

Lusitanispirifer lusitanensis n. gen. et sp. - A new delthyridoid spirifer and its palaeogeographical implications for the Dornes Syncline (Lower Devonian, Portugal)

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KEY WORDS - *Lusitanispirifer*, *Brachiopoda*, *Palaeobiogeography*, *Gondwana*, *Lower Devonian*, *Portugal*.

ABSTRACT - A new genus and species of delthyridoid spirifer brachiopods, *Lusitanispirifer lusitanensis*, is established in the present study. The taxon is described from the Dornes Formation within the Dornes Syncline (Central Portugal) and based on the associated fauna a Siegenian to Emsian (middle to late Early Devonian) age is indicated. [Remark: Neritic Gedinnian strata represent the pelagic Lochkovian strata, neritic Siegenian strata represent approximately pelagic Pragian strata]. Due to its capillate micro-ornamentation the new genus is attributed to the northern Gondwana delthyridoid spirifer fauna, however, it also shows similarities to the genus *Australospirifer* from the Malvinokaffric Realm. The relationship of *Lusitanispirifer* with the other genera within the capillate family *Filispiriferidae* to which it has been assigned, and *Australospirifer* is discussed. Implications derived from this study are put forward regarding the palaeogeographic position of the Dornes Syncline area during the Early Devonian.

RIASSUNTO - [*Lusitanispirifer lusitanensis* n. gen. et n. sp. - Un nuovo spiriferide delthyridoide e le sue implicazioni paleogeografiche per la sinclinale di Dornes (Devoniano Inferiore, Portogallo)] - *Lusitanispirifer lusitanensis* n. gen. e n. sp. è uno spiriferide delthyridoide ritrovato nella Sinclinale di Dornes (Portogallo centrale). Proviene da lenti all'interno dei livelli arenacei della Formazione di Dornes di età Sigeniano-Emsiano (parte media e superiore del Devoniano Inferiore), come testimoniato dalla fauna associata, costituita da *Torosospirifer*, *Turcispirifer* e *Ctenochonetes*. La caratteristica micro-ornamentazione "capillata" consente di collocare *Lusitanispirifer* n. gen. nella famiglia *Filispiriferida*, comprendente anche i generi *Filispirifer*, *Leonispirifer*, *Mauispirifer* e *Xerospirifer*: vengono discusse le relazioni tra questi generi, che costituiscono la fauna di spiriferidi delthyroidi del Nord Gondwana.

Lusitanispirifer assomiglia anche a *Australospirifer*, della Provincia Malvinokaffrica, a causa della micro-ornamentazione capillata con aree "fimbriate" e delle proiezioni in direzione posteriore nella zona degli adduttori dorsali. *Australospirifer* è tipico della Provincia Malvinokaffrica, caratterizzata da ambienti di acque fredde in cui i brachiopodi sono di grandi dimensioni e hanno gusci spessi. *Lusitanispirifer* n. gen. è invece piuttosto piccolo e ha un guscio sottile. La caratteristica morfologia della zona degli adduttori dorsali è quindi interpretata come omoplasia. *Lusitanispirifer* è apparentemente esclusivo del Portogallo e conferma l'esistenza di endemismi nel Devoniano Inferiore.

INTRODUCTION

The Dornes region is one of the classical study areas for Palaeozoic strata in Portugal. However, its intensive tectonic history complicates detailed stratigraphical assignment, furthermore, fossil content is rare and specimens are often deformed.

Brachiopods represent one of the major fossil groups for biostratigraphical assignment and palaeobiogeographical interpretation of Devonian strata in neritic facies and have been studied for almost two centuries. The first publications about Portuguese Palaeozoic brachiopods came out at the beginning of the 20th century (e.g., Delgado, 1908; Pruvost, 1914). With the works of Perdigão (1967, 1972, 1973, 1974, 1977, 1979), brachiopod investigation ended for a while. After the field trip of the international IGCP Project 421 meeting, brachiopods of Central Portugal again became a centre of interest (Oliveira et al., 2000; Gourvennec et al., 2008, 2010). This paper is one of a series of systematic descriptions of Portuguese Palaeozoic brachiopods under modern palaeontological aspects, conducted in order to improve the knowledge of the stratigraphy and palaeogeography of the Dornes Syncline.

Besides the study of historic brachiopod collections stored in the Museu Geológico, Lisbon, classical outcrops that are still accessible were visited and brachiopod material was carefully sampled stratigraphically. Even though the classical brachiopod collections are quite extensive, information about their exact stratigraphical position and location are often insufficient according to modern standards. For example, external moulds which are essential to study the micro-ornamentation are mostly lacking among this material.

The Rhenohercynian Province to which the study area belongs is regarded as a hotspot of brachiopod evolution during Early Devonian time. In recent years the spiriferids from this palaeogeographical province (represented by today's North Africa, Spain, France, Belgium, and Germany) have been especially studied. One of the foci of their investigation was the placement of their importance in correlation of strata on a regional and larger scales (e.g., Gourvennec, 1989; Carls et al., 1993; Jansen, 2001; Jansen et al., 2007; Schemm-Gregory, 2008a, b, c, 2011). The aim of this study is, besides the systematic description of brachiopods, to clarify the palaeogeographical relationship of the Northern Gondwana terranes and the Rhenohercynian Mountains during the Early Devonian.

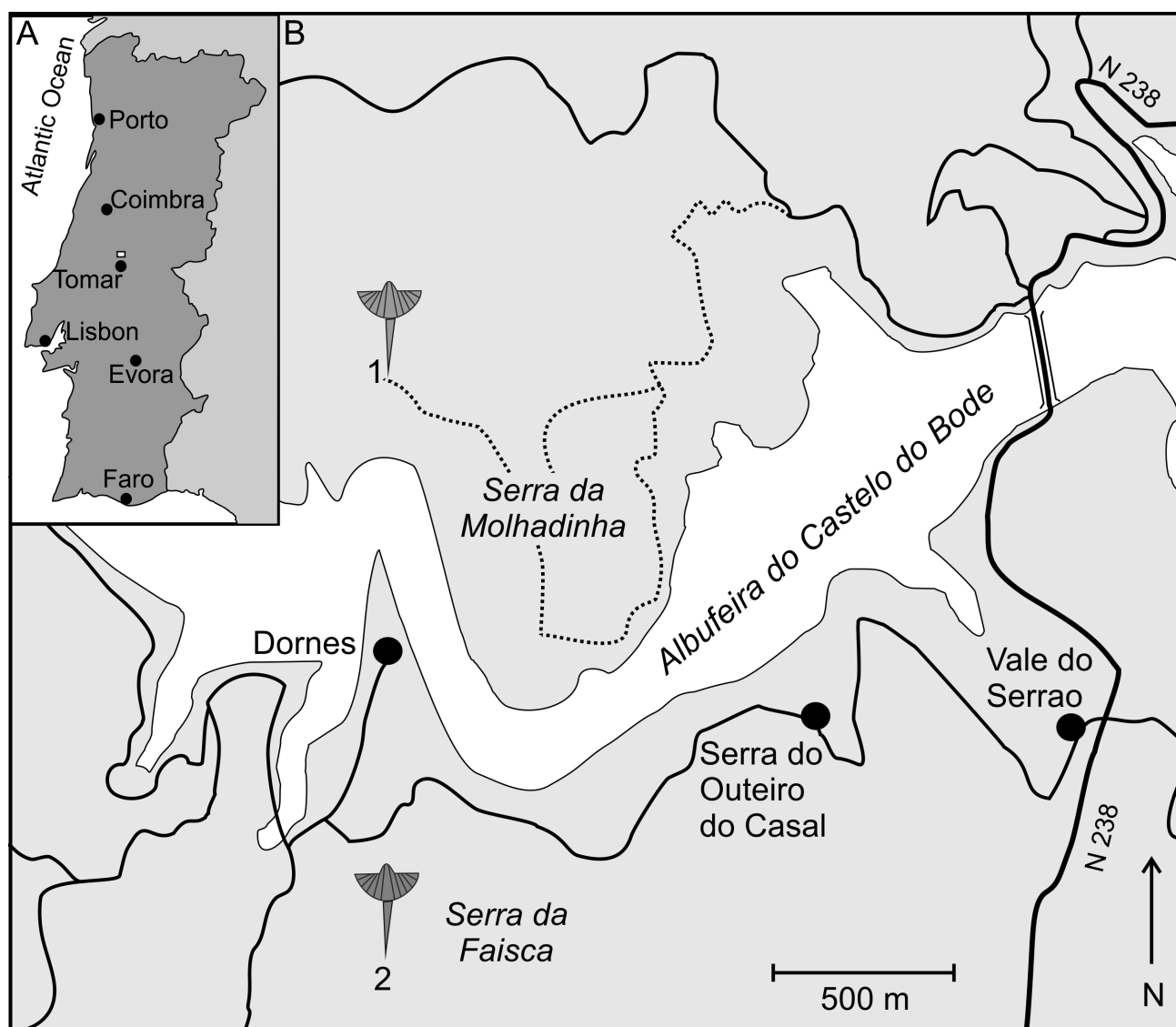


Fig. 1 - Geographical map of the Dornes region with the localities indicated by the spirifer symbol. Lines: roads; dotted lines: field paths. 1) Road cut on SW side of slope of the Serra da Molhadinha at the opposite N site of the reservoir "Albufeira do Castelo do Bode" at Dornes. 2) 850 m N 34° W do v. g. Junqueira, S of Dornes, Serra da Faisca.

GEOLOGICAL SETTINGS

The Dornes Syncline is situated in the Southern Central Iberian Zone, which is, next to the Galicia-Trás-os-Montes and the Ossa Morena zones, one of the three major tectonostratigraphical domains of the Iberian Massif representing Lower Devonian strata. It includes an area around the Dornes Village on both sides of the reservoir "Albufeira do Castelo do Bode" and is bordered to the SE by a system of Ordovician-Silurian synclines of the Amêndoa region (Teixeira & Thadeu, 1967). The whole Devonian "Dornes" succession is oriented in a N-S direction and consists mainly of two formations, the Gedinnian Serra do Lução Formation and the Siegenian-Emsian Dornes Formation (Cooper, 1980; Cooper et al., 2000). The latter consists of a 200 m thick sequence of sandstones, mudstones, and limestones. The stratigraphical

assignment of the Serra do Lução Formation has been revised in recent years based on palynomorphs and brachiopods (Gourvennec et al., 2008, 2010), whereas the revision of the faunal content of the Dornes Formation under modern palaeontological aspects is still lacking. The fact that the Lower Devonian sediments within the Dornes Syncline underwent a strong tectonic deformation during the Variscan Orogeny, resulted in bad preservation and strongly deformed fossils, complicates the work. Since their first description, brachiopods of the Dornes region have been assigned to a broad range of taxa and to different stratigraphical levels resulting in a still doubtful Siegenian and/or Emsian assignment of the Dornes Formation.

Cooper (1980) described several brachiopod yielding layers within the complete Dornes Formation. For this study, two of the layers were sampled, the first one, *Lusitanispirifer lusitanensis* n. gen. et sp. is quite

abundant, whereas it occurs rarely in the second one. The first outcrop is at the Serra de Molhadinha locality (Fig. 1), a few meters west of the locality described by Gourvennec et al. (2008, fig. 1). The brachiopods occur in sandstones and mudstones in almost monospecific lenses, which consist either of *Lusitanispirifer lusitanensis* or of *Plebejochonetes* cf. *semiradiatus* (Sowerby, 1842) each with low numbers of the other taxon. *Plebejochonetes* cf. *semiradiatus* indicates for an Early Emsian age, but it has to be stressed that it might also occur in the latest Siegenian. The second outcrop is Siegenian rather than Emsian in age due to the abundance of *Torosospirifer rousseaui* (Rouault, 1846), *Ctenochonetes* cf. *aremoricensis* Racheboeuf, 1976, *Turcispirifer* sp., and *Uncinulus* sp., which usually occur in Siegenian strata but may reach into the Emsian as well. It has to be stated that only taxa in my collected material are listed in order to provide secure and sufficient stratigraphical collecting data. Other taxa mentioned in literature were omitted because of their insecure identification.

In this work the subdivision of the Lower Devonian into "Siegenian" and "Emsian" is used in the classical German sense because brachiopods occur in the Rhenish (neritic) facies which is often biostratigraphically subdivided by brachiopod biozones (Carls, 1996; Jansen, 1996a, b; Schemm-Gregory & Jansen, 2006).

PALAEOBIOGEOGRAPHICAL INTERPRETATIONS

Gourvennec et al. (2008, 2010) already pointed out that the Gedinnian brachiopods from the Dornes area show affinities with brachiopod faunas described from the Armorican Massif (France), the Cantabrian Mountains and the Eastern Iberian Chains (both in Spain), the Anti-Atlas (Morocco), and the Meguma Zone (Nova Scotia) (compare also Binnekamp, 1965; Boucot, 1975; Carls, 1985; Gourvennec, 1989; Jansen, 2001). All of these regions represent northern Gondwanan terranes. *Lusitanispirifer* is so far only reported from the Dornes region and its capillate micro-ornamentation confirms its relationship to delthyridoid spiriferids from northern Gondwana (Schemm-Gregory, 2011). Representatives of the brachiopod genera *Torosospirifer* Gourvennec, 1989, *Turcispirifer* Schemm-Gregory, 2008a, and *Ctenochonetes* Racheboeuf, 1976 are hitherto only found in northern Gondwana (today's France, Spain, Morocco, and Turkey). These data are in accordance with Schemm-Gregory (2008a, b, c, d, 2009a, 2011) who already discussed faunal migration paths between Gondwanan terranes and Laurentia. The occurrence of *Turcispirifer* and *Torosospirifer* confirms her suggestions, however, the endemic occurrence of *Lusitanispirifer* in Central Portugal pleads for a rather temporarily isolated position of today's Central Portugal during Early Devonian time. The similarities with *Australospirifer* Caster, 1939 suggest a relationship of the Dornes region with the Malvinokaffric Realm. However, the Malvinokaffric Realm is characterized by a thick-shelled cold water fauna, whereas northern Gondwana is supposed to have warmer temperatures (Boucot & Blodgett, 2001). The brachiopod fauna is in general represented by smaller forms with

thinner shells. The similarities between *Australospirifer* and *Lusitanispirifer* are therefore considered as homoplasy and do not reflect a phylogenetic relationship or a possible faunal exchange between these two regions (see conclusions).

MATERIAL AND METHODS

All specimens are preserved as single external and internal moulds. Latex casts were prepared to study the internal morphology of the shell and the external micro-ornamentation. Drawings were done with the help of a camera lucida. Measurements were taken with a digital caliper and rounded to the closest 0.1 mm. Specimens were coated with magnesium oxide prior to photography. The systematics follow that of the revised Treatise on Invertebrate Paleontology (Johnson & Hou, 2006) and Schemm-Gregory (2008b, 2010).

Abbreviations - MG: Museu Geológico, Laboratório Nacional de Energia e Geologia, Lisbon, Portugal.

SYSTEMATIC PALAEOLOGY

Phylum BRACHIOPODA Duméril, 1806

Order SPIRIFERIDA Waagen, 1883

Superfamily DELTHYRIDOIDEA Phillips, 1841

Family FILISPIRIFERIDAE Schemm-Gregory, 2008b

Type genus - *Filispirifer* Jansen, 2001.

Diagnosis - Delthyridoid spiriferids with a capillate micro-ornamentation, in rare cases showing development of marginal micro-spines; ribs simple and moderate to coarse; sulcus smooth or with weak median rib [from Schemm-Gregory (2008b, p. 55)].

Genera included - *Filispirifer* Jansen, 2001; *Mauspirifer* Allan, 1947; *Xerospirifer* Havlíček, 1978; *Leonispirifer* Schemm-Gregory, 2010.

Lusitanispirifer n. gen.

Type species - *Lusitanispirifer lusitanensis* n. gen. et sp.

Diagnosis - Shells with little accretion of secondary shell material in the apical region, a strong dorsal median process, and a posteriorly embedded dorsal adductor field. Small notothyrial shelf present in juveniles, but lacking in adults. Micro-ornamentation capillate, rarely showing areas of fimbriate micro-ornamentation.

Geographical and stratigraphical distribution - Dornes Syncline, Dornes region, Central Portugal; Dornes Formation, Siegenian to Emsian in the classical German sense (middle to upper Lower Devonian).

Species included - At present only the type species *Lusitanispirifer lusitanensis* n. gen. et sp.

Lusitanispirifer lusitanensis n. gen. et sp.
(Fig. 2; Pl. 1, figs 1-21)

1914 *Spirifer hystericus*, forme *Rousseaui* Rouault - PRUVOST, p. 9.
v 1979 *Mauispirifer gosseleti* (Béclard) - PERDIGÃO, p. 194-196,
Pl. 2, fig. 1; Pl. 3, fig. 5.

Holotypus - Ventral internal mould with corresponding external mould stored at the Museu Geológico, Lisbon, under the inventory number MG-21485. Width 29.7 mm, length 19.3 mm of holotype; width 24.8 mm and length 19.2 mm of corresponding external mould.

Derivatio nominis - After Lusitania, the Latin name for Portugal.

Locus typicus et stratum typicum - Road cut on SW side of slope of the Serra da Molhadinha at the opposite N side of the reservoir "Albufeira do Castelo do Bode" at Dornes, Central Portugal; Emsian (upper Lower Devonian) beds of Dornes Formation (Fig. 1).

Geographical and stratigraphical distribution - See genus.

Material -

LOCALITY 1 (SERRA DA MOLHADINHA) - [Road cut on SW side of slope of the Serra da Molhadinha at the opposite N site of the reservoir "Albufeira do Castelo do Bode" at Dornes (Fig. 1), compare also Gourvennec et al. (2008, fig. 1)] 2 ventral internal moulds with corresponding external mould: MG-21485 (holotype and counterpart), 21493; 33 ventral internal moulds: MG-21486-21495, 21499-21500, 21503-21504, 21506-21508, 21510-21516, 21519, 21521-21523; 13 dorsal internal moulds MG-21486-21487, 21494, 21498, 21500, 21503-21504, 21507, 21520, 21525-21526; 16 ventral external moulds MG-21486, 21492, 21494-21495, 21498, 21502, 21509, 21512-21513, 21517-21518 (most of them incomplete); 7 dorsal external moulds MG 21497-21498, 21505-21506, 21512-21513 (most of them incomplete).

LOCALITY 2 (850 m N 34° W do v. g. Junqueira) [S of Dornes, Serra da Faisca (Fig. 1), compare Perdigão (1979, p. 194)] 1 ventral internal mould: MG-21524; 2 dorsal internal moulds: MG-21525-21526.

Diagnosis - See genus.

Description -

Form and size - Small to medium, rarely large specimens, transverse with greatest width at hinge line and mucronate cardinal extremities. Ratio of ventral to dorsal valve is unknown due to the strong tectonic deformation and the presence of isolated and mostly laterally incomplete valves.

Coarse ornamentation - Each flank of ventral external shell covered by 10 to 14 ribs, dorsal flank with one or two ribs less. Ribs are simple, angular in cross-section, and divided by furrows of the same size. Sulcus narrow to moderately wide, moderately deep, and mostly angular to rounded in cross-section. A median rib can be developed (Pl. 1, fig. 11b), however, it is lacking in most specimens.

Furrow moderately elevated, rounded to flat on top, and without median furrow. Sulcus bordering ribs not weakened and not included in the sulcus. Sulcus tongue short and with a rounded anterior margin. Strong growth lamellae rarely developed and only at the anterior margins of both shells.

Micro-ornamentation - Capillate without spines and nodes, rarely small areas with fimbriate micro-ornamentations are preserved (Pl. 1, figs 19a-b, 20a-b).

Exterior of ventral valve - Ventral umbo extending further to posterior over the hinge line than dorsal umbo. Interarea moderately high, apsacline, and gently curved posteriorly. In some specimens transverse growth lamellae are weakly developed. Margins of interarea not parallel to hinge line. Delthyrium open. Deltidial lamellae not reaching to the posterior end of the delthyrium, no deltidium developed (Pl. 1, fig. 14c).

Exterior of dorsal valve - Dorsal umbo small and extending little to posterior over the hinge line. Dorsal interarea low, anacline to almost orthocline, and straight. Notothyrium open, a pair of chilidial lamellae is recognizable, chilidium lacking (Pl. 1, fig. 16d).

Interior of ventral valve - Almost no accretion of secondary shell material in the ventral apical region. Filling of the ventral muscle field extending to posterior over the hinge line, not elevated and not impressed. Fillings of the lateral apical cavities sharply pointing in an apical direction and reaching almost as far to posterior as the filling of the ventral muscle field. Below the muscle field a thin and short septal pillow is present that can be lacking in rare cases. It is bordered by a pair of thin subdeltidial furrows that are often only weakly preserved as rounded ridges on the internal mould (Pl. 1, fig. 1b). A ventral process is clearly developed and preserved usually as a broad indentation at the posterior end of the filling of the ventral muscle field which can show a fine median ridge on moulds of gerontic specimens (Pl. 1, fig. 5). Towards the hinge line the ventral process is becoming blade-like and leaves a furrow on the internal mould of the septal pillow. A short and faint myophragm extends out of the ventral process for about 1/3 of the ventral muscle field. The ventral muscle field is relatively short, but elongate, always longer than wide, and pyriform in outline. One to two ribs are impressed on its filling on the internal mould. Impressions of diductor scars are not preserved. Adductor scars are elongated; thin, weakly impressed into shell material, and preserved as a flattened ridge anterior of the myophragm on the internal mould. It is not differentiable into a posterior and anterior pairs. A muscle bounding ridge is always lacking, subsequently, the anterior margin of the ventral muscle field is unknown. Free portions of dental plates are short, between 1/4 to 1/3 of shell length, thin, radial, straight, and usually situated between the impressions of the 2nd and 3rd pair of ribs. They become gently wedge-like in adult specimens. Teeth very small and knob-like, gently pointing in a posterior direction. No platform is developed next to the ventral muscle field, gonoglyphs are preserved as weak and small ridges pointing in an apical direction sitting on the fillings

of the lateral apical cavities on the internal mould (Pl. 1, fig. 10c). The sulcus is deeply impressed on the internal mould, narrow and rounded to rarely angular in cross-section, and without the impression of a median rib. On the flanks of the internal mould two or one impressions of ribs less than number of ribs on the external flanks are shown which are angular in cross section and separated by often gently wider furrows. The impressions of the sulcus

bordering ribs are not weakened and not included into the impression of the sulcus. No impressions of growth lamellae preserved.

Interior of dorsal valve - Almost no accretion of secondary shell material in the dorsal apical region. A thin and short notothyrial shelf is developed in juvenile specimens, but lacking in adults. Ctenophoridium broad to

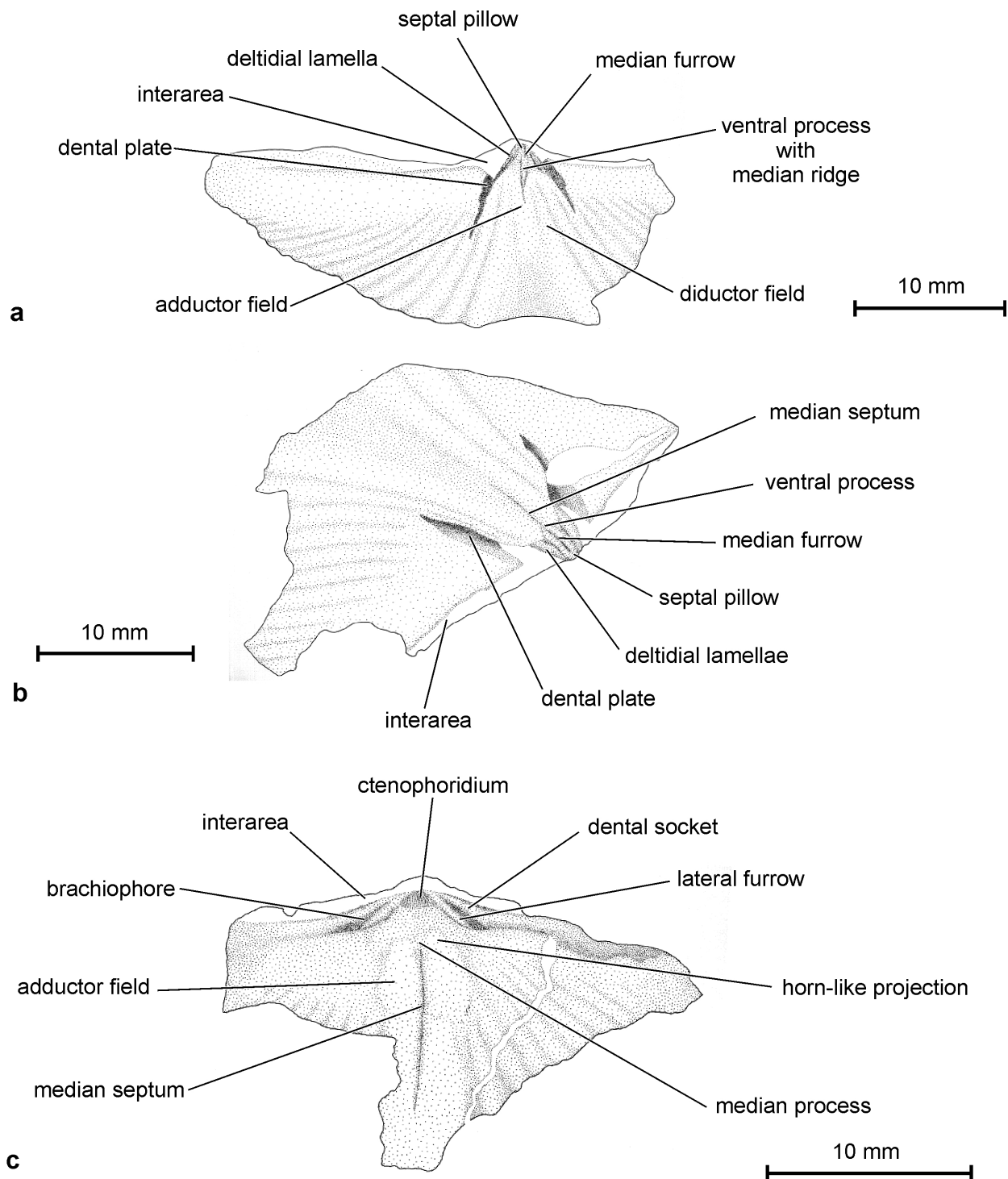


Fig. 2 - Morphological terms used for *Lusitanispirifer lusitanensis* n. gen. et sp. a) MG-21490. Upper view of ventral internal mould. b) MG-21490. Posterolateral view of ventral internal mould. c) MG-21486. Upper view of dorsal internal mould.

thin, but not well enough preserved to count its lamellae. It is bordered by a pair of faint lateral furrows. Thin crural plates are present in juvenile forms but imbedded in adults. Dental sockets, long, thin, circular in cross-section, of equal thickness, and oriented almost parallel to the hinge line. Brachioophores thin and not curved over dental sockets. A coarse and broad dorsal median process, preserved as a broad indentation on the internal mould, divides the posterior part of the adductor field (Pl. 1, figs 3, 13, 17). Out of it runs a faint myophragm in an anterior direction through the adductor field. It is weakly preserved as a very fine furrow on the internal mould. The posterior part of the adductor field is preserved as two gently elevated, horn-like projections pointing in an apical direction and leading into the impression of the first pair of ribs. They are weakly imbedded into shell material at all stages of growth. The posterior and anterior pairs of adductor scars are separated by a stage in which the anterior pair is more embedded into the shell material than the posterior pair of adductors (Pl. 1, fig. 1b). Remains of gonoglyphs are rarely preserved as elongated ridges of equal size, pointing in an apical direction, and situated on the fillings of the lateral apical cavities (Pl. 1, fig. 13a). The impression of the fold is elevated, smooth, and flattened on top. At least 8 impressions of ribs are preserved on each flank but impressions of growth lamellae are lacking.

Discussion - *Lusitanispirifer* n. gen. differs from all other delthyridoid genera in the combination of a combined capillate and fimbriate micro-ornamentation, a posterior imbedded dorsal adductor field, the presence of crural plates, the lack of a muscle bounding ridge, and

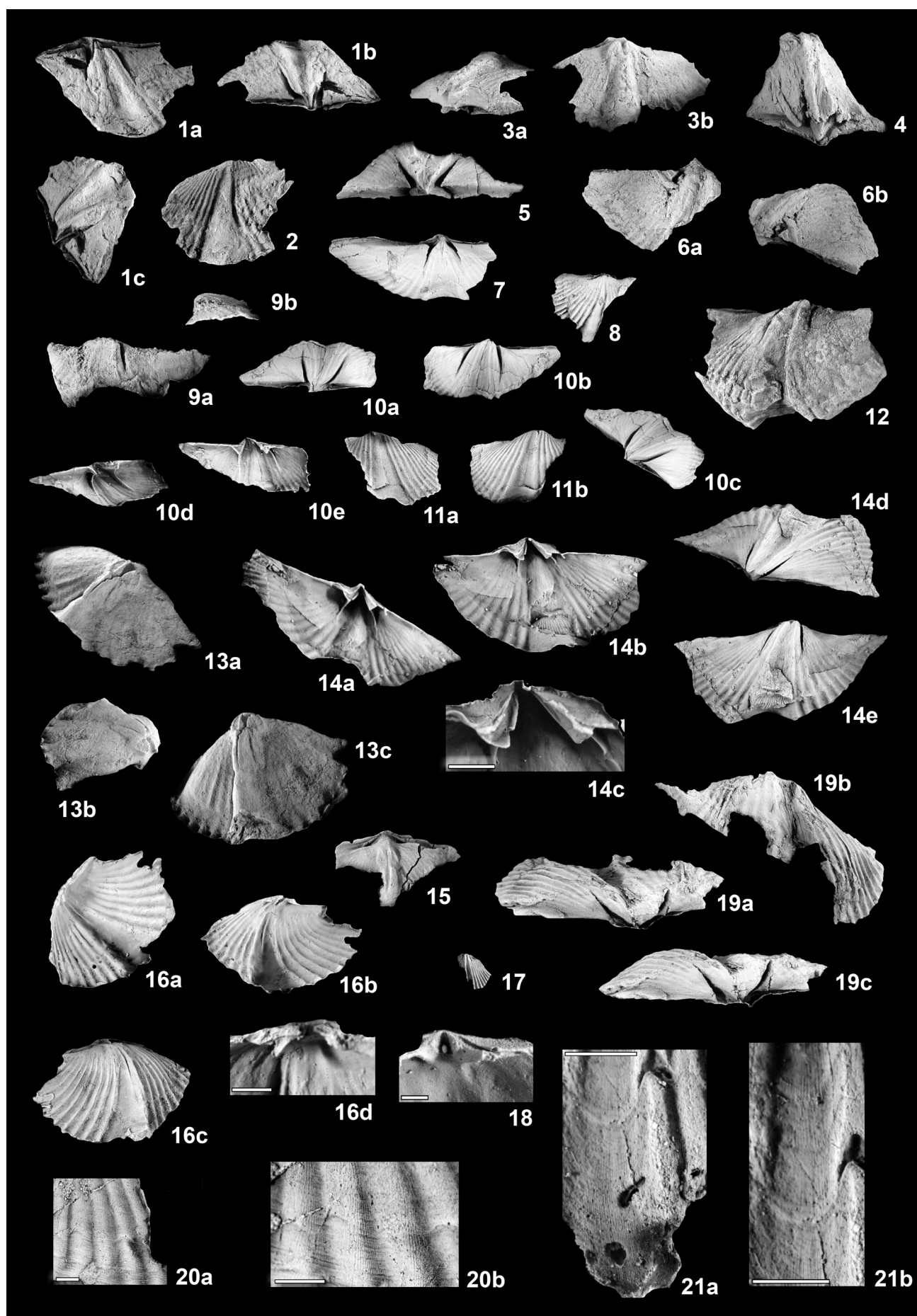
sometimes the presence of a median rib in the sulcus. This combination justifies the erection of a new genus. A morphological comparison with the closest related genera is provided in Tab. 1. In the following, *Lusitanispirifer* is compared with the capillate genera *Filispirifer* Jansen, 2001 and *Leonispirifer* Schemm-Gregory, 2010 with whom it belongs to the Filispiriferidae Schemm-Gregory, 2008b. The other genera within this family, *Mauispirifer* Allan, 1947 and *Xerospirifer* Havlíček, 1978 are discussed only by literature data because no material of these genera was available. A comparison of the other delthyridoid genera is omitted, because they are more distantly related to *Lusitanispirifer* due to their fimbriate and lacrimate micro-ornamentation. *Quiringites* Struve, 1992 shows a different kind of capillate micro-ornamentation which argues for a phylogenetic relationship to Asian delthyridoid spiriferids (Schemm-Gregory, 2009b, 2010), furthermore, its stratigraphical distribution (Middle Devonian) and additional morphological differences exclude this genus from a closer relationship to *Lusitanispirifer* than on the superfamily level.

Lusitanispirifer differs from *Filispirifer* in being smaller, the presence of mucronate cardinal extremities, a mostly weakly developed notothyrial shelf, crural plates, and the lack of a muscle bounding ridge, whereas *Filispirifer* shows only small ears, and a clearly developed muscle bounding ridge; crural plates and a notothyrial shelf are never present. The septal pillow in *Lusitanispirifer* is shorter than in *Filispirifer*. Secondary shell material is barely developed in *Lusitanispirifer*, but strongly developed in *Filispirifer*. Free portions of dental plates are shorter, straight, and clearly thinner in *Lusitanispirifer* and

EXPLANATION OF PLATE 1

Figs 1-21 - *Lusitanispirifer lusitanensis* n. gen. et sp. All specimens from the Dornes Formation (Siegenian to Emsian in the classical German sense, middle to upper Lower Devonian) and of original scale (1.0 x), if no other indication. Figs 1-12, 14-17, 19-21 from locality 1; figs 13 and 18 from locality 2.

- 1 - MG-21485, holotype. Upper (a), oblique posterior (b), and oblique anterolateral (c) views of ventral internal mould.
- 2 - MG-21485, counterpart of holotype. Upper view of ventral external mould.
- 3 - MG-21487. Oblique posterolateral (a) and upper (b) views of dorsal internal mould.
- 4 - MG-21487. Oblique posterior view of ventral internal mould.
- 5 - MG-21486. Posterior view of ventral internal mould.
- 6 - MG-21488. Upper (a) and oblique posterolateral (b) views of ventral internal mould.
- 7 - MG-21490. Upper view of ventral internal mould.
- 8 - MG-21494. Upper view of dorsal internal mould.
- 9 - MG-21496. Upper (a) and lateral (b) views of ventral internal mould.
- 10 - MG-21493. Oblique posterior (a), upper (b), and oblique posterolateral (c) views of ventral internal mould and oblique anterolateral (d) and upper (4) views of its latex cast.
- 11 - MG-21493. Upper view of ventral external mould (a) and its latex cast (b).
- 12 - MG-21489. Upper view of ventral internal mould.
- 13 - MG-21495. Oblique anterolateral (a), lateral (b), and upper (c) views of dorsal internal mould.
- 14 - MG-21494. Oblique posterolateral (d) and upper (e) views of ventral internal mould and oblique anterolateral (a), upper (b), and detailed views of delthyrium (c) of its latex cast; scale bar 2 mm.
- 15 - MG-21486. Upper view of dorsal internal mould.
- 16 - MG-21496. Upper view of dorsal internal mould (c) and oblique anterolateral (a), upper (b), and detailed views of cardinalia (d) of its latex cast; scale bar 2 mm.
- 17 - MG-21499. Upper view of ventral internal mould.
- 18 - MG-21526. Detailed view of notothyrium of its latex cast; scale bar 2 mm.
- 19 - MG-21495. Oblique posterior (a), upper (b), and posterior (c) views of ventral internal mould.
- 20 - MG-21497. Detailed views of micro-ornamentation of latex cast of dorsal external mould; scale bars 2 mm.
- 21 - MG-21497. Detailed views of micro-ornamentation of latex cast of ventral external mould; scale bars 2 mm.



	<i>Lusitanispirifer</i> gen. nov.	<i>Filispirifer</i> Jansen, 2001	<i>Leonispirifer</i> Schemm-Gregory, 2010	<i>Australospirifer</i> Caster, 1939
size	small to large	medium to large	medium to large	medium to large
outline	megathyrid	brachythyrid to megathyrid	megathyrid	megathyrid
mucronations/ears	mucronations	small ears	absent	mucronations
curvature	equi- to ventribiconvex	equi- to dorsibiconvex	strongly dorsibiconvex	ventribiconvex
micro-ornamentation	capillate and fimbriate	capillate, capillae intercalated	capillate, capillae not intercalated	capillate and fimbriate
no of ribs on ventral external flank	10 to 14	5 to 15	4 to 7	7 to 11
ribs	fine, angular to rounded	fine to coarse, angular	coarse, rounded	fine to coarse, mostly rounded
median rib	absent	present to absent	absent	absent to present
sulcus bordering ribs	not included, not weakened	included, weakened	included, weakened	not included, not weakened
deltidium		absent or present	present	absent
secondary shell material in ventral apical region	absent	strong	moderate	strong
septal pillow	small	large	large	large to very large
ventral process	broad, long, with median furrow	thin, short, without median furrow	broad, short, without median furrow	thin, short, without median furrow
free portions of dental plates	Moderate long, thin, straight	short to long, wedge-like, curved	short, wedge-like, curved	short to lacking, wedge-like, straight to curved
muscle bounding ridge	absent	present	present	present
notothyrial shelf	weakly developed to absent	absent to weakly developed	absent	present
angle of brachiophores		75°	40°	
crural plates	present to absent	absent	absent	absent
dorsal median process	broad, coarse, short	absent	absent	broad, coarse, long
dorsal adductor field	posterior imbedded and with horn-like projections, without muscle bounding ridge	not imbedded, with very faint or without muscle bounding ridge	not imbedded, without muscle bounding ridge	posterior imbedded and with horn-like projections, with muscle bounding ridge
geographical distribution	Portugal	Morocco, Spain, Germany, Belgium	Spain, ?Morocco	Brazil, Argentina, Falkland Islands, Bolivia, South Africa, Antarctica
stratigraphical distribution	Siegenian to ?Emsian	Lower Siegenian to Lower Emsian	?Siegenian, Emsian	Emsian

Tab. 1 - Morphological comparison of *Lusitanispirifer* with *Filispirifer*, *Leonispirifer*, and *Australospirifer*.

its ventral process is coarser and broader. On most internal moulds, a fine median furrow is preserved which is never present in the ventral process in *Filispirifer*. The dorsal adductor field in *Lusitanispirifer* is clearly imbedded into shell material, but never in *Filispirifer*.

Lusitanispirifer differs from *Leonispirifer* in a less curvate dorsal valve, numerous fine and angular ribs, a small septal pillow, the lack of secondary shell material, the presence of a notothyrial shelf and crural plates, and longer free portions of dental plates. The new genus shows mucronate cardinal extremities, whereas they are lacking in *Leonispirifer*. *Leonispirifer* has broad, low rounded ribs, strongly dorsibiconvex shells with strong development of secondary shell material in the apical region, a larger septal pillow, and shorter free portions of dental plates. A notothyrial shelf and crural plates are always lacking in *Leonispirifer*. The ventral process in *Lusitanispirifer* is broader and has a median ridge, in *Leonispirifer* it is thinner and without the median furrow. In contrast to *Leonispirifer*, the sulcus bordering ribs are

never weakened and never included into the sulcus in *Lusitanispirifer*.

Mauispirifer is a genus originally described from New Zealand and the problem of the relationship between European and New Zealand *Mauispirifer* forms was already noted by Schemm-Gregory (2008b). However, from the New Zealand forms, *Lusitanispirifer* differs in larger shells, longer and straight dental plates, and a much coarser ventral median septum. *Mauispirifer* has short, thin but curved dental plates and small “hysteroliticidimorph” shells, furthermore, during ontogeny the ventral medium septum is imbedded into shell material. Study of the European forms of *Mauispirifer* is recommended to clarify their systematic position, however, no material was available.

Xerospirifer shows a weakly elevated dorsal valve with a fold not extending above the height of the ribs. Sulcus and fold in *Xerospirifer* are narrower than in *Lusitanispirifer* and angular in cross-section. Both genera show thin and posterior unthickened dental plates,

which are curved medially in *Xerospirifer* and straight in *Lusitanispirifer*. *Xerospirifer* shows a weakly developed muscle bounding ridge and diductor scars preserved as radial striae on the internal mould. A muscle bounding ridge is never developed in *Lusitanispirifer* and diductor scars in rare cases weakly and only partly preserved. The micro-ornamentation in *Xerospirifer* is clearly interrupted by filae, whereas the capillae run through the complete shell length in *Lusitanispirifer*.

Lusitanispirifer shares with *Australospirifer* a posterior imbedded dorsal muscle field with horn-like projections, mucronate cardinal extremities, sulcus bordering ribs which are not weakened and not included into the sulcus, and a combination of capillate and fimbriate micro-ornamentation. These horn-like projections of the dorsal adductor field are hitherto only described from *Australospirifer* (Boucot et al., 1965) and are interpreted to strengthen the closure of the shells. *Lusitanispirifer* shows up to 3 more ribs on each ventral flank, a smaller septal pillow, generally finer ribs, and a shorter ventral process which never has a median furrow as in *Australospirifer*.

CONCLUSIONS

Lusitanispirifer lusitanensis n. gen. et sp. is newly established herein. Due to its capillate micro-ornamentation it belongs to the Filispiriferidae which are part of the northern Gondwana delthyridoid spiriferids. The similarities in micro-ornamentation and the unique structure of the dorsal adductor field with *Australospirifer* could also suggest a relationship between these two genera. However, *Australospirifer* occurs only in the Malvinokaffric Realm, which represents a cold water environment in which brachiopods are characterized in general by large forms with thick shells. The new genus is rather small and thin-shelled. The distinct morphology of the dorsal adductor field resembling *Australospirifer* is interpreted, therefore, as homoplasy. *Lusitanispirifer* is only reported from Portugal and confirms the development of strong endemism during the Early Devonian. However, the associated fauna with *Turcispirifer*, *Torosospirifer*, and *Ctenochonetes* shows affinities to Gondwanan terranes rather than to those characteristic of present-day Central Europe.

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