from our species in possesing a laterally compressed shell, which does not show the subrhomboidal outer whorls and the prominent polar ends of the type material of *O. paratingi*).

Stratigraphic data and age. Samples LC-19 and LC-25, La Collaona section; Tendeyón Stratal Package, Lena Group. Moscovian (Podolian).

Ozawainella aff. *nikitovkensis* (Brazhnikova, 1939)
(Fig. 6u)

Measurements. L = 0.37 mm; D = 1.08 mm; L/D = 0.34; n = 7; D_{IV} = 0.38 mm; d = 25 µm.

Remarks. Test with strong lateral compression. Median region acute from the third whorl onwards, sometimes showing a distinct keel. Shallow umbilical depressions. Chomata ribbon-like and of moderate height (usually less than half the chamber height). Wall consisting of three layers. Our specimen somewhat resembles *O. nikitovkensis* (Brazhnikova) (*fide* Rauzer-Chernousova *et al.*, 1951, pl. 10, fig. 9) although apparently its lateral sides are less prominent than in the specimen illustrated by Rauzer-Chernousova *et al.*, 1951. Moreover, *Ozawainella* aff. *nikitovkensis* has a three-layered wall, whereas Rauzer-Chernousova *et al.* (1951) mentioned a four-layered wall in the specimen from the Russian Platform.

Stratigraphic data and age. Sample LC-20, La Collaona section; Tendeyón Stratal Package, Lena Group. Moscovian (Podolian, probably lower part).

Ozawainella aff. *recta* Pogrebnyak, 1975
(Fig. 6v)

Measurements. L = 0.48 mm; D = 1.62 mm; L/D = 0.29; n = 6.5; d = 35 µm; D_{IV} = 0.84 mm.

Remarks. Test with strong lateral compression, very weak umbilical depressions (nearly flat and only manifested in the last two volutions), acute, but not stretched, median region in all volutions, and massive chomata, higher near the tunnel and thinning progressively towards the axial region. This species resembles *O. recta* Pogrebnyak in the shape and size of the shell and type of chomata, but differs in having a less stretched median region and slightly depressed umbilici. It also bears some resemblance to *O. stellae* Manukalova and *O. praestellae* Rauzer-Chernousova. From *O. stellae*, *O.* aff. *recta* can be easily distinguished by its wider and involute shell, whereas *O. praestellae* has more convex lateral sides and deeper umbilical depressions.

Stratigraphic data and age. Sample LC-20, La Collaona section; Tendeyón Stratal Package, Lena Group. Moscovian (Podolian, probably lower part).

Ozawainella cf. *kurachovensis* Manukalova, 1950
(Fig. 6p)

Measurements. L = 0.46 mm; D = 1.08 mm; L/D = 0.43; D_{IV} = 0.57 mm; d = 50 µm; n = 6; wth = 40 µm.

Remarks. Size and shape of the shell and proloculus and type of chomata closely match *Ozawainella kurachovensis* Manukalova, 1950, only differing from the holotype of this species in having slightly more pronounced umbilical depressions in the last volution.

Stratigraphic data and age. Sample NV-1, La Sucia Limestone, Caleras Stratal Package, Lena Group. Upper Moscovian (Podolian).

Genus *Pseudostaffella* Thompson, 1942

Type species *Pseudostaffella needhami* Thompson, 1942

Pseudostaffella cf. *khotunensis* Rauzer-Chernousova *in* Rauzer-Chernousova *et al.*, 1951
(Figs 7a-7b, 7g)

Measurements. L = 1.15-1.25 mm; D = 1.18-1.45 mm; L/D = 0.86-1.00; n = 6-7.5; D_{IV} = 0.62-0.65 mm; d = 60-80 µm; wth = 30-40 µm.

Remarks. With their rounded subquadratic test, ribbon-like chomata (whose height at the side reaches, and sometimes exceeds, half the chamber height, then decreasing towards the poles), and narrow aperture, these specimens resemble *P. khotunensis* Rauzer-Chernousova, 1951 (*in* Rauzer-Chernousova *et al*., 1951), *P. subquadrata* Grozdilova & Lebedeva, 1950, and *P. vozghalica* Safonova (*in* Rauzer-Chernousova *et al*., 1951). Most similar seems to be *P. khotunensis*, from which the Cantabrian form differs in having more volutions and a larger size (larger proloculus and larger diameter for corresponding whorls). Another similar form is *P. subquadrata* Grozdilova & Lebedeva, which has a subquadratic periphery and slightly convex median region (as in our specimen LC6/14), but may be distinguished by its smaller size, lesser number of volutions and higher chomata, which decrease very sharply close to the polar ends. The resemblance to *P. vozghalica* is more remote, since the latter has lower chomata and tighter coiling.

Stratigraphic data and age. Samples LC-6, LC-9, LC-14 and LC-15, La Collaona section; Pumarada Limestone of the Tendeyón Stratal Package, Lena Group. Lower Moscovian (upper Kashirian).

Pseudostaffella umbilicata (Putrya & Leontovich, 1948)
(Fig. 7h)

Measurements (approximate). L = 1.33 mm; D = 1.60 mm; L/D = 0.82; D_{IV} = 0.53 mm; n = 8; wth = 30 µm.

Remarks. More distinctive features of this specimen are the slightly concave median region of the test, the laterally compressed polar regions, and the shallow umbilical depressions, as well as the massive chomata, which often reach more than half the chamber height. Regarding the size of the shell and number of volutions, the Central Asturian Coalfield specimen more closely matches the specimens of *Pseudostaffella umbilicata* illustrated in Rauzer-Chernousova *et al.* (1951) than those of the original material from Putrya & Leontovich (1948). Both our material and that of Rauzer-Chernousova *et al.* (1951) are also very similar to *Pseudostaffella larionovae* Rauzer-Chernousova (*in* Rauzer-Chernousova *et al.*, 1951), from which they are hardly distinguishable.

Stratigraphic data and age. Sample NV-2, Meruxalín Limestone of the Caleras Stratal Package. Upper Moscovian (Podolian).

Pseudostaffella larionovae Rauzer-Chernousova & Safonova *in* Rauzer-Chernousova *et al.*, 1951
(Figs 7c-7f, 7i-7l, 7r-7s)

Measurements. L = 0.95-1.23 mm; D = 0.97-1.57 mm; L/D = 0.81-1.00; d = 40-100 µm; D_{IV} = 0.40-0.62 mm; n = 5.5-7; wth = 10-40 µm.

Remarks. This *Pseudostaffella* population from the La Nueva Limestone is considered to belong to a single species whose outer shape varies from subsphaerical (e.g., specimens NV4/2a and NV4/1d) to subquadratic (NV4/4a) or nautiloid (NV4/1a) as a result of the different degree of flattening of the umbilical and median regions. Umbilical depressions are weakly developed in most of the specimens (NV4/4b, NV4/2h, NV4/3b) and almost non-existent in others (NV4/2a, NV4/2k). The first whorl is usually coiled at a large angle with respect to subsequent ones. Chomata are rather massive (and often assymetrical) in the intermediate whorls, where they usually reach half the chamber height and extend to the poles, and lower and frequently narrower in the first one and a half volutions and in the penultimate one. The wall consists of three layers: tectum, primatheca, and outer tectorium. The primatheca is frequently somewhat clearer than the outer tectorium, the latter having the same microstructure as the chomata. Very weak wall porosity is visible in some specimens.

This species resembles several forms belonging to the *Pseudostaffella parasphaeroidea* (Lee & Chen) group of Rauzer-Chernousova *et al.*, 1951. Most similar are *P. larionovae larionovae*, *P. larionovae polasnensis,* and *P. larionovae mosquensis* (the three introduced by Rauzer-Chernousova & Safonova *in* Rauzer-Chernousova *et al*., 1951) and *P. parasphaeroidea*. Unfortunately, the poor orientation of the two specimens of *P. parasphaeroidea* illustrated by Lee & Chen (*in* Lee *et al*., 1930) does not enable an adequate comparison to be made. As for the three forms described by Rauzer-Chernousova & Safonova, they are so similar that they are hardly distinguishable from one another. In fact, our material comprises specimens representing each of these subspecies, this being the reason why the Spanish material is assigned to the nominal species *P. larionovae.* The resemblance of the Cantabrian

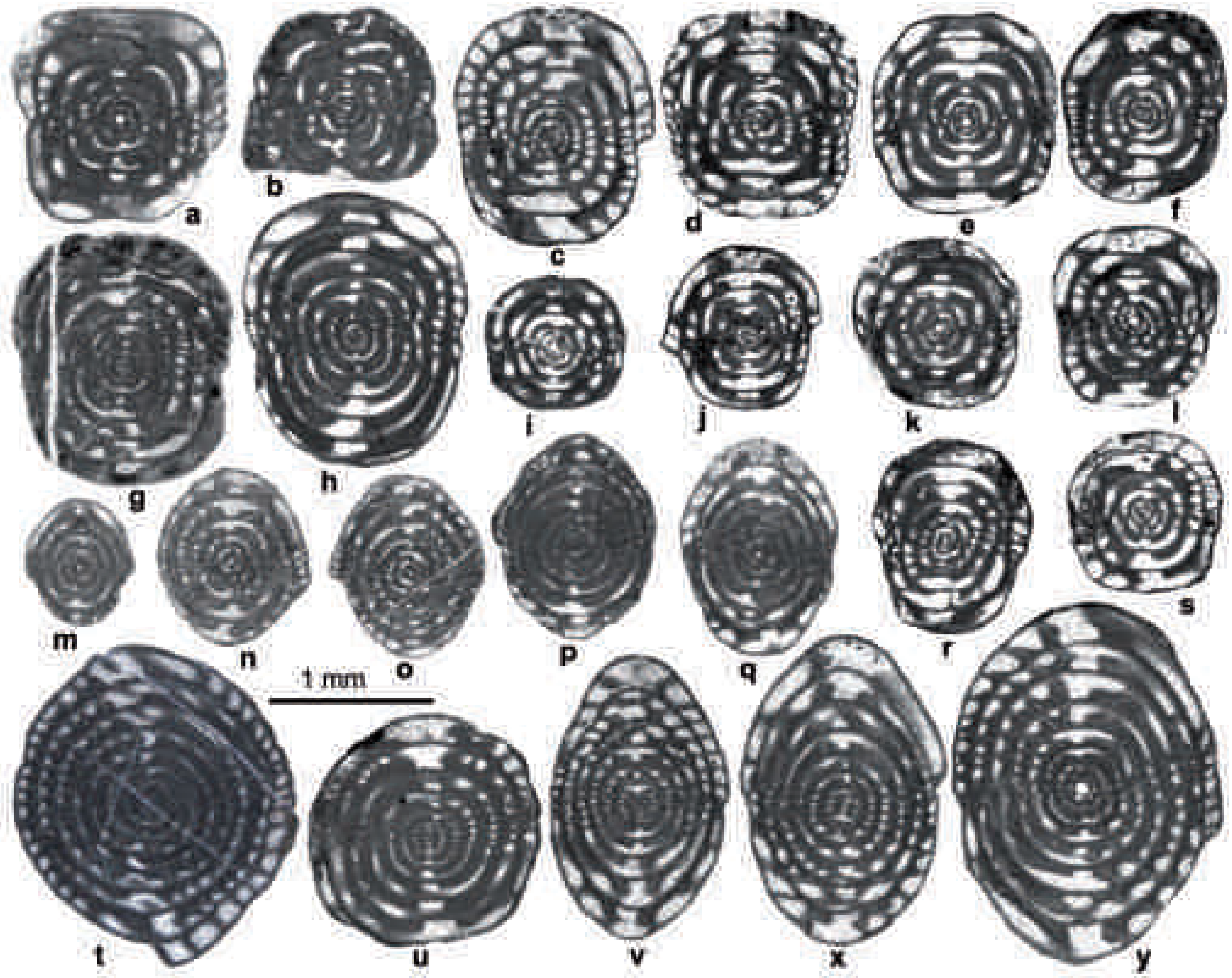

Figure 7. a-b, g) *Pseudostaffella* cf. *khotunensis* Rauzer-Chernousova *in* Rauzer-Chernousova *et al*., 1951. **(a)** LC6/14; **(b)** LC9/5; **(g)** LC9/4. **h)** *Pseudostaffella umbilicata* (Putrya & Leontovich, 1948), NV2/4. **c-f, i-l, r-s)** *Pseudostaffella larionovae* Rauzer-Chernousova & Safonova *in* Rauzer-Chernousova *et al*., 1951. **(c)** NV4/2g; **(d)** NV4/4a; **(e)** NV4/2a; **(f)** NV4/2b; **(i)** NV4/2d; **(j)** NV4/2f; **(k)** NV4/1d; **(l)** NV4/4b; **(r)** NV4/2j; **(s)** NV4/2e. **m-q)** *Pseudostaffella* ex gr. *ozawai* (Lee & Chen *in* Lee *et al*., 1930). **(m)** LC18/3; **(n)** LC19/4; **(o)** LC19/1; **(p)** LC16/4; **(q)** LC18/5. **t)** *Pseudostaffella* cf. *ozawai compacta* Manukalova, 1950, NV1/1. **u)** *Pseudostaffella* ex gr. *sphaeroidea* (Ehrenberg, 1842), NV9/6c. **v-y)** *Pseudostaffella* cf. *ozawai* (Lee & Chen *in* Lee *et al*., 1930). **(v)** LC21/1; **(x)** LC21/2; **(y)** NV5/4.

specimens to those from the L_5 limestone of the Donets Basin illustrated by Ueno (*in* Fhorer *et al.*, 2007) is also notewhorthy; however, the latter seem to exhibit a more differientiated (or perhaps better preserved) microstructure of the wall. Another similar species is *Pseudostaffella latispiralis* Kireeva (*in* Rauzer-Chernousova *et al.*, 1951), to which specimen NV4/3b bears a great resemblance.

Stratigraphic data and age. Sample NV-4, Nalón Valley, La Nueva Limestone, Caleras Stratal Package. Upper Moscovian (Podolian).

Pseudostaffella ex gr. *ozawai* (Lee & Chen *in* Lee *et al.*, 1930)
(Figs 7m-7q)

Measurements. L = 0.64-0.98 mm; D = 0.75-1.28 mm; L/D = 0.72-0.87; n = 5.5-7; d = 45-50 µm; D_{IV} = 0.46-0.70 mm; wth = 25-30 µm.

Remarks. The morphology of these specimens is very similar to *Pseudostaffella ozawai* (Lee & Chen *in* Lee *et al.*, 1930), although the lack of detailed measurements in the Chinese material impedes valid comparisons;

apparently, the L/D ratio is larger in the original material. Also similar is *Pseudostaffella* cf. *ozawai* described below, but the latter differs in having larger shell size, larger proloculus, and larger diameter of the 4th whorl (D_{IV} = 0.46-0.70 mm, against 0.59-0.73 mm in *P.* cf. *ozawai*), as well as a greater number of volutions.

Stratigraphic data and age. Samples LC-16, LC-18, and LC-19, La Collaona section, Tendeyón Stratal Package, Lena Group. Moscovian (lower Podolian).

Pseudostaffella cf. *ozawai* Lee & Chen in Lee *et al*., 1930
(Figs 7v-7y)

Measurements. L = 1.25-1.58 mm; D = 1.75-2.13 mm; L/D = 0.68-0.79; n = 7.5-8.5; d = 90-100 µm; D_{IV} = 0.59-0.73 mm; wth = 25-40 µm.

Remarks. The shape of the test, laterally compressed and becoming angulate in the median region of the last two volutions, as well as the massive chomata, which extend to the poles and occasionally exceed half the chamber height, are typical for the *Pseudostaffella ozawai* species group. With respect to the original material of Lee & Chen (in Lee *et al*., 1930), the Cantabrian specimens differ in having a larger size, smaller L/D ratio and larger proloculus. In all these parameters, they are closer to *Pseudostaffella ozawai* described from the Russian Platform by Rauzer-Chernousova (in Rauzer-Chernousova *et al*., 1951).

Stratigraphic data and age. Samples LC-21 and LC-24, La Collaona section, Tendeyón Stratal Package, and sample NV-5, La Torala Limestone, Caleras Stratal Package. All from the Lena Group. Upper Moscovian (Podolian).

Pseudostaffella cf. *ozawai compacta* Manukalova, 1950
(Fig. 7t)

Measurements (approximate). L = 1.95 mm; D = 1.65 mm; L/D = 1.18; D_{IV} = 0.68 mm; n = 8.25; wth = 40 µm.

Remarks. Although poorly orientated, the large and broad test and the massive chomata of this single specimen indicate that it belongs to a species close to *P. ozawai compacta* Manukalova, 1950.

Stratigraphic data and age. Sample NV-1, La Sucia Limestone, Caleras Stratal Package. Upper Moscovian (Podolian).

Pseudostaffella ex gr. *sphaeroidea* (Ehrenberg, 1842)
(Fig. 7u)

Measurements. L = 1.35 mm; D = 1.38 mm; L/D = 0.98; n = 7.5 (?).

Remarks. The illustrated specimen is one of the several oblique sections of forms belonging to the *Pseudostaffella* ex gr. *sphaeroidea* group and occurring in this level. The scarcity of the available material and the lack of well-orientated sections prevent us from making an adequate comparison.

Stratigraphic data and age. Sample NV-9, Entrerregueras Limestone of the Entrerregueras Stratal Package. Upper Moscovian (Myachkovian).

Family **Schubertellidae** Skinner, 1931

Genus *Schubertella* Staff &Wedekind, 1910

Type species *Schubertella transitoria* Staff &Wedekind, 1910

Schubertella znensis Rauzer-Chernousova in Rauzer-Chernousova *et al*., 1951
(Figs 8l-8n)

Measurements. L = 0.55-0.62; D = 0.40-0.48; L/D = 1.25-1.44; n = 3-4.5; d = 55-85 µm; wth = 10-15 µm.

Remarks. Test globose, with rounded polar ends that become slightly pointed in the last volution of some specimens. Chomata weak to moderately developed, often extending to the axial region. Axis of coiling usually stable in the last three volutions. This species matches well *S. gracilis znensis,* described by Rauzer-Chernousova (in Rauzer-Chernousova *et al*., 1951), except for the width of the aperture, which seems to be broader in the Cantabrian species.

Stratigraphic data and age. Sample LC-23, La Collaona section, Tendeyón Stratal Package. Moscovian (Podolian).

Schubertella luisorum Villa sp. nov.
(Figs 8a-8k)

***Derivatio nominis*.** The species is dedicated to the geologists Dr. María Luisa Martínez-Chacón and Dr. Luis Sánchez de Posada, a married couple who devoted their entire scientific lives to the study of Carboniferous palaeontology and biostratigraphy.

Material. 12 axial or nearly axial sections, and a number of paraxial and oblique sections. Holotype: specimen NV3/6a (Fig. 8c).

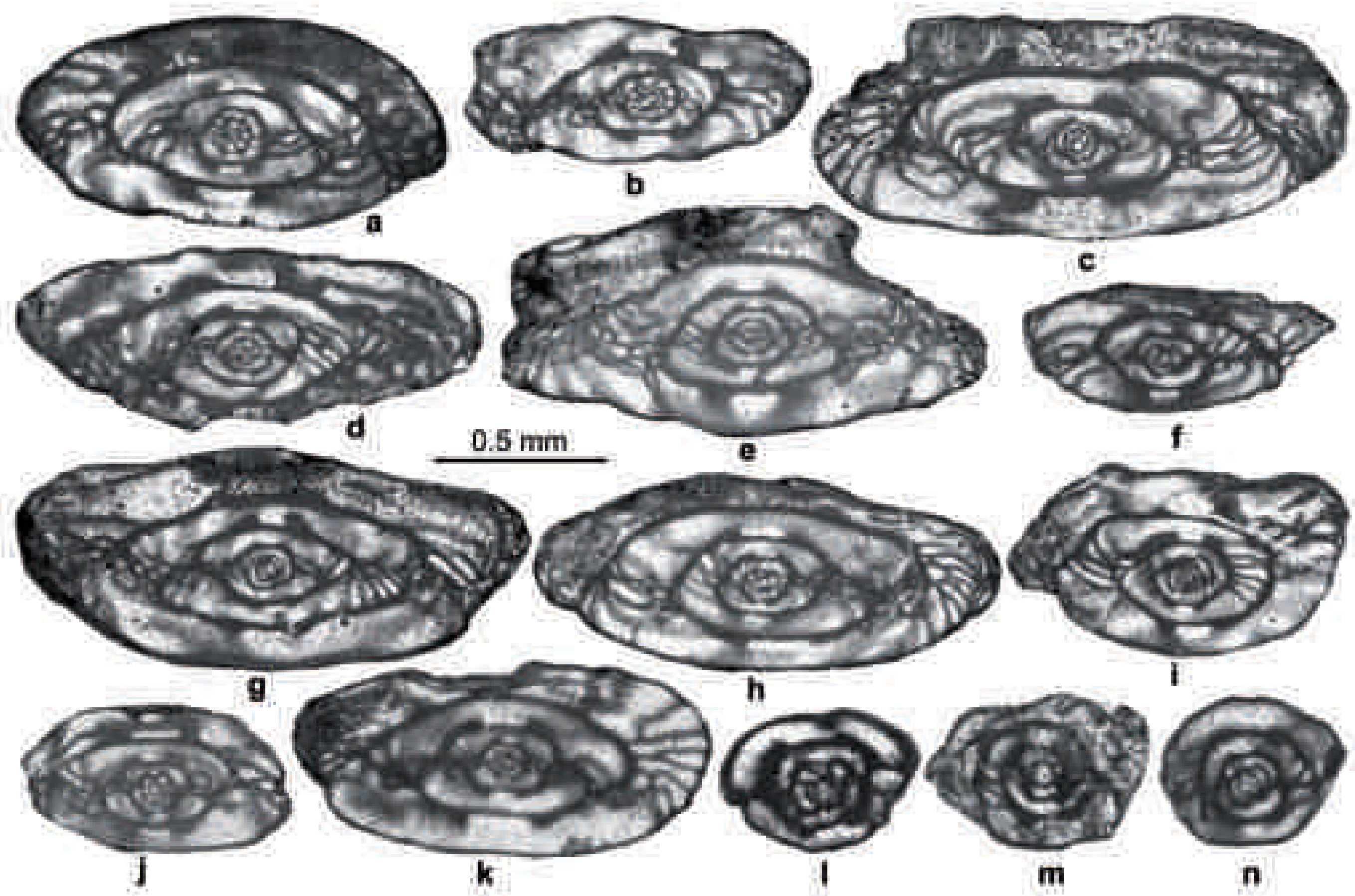

Figure 8. a-k) *Schubertella luisorum* Villa sp. nov. **(a)** NV3/1a; **(b)** NV3/6d; **(c)** NV3/6a; **(d)** NV3/5b; **(e)** NV3/2a; **(f)** NV3/4c; **(g)** NV3/1c; **(h)** NV3/2b; **(i)** NV2/1b; **(j)** NV3/4f; **(k)** NV3/6b. **l-n)** *Schubertella znensis* Rauzer-Chernousova *in* Rauzer-Chernousova *et al*., 1951. **(l)** LC23/1b; **(m)** LC23/5a; **(n)** LC23/5b.

Type locality. Sutu Limestone section exposed south of the Polígono Industrial Sutu, in the vicinity of Pola de Laviana village.

Measurements. L = 0.80-1.73 mm; D = 0.42-0.68 mm; L/D = 1.56-2.69; n = 4-5.5; d = 25-45 µm; D_{IV} = 0.30-0.51 mm; wth = 8-30 µm. Holotype: L = 1.73 mm; D = 0.67 mm; L/D = 2.58; d = 45 µm; n = 4.5; D_{IV} = 0.51; wth = 30 µm.

Diagnosis. Specific characteristics of this *Schubertella* are the large size and the great variability in shape of its shell as well as the distinct chomata, which are stronger than usual in the Carboniferous species of this genus.

Description. Test elliptical to short fusiform, usually with flattened median region and rounded polar ends. First to second volutions are tightly coiled and arranged at a large angle to the subsequent whorls, after which the spire increases rapidly, especially in the outermost whorl. Chomata distinct but variable in shape, from rather narrow and wedge shaped to broad and quadrangular. Wall consists of three layers, tectum, primatheca and outer tectorium, all of them dark, thus sometimes making it difficult to distinguish the tectum.

Discussion. This form is one of the largest Carboniferous *Schubertella* so far described, as well as the one exhibiting strongest chomata for this genus. In shape and type of coiling, it resembles *Schubertella lata lata* Lee & Chen (in Lee *et al.*, 1930), *S. lata elliptica* Sheng, 1958, *S. magna* Lee & Chen (in Lee *et al*., 1930), *S. pseudomagna* Putrya & Leontovich, 1948, and S. *mjachkovensis* Rauzer-Chernousova (in Rauzer-Chernousova *et al*., 1951). From *S. lata lata* and *S. lata elliptica, S. luisorum* differs in its larger size and stronger chomata. Moreover, it has a larger L/D ratio than *S. lata lata* and fewer volutions than *S. lata elliptica*. *S. magna*, for its part, exhibits a looser coiling, more rounded test (shorter L/D ratio), and a less differentiated microstructure of the wall, whereas *P. pseudomagna* has a shorter text. As mentioned above, *S. luisorum* sp. nov. exhibits a remarkable variability in the shape of the outer shell. In this respect, the resemblance of the specimens showing the shortest L/D ratio to

Schubertella mjachkovensis is noticeable, except for their larger size (outer diameter is 0.42-0.68 mm against 0.30-0.35 mm in the Rauzer-Chernousova material).

Stratigraphic data and age. Samples NV-3 (Sutu Limestone), NV-2 (Meruxalín Limestone), and NV-4 (La Nueva Limestone), all from the Caleras Stratal Package. Upper Moscovian (Podolian).

Family **Fusulinidae** von Möller, 1878

Genus *Taitzehoella* Sheng, 1951

Type species *Taitzehoella taitzehoensis* Sheng, 1951

Taitzehoella taitzehoensis extensa Sheng, 1958
(Figs 9a-9b)

Measurements. L = 1.33-2.23 mm; D = 0.60-1.33 mm; L/D = 2.12-2.23; d = 30-45 µm; D_{IV} = 0.28-0.38 mm; n = 5.5-7.5; wth = 15-30 µm.

Remarks. In spite of the wide range in the dimensions of the outer shell, these specimens are considered to belong to a single species showing the extended polar ends and the large L/D ratio as their most distinct features. Similar forms are *Taitzehoella taitzehoensis extensa* Sheng, 1958, and *T. librovitchi perseverata* Rauzer-Chernousova (in Rauzer-Chernousova *et al.*, 1951), the former being more similar to the Cantabrian form. Apparently, our material differs from *T. librovitchi perseverata* in having more pronounced concavities in the lateral sides and probably less elongated intermediate whorls.

Stratigraphic data and age. Sample LC-24, La Collaona section, Tendeyón Stratal Package. Moscovian (Podolian).

Taitzehoella prolibrovichi (Rauzer-Chernousova in Rauzer-Chernousova *et al.*, 1951)
(Figs 9c-9d)

Measurements. L = 1.40-2.30 mm; D = 0.65-0.88 mm; L/D = 2.15-2.56; d = 30-40 µm; D_{IV} = 0.22-0.40 mm; n = 5.5(?)-7; wth = 20 µm.

Remarks. These specimens resemble *Taitzehoella prolibrovichi* (Rauzer-Chernousova *in* Rauzer-Chaernousova *et al.*, 1951) in having inflated fusiform test with slightly concave lateral sides, and stretched polar ends in the last volutions. All these characteristics are also present in *Taitzehoella pseudolibrovichi* (Safonova) (in Rauzer-Chernousova *et al.*, 1951), although the latter apparently differs from *T. prolibrovichi* in having a more prominent median region.

Stratigraphic data and age. Sample NV-2, Meruxalín Limestone, and sample NV-3, Sutu Limestone, both from the Caleras Stratal Package. Upper Moscovian (Podolian).

Taitzehoella cf. *compacta* Leven, 1998
(Figs 9e-9f)

Measurements. L = 1.40-1.92 mm; D = 0.55-0.83 mm; L/D = 2.30-2.72; d = 20-40 µm; D_{IV} = 0.21-0.35 mm; n = 6-6.5; wth = 12-25 µm.

Remarks. The most distinctive features in these specimens are the innermost one to one and a half volutions, arranged at a large angle with respect to the rest of the whorls, and the constant subrhomboidal shape of the last whorl, whose lateral sides do not show clearly the typical concavities of *Taitzehoella* species. In other respects (size of shell, narrow chomata, two-layered wall) our material does not differ from typical *Taitzehoella.* These characteristics place it close to *Taitzehoella compacta*, described by Leven (1998) from the Pamir.

Stratigraphic data and age. Sample NV-4, La Nueva Limestone, Caleras Stratal Package. Upper Moscovian (Podolian).

Taitzehoella cf. *librovitchi* (Dutkevitch, 1934)
(Figs 9g-9l)

Measurements. L = 0.85-2.12* mm; D = 0.60-1.13 mm; L/D = 1.06-2.16*; n = 5.5-7.5; d = 15-45 µm; D_{IV} = 0.23-0.44 mm; wth = 15-45 µm. Another specimen (oblique section) shows 8 volutions and a diameter of 1.37 mm. (* = measurement for the whorl 6.5 in one specimen having 7 volutions).

Remarks. Test fusiform, strongly inflated in its median region. Whorls tightly coiled, with the innermost volutions arranged at a large angle to subsequent ones. Proloculus minute. Polar ends frequently stretched and pointed. Concavities of the lateral sides are almost absent or only very slightly developed in the smaller specimens (5.5 to 6 volutions), but more deeply marked in the final whorls of the largest individuals. Chomata distinct, narrow, wedge-shaped or quadrangular, and relatively high in the last whorls. In spite of their striking variability, particularly with respect to the diameter of the shell and elongation of the polar ends, these *Taitzehoella* specimens are considered to belong to a single species as they maintain rather uniform characteristics in the inner and intermediate volutions. The characteristics of this species closely match those of *Taitzehoella librovitchi* (Dutkevitch) and *T. librovitchi perseverata* (Safonova in Rauzer Chernousova *et al.*, 1951). Apparently, the values of size and number of volutions

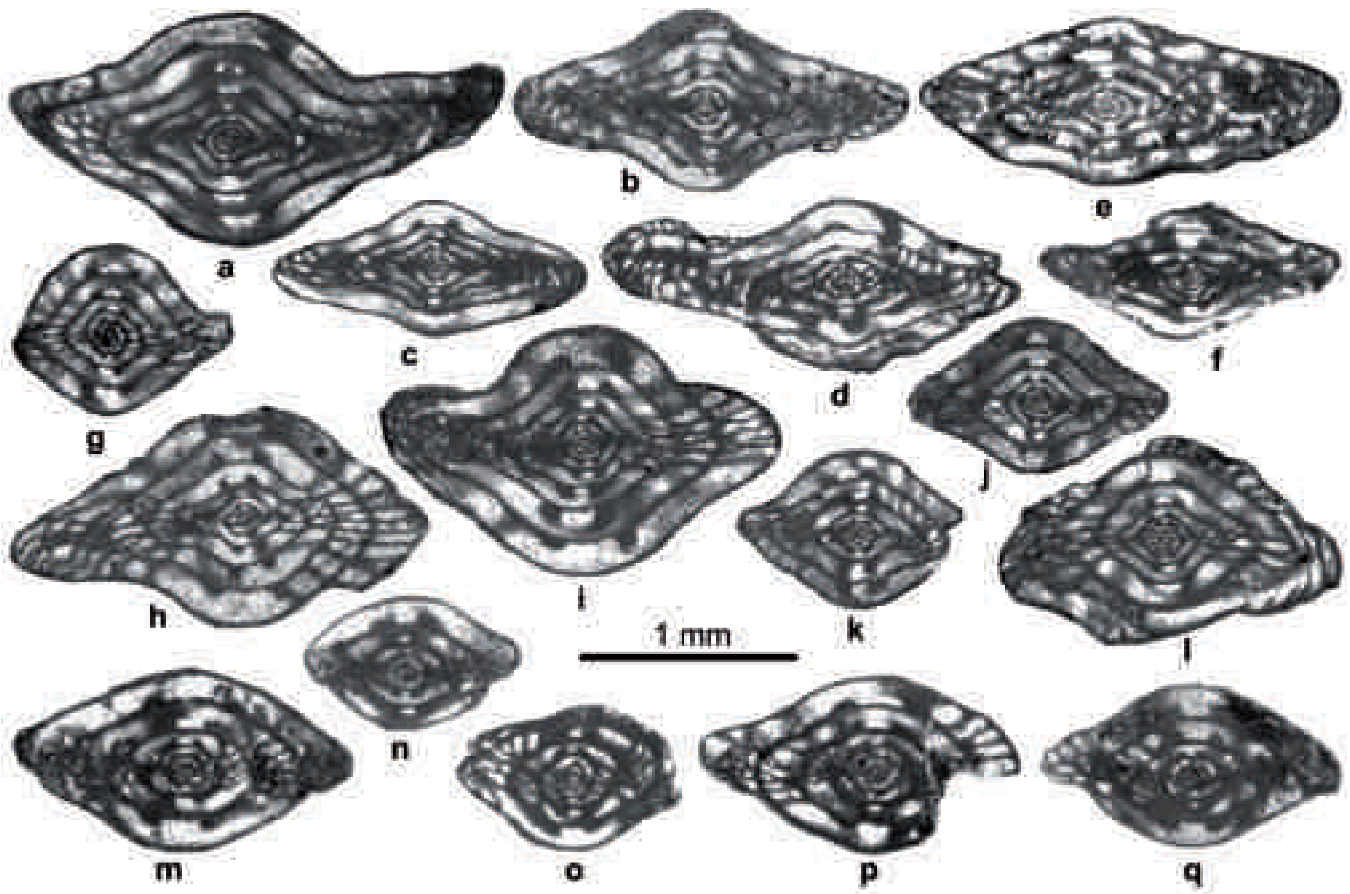

Figure 9. a-b) *Taitzehoella taitzehoensis extensa* Sheng, 1958. **(a)** LC24/6; **(b)** LC24/10. **c-d)** *Taitzehoella prolibrovichi* (Rauzer-Chernousova *in* Rauzer-Chernousova *et al.*, 1951). **(c)** NV3/3c; **(d)** NV3/5a. **e-f)** *Taitzehoella* cf. *compacta* Leven, 1998. **(e)** NV4/1e; **(f)** NV4/3a. **g-l)** *Taitzehoella* cf. *librovitchi* (Dutkevitch, 1934). **(g)** NV9/6e; **(h)** NV9/10b; **(i)** NV9/9a; **(j)** NV9/2a; **(k)** NV9/6a; **(l)** NV9/6d. **m-q)** *Profusulinella* aff. *polasnensis* Safonova *in* Rauzer-Chernousova *et al.*, 1951. **(m)** LC15/2; **(n)** LC6/1; **(o)** LC15/7; **(p)** LC15/4; **(q)** LC6/16a.

encompass those stated in the diagnoses of both forms, but they are, on average, closer to Dutkevitch's specimens.

Stratigraphic data and age. Sample NV-9, Entrerregueras Limestone of the Entrerregueras Stratal Package. Upper Moscovian (Myachkovian).

Genus *Profusulinella* Rauzer-Chernousova & Belyaev (in Rauzer-Chernousova *et al.*, 1936)

Type species *Profusulinella pararhomboides* Rauzer-Chernousova & Belyaev (in Rauzer-Chernousova *et al.*, 1936)

Profusulinella aff. *polasnensis* Safonova in Rauzer-Chernousova *et al.*, 1951
(Figs 9m-9q)

Measurements. L = 0.94-1.58 mm; D = 0.60-0.92 mm; L/D = 1.57-1.95; d = 25-45 µm; D_{IV} = 0.35-0.49 mm; n = 4.5-6; wth = 20-40 µm.

Remarks. Test small, short-fusiform to rhomboidal in the last volutions, with prominent central region and straight to slightly concave lateral sides. The axis of the first volution is arranged at an angle to that of the later volutions. Proloculus minute. Chomata narrow, wedge-shaped, moderately developed. Septa undulated in the polar ends. This species is reminiscent of some lower Moscovian *Profusulinella* species, of which the most similar is *P. polasnensis* Safonova (*in* Rauzer-Chernousova *et al.*, 1951). However, compared to the original description of the latter, the Spanish form has, on average, a larger size and slightly tighter coiling of the inner volutions.

Stratigraphic data and age. Samples LC-6 and LC-15, La Collaona section; Pumarada Limestone, of the Tendeyón Stratal Package, Lena Group. Lower Moscovian (upper Kashirian).

Genus *Dagmarella* Solovieva, 1955

Type species *Dagmarella prima* Solovieva, 1955

Dagmarella? sp.
(Fig. 10m)

Measurements. L = 0.95 mm; D = 0.69 mm; L/D = 1.34; d = 60 µm; D_{IV} = 0.54 mm; n = 4.5; wth = 20 µm.

Remarks. Test small, short fusiform. Septa plane in the innermost whorls, then slightly folded in the axial ends and occasionally in the lateral sides. Chomata wide, extending to the poles (as thickenings of the outer tectoria?) in the three innermost volutions; in the fourth volution they become higher close to the tunnel, but still prolongate to the axial region. The wall consist of three layers in the two innermost volutions and four layers (including a thick outer tectorium, tectum, grey diaphanotheca, and very thin inner tectorium) in the rest of the whorls; weak pores are occassionally observed piercing these layers. The characteristics of this specimen mainly differ from the diagnostic features of the genus in the weaker septal folding in the penultimate volution. Furthermore, the specimen also differs from the type species *Dagmarella prima* in having a more globose shell and shorter axial ends. *Dagmarella*? sp. also resembles the material assigned to *Hemifusulina* sp. 2 ex gr. *dutkevichi* by van Ginkel (1973), although the latter does not show such clear ribbon-like supplementary deposits covering the base of the intermediate whorls. Interestingly, *Hemifusulina* sp. 2 ex gr. *dutkevichi* was described from a shaly bed of the San Antonio Stratal Package, the stratigraphic interval of the Central Asturian Coalfield situated just below the one containing the La Escribana Limestone. The characteristics of the wall of both *Dagmarella*? sp. and *Hemifusulina* sp. 2 ex gr. *dutkevichi* seem to be closer to *Dagmarella* than to *Hemifusulina*.

Stratigraphic data and age. Sample NV-8, La Escribana Limestone of the María Luisa Stratal Package. Upper Moscovian (upper Podolian or lower Myachkovian).

Genus *Beedeina* Galloway, 1933

Type species *Fusulina girtyi* Dunbar & Condra, 1928

Beedeina ex gr. *schellwieni* (Staff, 1912)
(Figs 10a-10l)

Measurements. L = 2.67-4.00 mm; D = 1.17-1.80 mm; L/D = 1.76-2.53; D_{IV} = 0.73-1.23 mm; d = 60-165 µm; n = 5-6; wth = 25-50 µm.

Remarks. The specimens show rhombic shape in the inner whorls, irregular septal folding, chomata only in the inner whorls (that become pseudochomata in the last ones), and a four-layered wall consisting of tectum, diaphanotheca, and thin tectoria. These features are typical of the *B. schellwieni* group of Rauzer-Chernoussova *et al.* (1951), a group of forms abundant in the uppermost Kashirian and, especially, in the Podolian. Although we cannot rule out the possibility that more than one species exists within our collection, separation of taxa proves difficult since it includes transitional forms exhibiting gradual steps in the development of the more variable features (e.g., enlargement and shape of the polar ends and width of chomata in the inner whorls). Specimens LT57/3, LC7/1, LC12/1 could be compared to *B. pseudoelegans*, LC9/3, LC13/1, LCSU/2a resemble *B. bona*, and LC22/3 somewhat resemble *B. dunbari*. However, all of them differ from the nominal species described by Rauzer-Chernoussova *et al.* (1951) in having weaker septal folding in the median region of the shell. This difference supports our interpretation that they are primitive *Beedeina* forms, occurring in the Kashirian.

Stratigraphic data and age. Samples LT55, and LT57, Los Tornos section, and samples LC7, LC8, LC9, LC11, LC12, and LC13, La Collaona section, all from the Pumarada Limestone of the Tendeyón Stratal Package, lower Moscovian (uppermost Kashirian). Sample NV-1, La Sucia Limestone of the Caleras Stratal Package, upper Moscovian (Podolian).

Beedeina truyolsi Villa, 1995
(Fig. 10n)

Measurements. L = 3.70 mm; D = 2.00 mm; L/D = 1.85; n = 6.5; d = 140 µm; D_{IV} = 0.88 mm; wth = 35 µm.

Remarks. The characteristics of this single specimen closely match those of *Beedeina truyolsi* Villa 1995, a species relatively abundant in the Podolian of the Cantabrian Zone. The similarity is especially noticeable in regard to the size and rhombic shape of the shell, short L/D ratio, moderate to strong septal folding, and presence in the inner whorls of chomata of variable shape, which are replaced by pseudochomata in the outer ones. The wall is four-layered, although the diaphanotheca is only clearly differentiated in one to two outer whorls. A somewhat similar species is *B. subdistenta* Putrya, 1956, from which *B. truyolsi* differs in having stronger septal folding.

Stratigraphic data and age. Sample NV-3, Sutu Limestone of the Caleras Stratal Package. Upper Moscovian (Podolian).

Beedeina ozawai (Rauzer-Chernousova & Belyaev, *in* Rauzer-Chernousova & Fursenko, 1937)
(Figs 10o-10s)

Measurements. L = 3.15-4.60 mm; D = 1.15-1.80 mm; L/D = 2.42-2.97; D_{IV} = 1.05-1.33 mm; d = 160-240 µm; n = 4-5.5; wth = 40-50 µm.

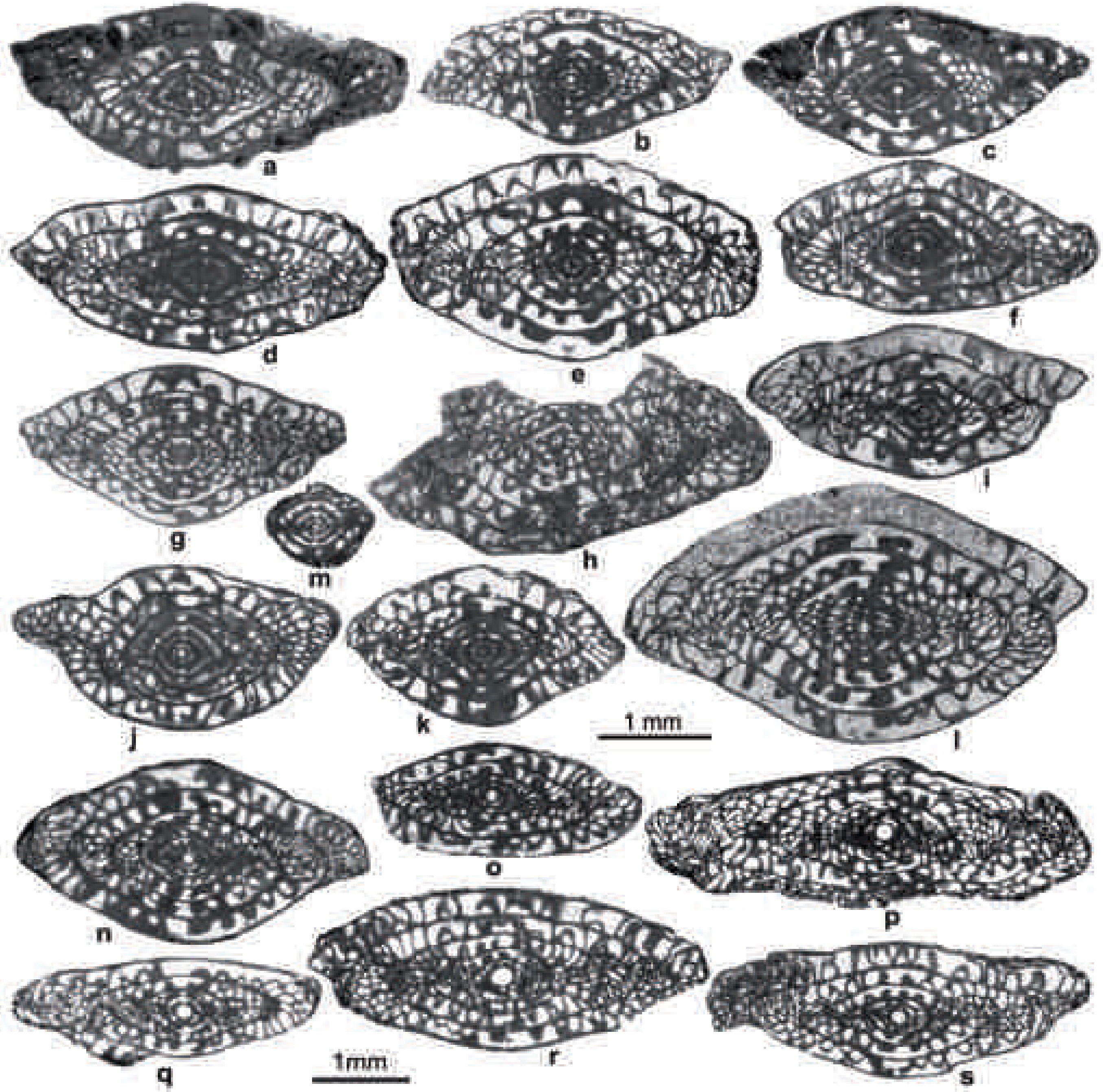

Figure 10. a-l) *Beedeina* ex gr. *schellwieni* (Staff, 1913). **(a)** LT55/3; **(b)** LT55/1b; **(c)** LC7/1; **(d)** LC13/6; **(e)** LC12/3; **(f)** LC12/3; **(g)** LC21/7; **(h)** LC22/3; **(i)** LC7/2; **(j)** LC11/1; **(k)** LC13/1; **(l)** LC24/8. **m)** *Dagmarella*? sp., NV8/1. **n)** *Beedeina truyolsi* Villa, 1995, NV3/6c. **o-s)** *Beedeina ozawai* (Rauzer-Chernousova & Belyaev, 1937). **(o)** NV2/4b; **(p)** NV2/6b; **(q)** NV2/3; **(r)** NV2/1c; **(s)** NV2/6a.

Remarks. The specimens exhibit typical features of *Beedeina ozawai* described by Rauzer-Chernousova & Belyaev (in Rauzer-Chernousova & Fursenko, 1937), especially with respect to the shape of the shell, presence in inner whorls of chomata, which are replaced by pseudochomata in the outer ones, irregular septal folding frequently showing triangular arcs in section, and a four-layered wall.

Stratigraphic data and age. Sample NV-2, Meruxalín Limestone of the Caleras Stratal Package. Upper Moscovian (Podolian).

Genus *Putrella* Rauzer-Chernousova in Rauzer-Chernousova *et al*., 1951

Type species *Pseudotriticites brazhnikovae* Putrya, 1948

Putrella cf. *gurovi* Putrya, 1956
(Fig. 11a)

Measurements. L = 3.05 mm; D = 1.08 mm; L/D = 2.82; n = 4.5; d = 110 µm; D_{IV} = 0.91 mm; wth = 35 µm.

Remarks. The characteristics and size of the type material of *Putrella gurovi* Putrya closely matches those of this single specimen; apparently, it only differs from *P. gurovi* in having slightly broader and rounder septal loops.

Stratigraphic data and age. Sample LC-22, La Collaona section, Tendeyón Stratal Package, Lena Group. Upper Moscovian (Podolian).

Putrella aff. *persica* Leven & Davydov in Leven *et al*., 2006
(Figs 11b-11f)

Measurements. L = 3.18-4.90 mm; D = 1.38-1.80 mm; L/D = 2.30-3.06; n = 5-5.5; d = 90-200 µm; D_{IV} = 0.88-1.38 mm; wth = 40-50 µm.

Remarks. Test fusiform, with subrhomboidal inner volutions and bluntly pointed polar ends. The spiral is tightly coiled in the three inner volutions, growing rapidly in the two outermost whorls. The diameter of the fourth whorl is rather similar (0.88-0.95 mm) in most specimens, except for specimen NV7/1, in which it is 1.38 mm. Chomata narrow, usually present on the proloculus and three innermost whorls. Septal folding irregular, somewhat weaker in the median region and stronger in the axial ends. Wall consists of two layers, tectum and a primatheca pierced by thin but very distinct pores. In the first two volutions, the chomata merge with supplementary deposits that extend to the poles and could be considered either as a prolongation of the chomata or as an irregular outer tectorium.

Putrella was introduced by Rauzer-Chernousova (*in* Rauzer-Chernousova *et al.*, 1951) based on the following main differentiating features: 1) its two-layered wall, consisting of tectum and a less dense and thicker layer pierced by distinct pores; 2) irregularly but strongly fluted septa; and 3) chomata developed only on the proloculus and first whorl. Supplementary deposits covering the base of the chambers do not exist in the type species *Putrella braznikhovae* (Putrya, 1948), neither do in most of the rather few species assigned to this genus by subsequent authors. Therefore, the form described here as *P.* aff. *persica* could only be assigned to *Putrella* if the original diagnosis of the genus were amended to include forms exhibiting supplementary deposits. Another exceptions are *P. persica*, *Putrella?* sp. and *Putrella* sp. 2 described by Leven & Davydov (in Leven *et al.*, 2006) from the lower part of the upper Moscovian of Iran. *P. persica* exhibits an upper tectorium on the first one or two volutions and more massive and wider chomata than typical *Putrella*. *Putrella?* sp. is not described, but, from its picture, it can be inferred that supplementary deposits exist on the base of the chambers of the three first volutions. Finally, *Putrella* sp. 2 shows chomata and supplementary deposits in the three innermost volutions (Leven *et al.*, 2006, figs 18-11). Most similar to our material is *P. persica*, from which the Asturian form mainly differs by having stronger supplementary deposits.

Stratigraphic data and age. Sample NV-5, La Torala Limestone of the Caleras Stratal Package. Upper Moscovian (Podolian).

Putrella? sp.
(Fig. 11g)

Measurements (approximate). L = 5.5 mm; D = 2.05 mm; L/D = 2.68; n = 6.5; d = 110 µm; D_{IV} = 0.82 mm; wth = 50 µm.

Remarks. Section slightly oblique that could correspond (if the genus is confirmed) to one of the largest specimens of *Putrella* so far known, and probably one of the youngest records of the genus. Chomata are developed on the proloculus and the three innermost whorls, which are exhibiting supplementary deposits on the base of the chambers. Septa are moderately to strongly folded, the folding diminishing progressively and finally disappearing in the median region of the penultimate two volutions. The wall in the mature whorls (from the 4th whorl onwards) consists of two layers, tectum and a primatheca pierced by thin pores. Among the known *Putrella* species, our specimen resembles *P. miranda* Leven (described from Darvas, Pamir) in size and shape of the shell and L/D ratio. However, *Putrella*? sp. clearly differs in having stronger supplementary deposits and tighter coiling.

Stratigraphic data and age. Sample NV-8, La Escribana Limestone of the María Luisa Stratal Package. Upper Moscovian (uppermost Podolian or lower Myachkovian).

Genus *Eofusulina* Rauzer-Chernousova *in* Rauzer-Chernousova *et al.*, 1951

Type species *Fusulina triangula* Rauzer-Chernousova & Belyaev (*in* Rauzer-Chernousova *et al.*, 1936)

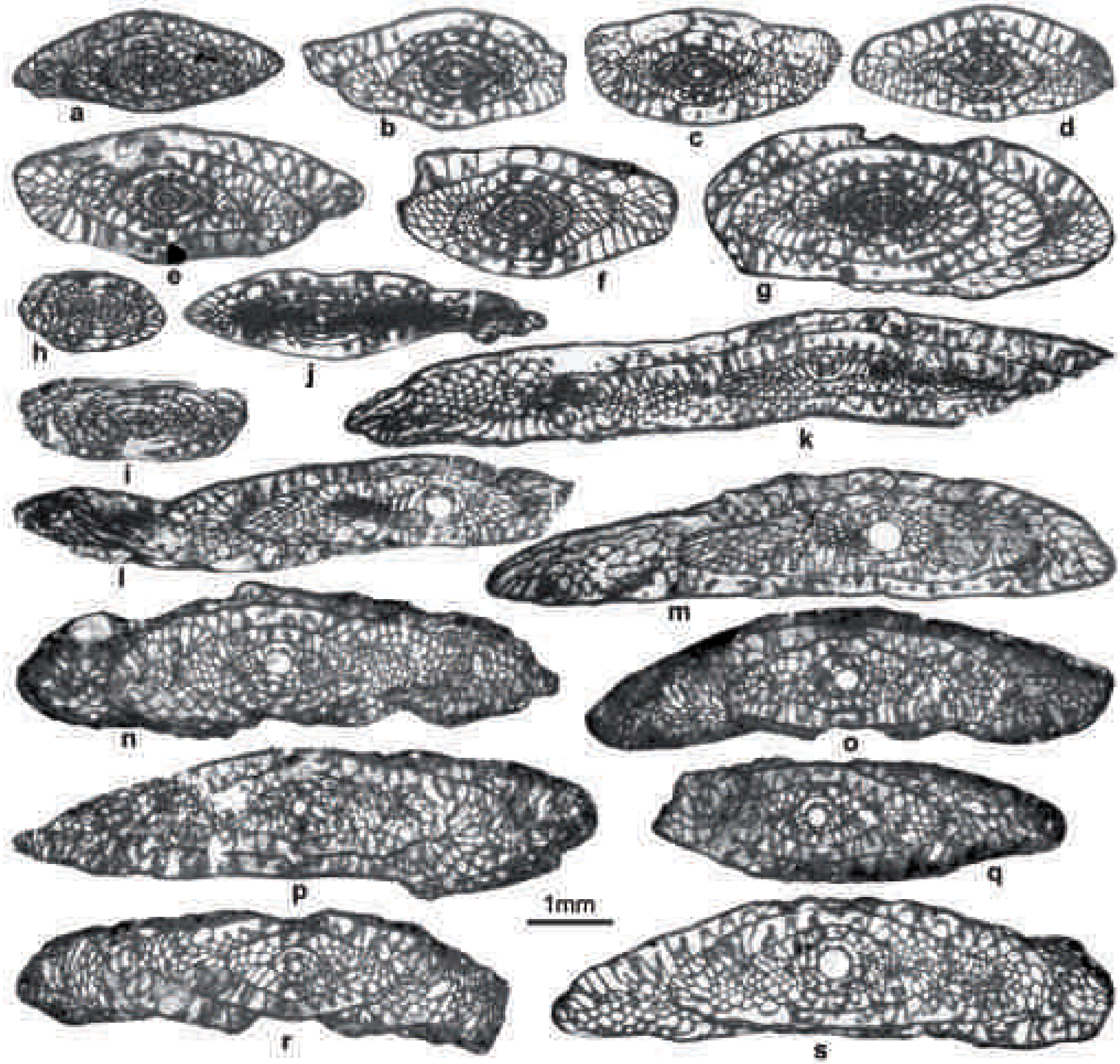

Figure 11. a) *Putrella* cf. *gurovi* Putrya, 1956, LC22/1. **b-f)** *Putrella* aff. *persica* Leven & Davydov *in* Leven *et al.*, 2006. **(b)** NV7/1; **(c)** NV6/1; **(d)** NV6/2; **(e)** NV6/3; **(f)** NV7/2. **g)** *Putrella*? sp., NV8/2. **h-i)** *Hemifusulina* ex gr. *moelleri* Rauzer-Chernousova *in* Rauzer-Chernousova *et al.*, 1951. **(h)** NV9/8; **(i)** NV9/2d. **j)** *Eofusulina* aff. *triangula* Rauzer-Chernousova & Belyaev *in* Rauzer-Chernousova *et al.*, 1936. **k-m)** *Eofusulina* aff. *paratriangula* Putrya, 1938. **(k)** LC24/2; **(l)** LC24/3; **(m)** LC24/1. **n-s)** *Fusulina cotarazoe* van Ginkel, 1965. **(n)** NV9/4a; **(o)** NV9/7b; **(p)** NV9/9b; **(q)** NV9/1; **(r)** NV9/3a; **(s)** NV9/10a.

Eofusulina aff. *triangula* (Rauzer-Chernousova & Belyaev in Rauzer-Chernousova *et al.*, 1936)
(Fig. 11j)

Measurements. L≈5.25 mm; D = 1.05 mm; L/D≈5.0; n = 3.5; d = 150 µm; wth = 30 µm.

Remarks. Single specimen showing an elongate fusiform test in section. Septa irregular and moderately folded, the fluting increasing towards the polar regions. Chomata weak, present only on the proloculus. Axial fillings moderately developed. Wall thin, two-layered. The specimen resembles *E. triangula triangula* (Rauzer-Chernousova & Belyaev *in* Rauzer-Chernousova *et al.*,

1936) and *E. triangula fusiformis* Grozdilova & Lebedeva, 1960, but differs from both in exhibiting weaker septal folding.

Stratigraphic data and age. Sample LT-54, Los Tornos section, top of the Levinco Stratal Package, Lena Group. Lower Moscovian (Kashirian).

Eofusulina aff. *paratriangula* Putrya, 1939
(Figs 11k-11m)

Measurements. L≈10.00-12.00 mm; D = 1.30-1.50 mm; L/D≈7.70-9.23; n = 3-4; d = 320-390 µm; wth = 25-30 µm.

Remarks. Specimens studied are fragments and poorly-orientated sections, thus the measurements obtained must be taken as approximate indications of the actual data. However, *E.* aff. *paratriangula* shows some characteristic features (great elongation of the test, large proloculus, chomata absent or only weakly developed on the proloculus, irregular and intensive septal folding, and narrow and discontinuous axial fillings) that seem to indicate a close relationship to *Eofusulina paratriangula* (Putrya, 1939). *E.* aff. *paratriangula* only differs from the latter in having a larger shell and axial fillings that, although very weak, are perhaps slightly more developed than in the Putrya form.

Stratigraphic data and age. Sample LC-24, La Collaona section, Tendeyón Stratal Package, Lena Group. Upper Moscovian (Podolian).

Genus *Fusulina* Fisher de Waldheim, 1829

Type species *Fusulina cylindrica* Fisher de Waldheim, 1829

Fusulina cotarazoe van Ginkel, 1965
(Figs 11n-11s)

Measurements. L = 4.75-7.65 mm; D = 1.50-2.10 mm; L/D = 2.79-4.13; n = 4-5; d = 190-390 µm; D_{IV} = 1.45-1.80 mm; wth = 35-60 µm.

Remarks. Test fusiform to elongate fusiform, with the two innermost whorls frequently subrhomboidal, and the elongation of the shell increasing sharply from the third volution onwards. Proloculus of variable size, from moderate (proloculus diameter around 200 µm) to rather large (nearly 400 µm). Septa intensively folded along their entire length. Chomata present on the proloculus and up to the first one and a half whorls. The wall essentially consists of three layers (tectum, diaphanotheca and inner tectorium) pierced by thin pores. Van Ginkel (1965) described from the Cantabrian Mountains two very similar species, *Fusulina agujasensis* and *F. cotarazoe.* According to the criteria provided by van Ginkel, (1965, p. 145), *F. cotarazoe* differs from *F. agujasensis* in showing, on average, a slightly larger shell, proloculus diameter, number of whorls, and L/D ratio, though these differences arevery small. In our experience, however, the parameters of *F. agujasensis* and *F. cotarazoe* overlap; and even the entire range of values established for both species may be observed within a single population. Therefore, the present collection is assigned to one of them, *F. cotarazoe,* whose original description includes the broader range of measurements.

Stratigraphic data and age. Sample NV-9, Entrerregueras Limestone of the Entrerregueras Stratal Package. Upper Moscovian (Myachkovian).

Genus *Hemifusulina* von Möller, 1877

Type species *Hemifusulina bocki* von Möller, 1878

Hemifusulina sp. ex gr. *bocki* Moeller, 1878
(Figs 11h-11i)

Measurements. L = 2.67 mm; D = 0.95 mm; L/D = 2.81; n = 7.5; d = 45 µm; D_{IV} = 0.30 mm; wth = 40 µm (specimen 2). D = 0.95 mm; n = 7.5; D_{IV} = 0.38; wth = 25 µm (specimen 8).

Remarks. Test subcylindrical, tightly coiled, with almost flat to slightly convex median region in the outer volutions, and rounded polar ends (data of specimen 2). Proloculus minute. Septa moderately folded; folding weak or almost absent in the median region of the shell, increasing gradually to the axial ends. Chomata narrow and low. Wall consisting of tectum, grey diaphanotheca, and very thin and discontinuous inner and outer tectorium. Some weak porosity is visible piercing the diaphanotheca. These specimens remind us of the *Hemifusulina* ex gr. *bocki* in the shape of the shell and type of septal folding. They also are somewhat reminiscent of the species belonging to the *Hemifusulina* ex gr. *moelleri* (described by Rauzer-Chernousova *et al.* (1951) from the Kashirian.

Stratigraphic data and age. Sample NV-9, Entrerregueras Limestone of the Entrerregueras Stratal Package. Upper Moscovian (Myachkovian).

5. CONCLUDING REMARKS

Fusulines collected from limestone beds from a stratigraphic interval ranging from the uppermost part of the Levinco package to the Entrerregueras package of the Central

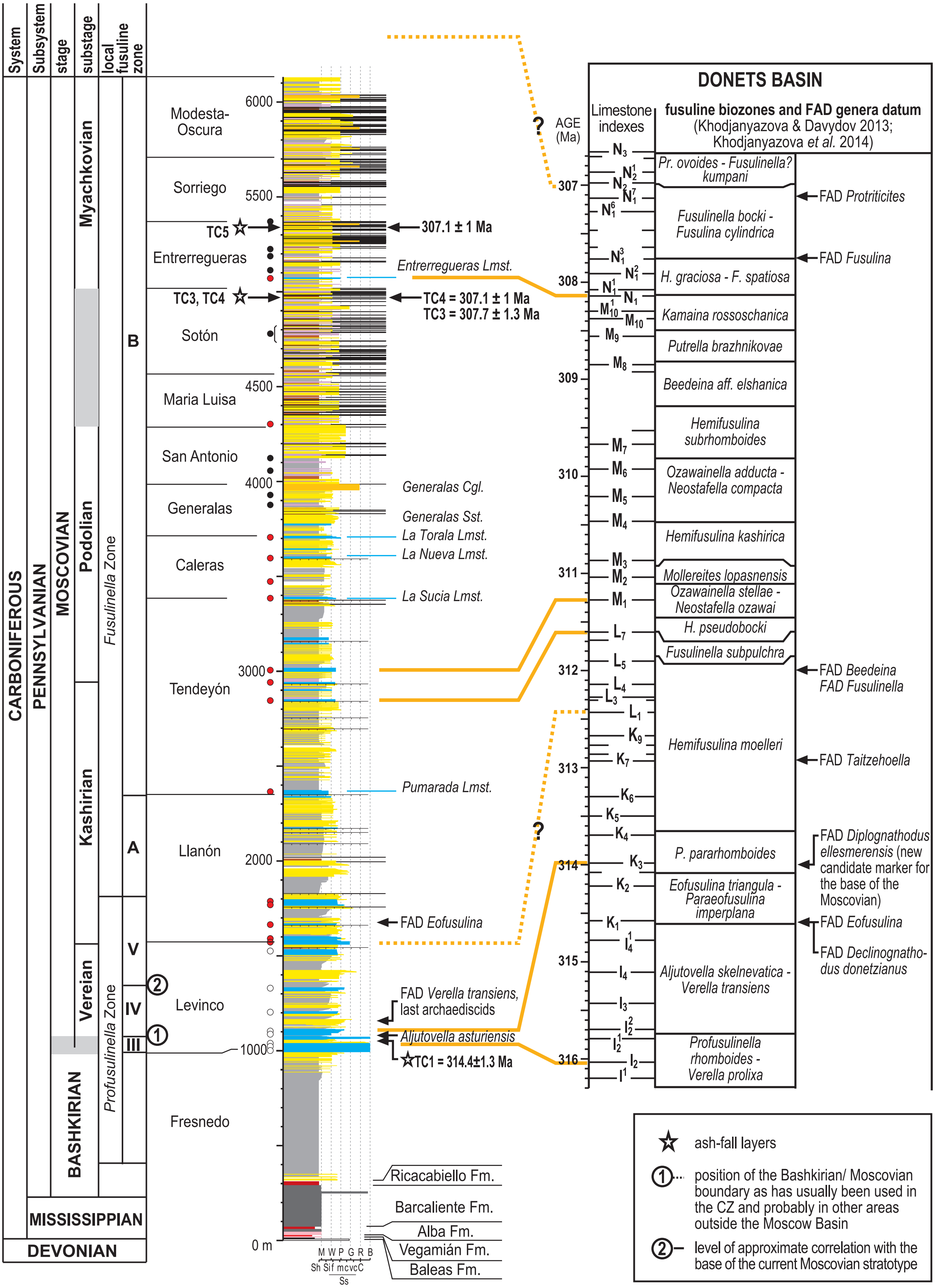

Figure 12. Tentative correlation of latest Bashkirian-Moscovian strata of the Central Asturian Coalfield with key limestone indexes in the Donets Basin based on their fusuline content.

Asturian Coalfield (Cantabrian Zone, NW Spain) are studied in detail for the first time.

36 species are described and illustrated, among them the new species *Schubertella luisorum* Villa.

Sedimentary facies and the palaeogeographic location of the Central Asturian Coalfield within the Variscan foreland basin of the Cantabrian Zone seem to play a main role in determining the fusuline assemblage composition. *Ozawainella*, *Pseudostaffella*, and *Beedeina,* as well as *Taitzehoella* and *Putrella*, all common elements of the Kashirian to Podolian assemblages of the Central Asturian Coalfield, are comparable to the *Beedeina*-dominated assemblages described by Khodjanyazova *et al.* (2014) for the Donets Basin. In contrast, species of the *Fusulinella* genus, common thoroughout the world in Moscovian strata deposited in the Palaeoequatorial belt, and which in the Donets Basin give name to the *Fusulinella*-dominated assemblages, are absent from the Central Asturian Coalfield succession (although they are abundant in the carbonate platform strata of other areas of the Cantabrian Zone, e.g., the Ponga and Picos de Europa areas). Finally, the *Hemifusulina*-dominated assemblages of Khodjanyazova *et al*. (2014) are here replaced by monospecific *Hemifusulina* associations. These characteristics of the Central Asturian Coalfield assemblages are interpreted as being a result of the overall near-shore location of the sedimentary basin. Fusuline occurrences, on the other hand, are observed to occur during early high-stands, as was interpreted by Khodjanyazova *et al.* (2014) for the Donets Basin.

In spite of the observed facies-control on the fusuline assemblage composition, species described exhibit similarities to those from other Eurasian areas that allow us to assign an age to several informal stratigraphic intervals known as 'mining stratal packages' and to propose their correlation with several horizons of the Donets Basin (Fig. 12): 1) The Levinco package seems to correlate with the K interval and possibly the lower part of the L interval; 2) the Tendeyon package fusulines are best compared with those of the upper L and lowermost M intervals; 3) the Caleras package is probably equivalent to the lower part of the M suite; and 4) the Entrerregueras Limestone (Entrerregueras stratal package) could be roughly equivalent to or slightly older than the N1 limestone.

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