BRACHIOPODS OF THE LOWER CARBONIFEROUS VEGAMIÁN FORMATION (CANTABRIAN MTS, SPAIN): PART I. INTRODUCTION, LINGULIFORMEA

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ABSTRACT

The history of the Tournaisian Vegamián Formation of the Cantabrian Mts (Spain) consisting of gray to black shales with a typical quiet-water ("Culm") fauna characterised by Linguliformea and small Rhynchonelliformea, is discussed. After an overview of the faunas studied thus far, an evaluation of the age of the Vegamián Formation is given, concluding to the Tournaisian, mainly middle to late Tournaisian. Also, the environment of deposition is discussed.

The linguliform fauna, discussed in this first part, is found mainly in the black, thinly bedded shales. Species of the genera *"Lingula", Lachrymula* and *Orbiculoidea* are described, including the new species *Lachrymula truyolsi*. The new subfamily Lachrymulinae of the Lingulidae is created for the genera *Lachrymula* and *Trigonoglossa*. It is distinguished from the Lingulinae by a relatively thick, subtriangular shell with a distinct pedicle groove and a rugose ornamentation.

The rhynchonelliform fauna, occurring mostly in more thickly bedded, often decalcified grayish layers, will be dealt with in a subsequent paper.

Keywords: Brachiopods, Linguliformea, Lower Carboniferous, Vegamián Formation, Cantabrian Mountains, Spain.

RESUMEN

La Formación Vegamián está constituida fundamentalmente por lutitas grises a negras y contiene una fauna típica de aguas tranquilas ("Culm"), caracterizada por Linguliformea y pequeños Rhynchonelliformea. En el presente trabajo se discute la historia de la formación, toda la fauna estudiada hasta el momento, la edad atribuida a la formación (concluyendo que es Turnesiense, principalmente Turnesiense medio-superior) y el ambiente de depósito. Por lo que se refiere a los braquiópodos, el trabajo se ocupa del estudio de los Linguliformea, procedentes, en su mayor parte, de lutitas negras en capas delgadas. Se describen especies de los géneros *"Lingula", Lachrymula* y *Orbiculoidea,* incluyendo la nueva especie *Lachrymula truyolsi.* Se crea la nueva subfamilia Lachrymulinae, dentro de los Lingulidae, en la que se incluyen los géneros *Lachrymula* y *Trigonoglossa*. La nueva subfamilia se distingue de la Lingulinae por la posesión de una concha relativamente espesa, subtriangular, con desarrollo de un surco peduncular y ornamentación rugosa.

Los Rhynchonelliformea se encuentran generalmente en capas más gruesas, grisáceas y descalcificadas; su estudio será objeto de un trabajo posterior.

Palabras clave: Braquiópodos, Linguliformea, Carbonífero Inferior, Formación Vegamián, Cordillera Cantábrica, España.

INTRODUCTION

VEGAMIÁN FORMATION

The black and grayish to cream-coloured shales of the Vegamián Formation lie, presumably with a slight disconformity, on the Ermita Formation. Deposition of the latter started at the end of the Devonian after a period of uplift resulting in a hiatus of varying length and lies therefore on formations which can be as old as Cambrian or as young as the Late Devonian. The sandstones are of varying composition, depending on the formation they

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are derived from, and they may be substituted by (bio)clastic limestones. The top part of the Ermita Formation may reach the Lower Tournaisian.

The Vegamián Formation was first described from the Cantabrian Mountains by Comte (1959, p. 330) as the "couches de Vegamian", although the black shales below the griotte limestones and shales (referred to as "marbre griotte", Alba Formation, or Genicera Formation) have often been mentioned in the older literature (*e.g.* Barrois, 1882). The type locality S of Vegamián has since been flooded by the Porma Reservoir and Evers (1967, p. 104, fig. 18) described a new type section higher up the mountain. Wagner *et al.* (1971, pp. 624-625) consider this a hypostratotype and interpret it differently, drawing the base of the Genicera Formation considerably lower, *i.e.* at the base of the brachiopod-bearing red and black shales with limestone nodules. A good section, rich in fossils, is found immediately below the Genicera Formation at its type section, *c.* 2 km SW of Genicera, León. This locality was completely exposed, measured and sampled by Dr R.H. Wagner and his collaborators (see Wagner, 1963; Higgins *et al.*, 1964).

The combination of the black shales and griotte limestones and shales into one Sella Formation by Brouwer and van Ginkel (1964) was later abandoned (van Ginkel, 1965, p. 182). Also, the rather confusing usage of the Sella Formation for the top part of the Alba Formation and the combination of the Vegamián Formation with the lower part of the Alba Formation, consisting of greenish and red-coloured shales, marls and cherts, into a single Getino Formation (Rácz, 1964) was not followed. Van Staalduinen's usage (1973, p. 179) of the Vegamián Formation apparently comes close to the Getino Formation of Rácz, but one cannot be sure about his exact intentions since he does not give stratigraphic sections.

In his original description, Comte (1959, p. 330) mentions the greenish and reddish shales transitional to the griotte but describes the type section south of Vegamián as consisting of black shales with silico-phosphate nodules. Wagner *et al.* (1971), in accordance with Winkler Prins' (1968) usage, confined the Vegamián Formation therefore to the black, sometimes greyish, shales, and included the greenish and reddish shales, with the marls and nodular limestones in the Gorgera Member of the Genicera Formation.

It should be noted that the Vegamián Formation is not everywhere found in the Cantabrian Mountains. In its southern and western flank the Baleas Limestone Formation occurs locally as a lateral replacement (Wagner *et al.*, 1971; Truyols Santonja and Sánchez de Posada, 1983; Eichmüller and Seibert, 1984, fig. 3). The Portillas Limestone of the Picos de Europa area (Marquínez, 1978, p. 297; not to be confounded with the Portilla Formation) could be a similar replacement.

FAUNAL RESEARCH

Brachiopods

Wagner (1963, p. 54) was the first to mention the linguliform brachiopods from the Vegamián Formation, be it only at the generic level, as many did later on (Wagner, in Higgins *et al.*, 1964, p. 221; van Adrichem Boogaert, 1967, p. 163; Winkler Prins, 1983; Martínez Chacón and Winkler Prins, 1993). These citations are not included in the synonymy lists, even though the citations of *Orbiculoidea* could have been included in the synonymy of *O. cincta.* Winkler Prins (1968) described the chonetid and productid brachiopods and gave a provisional list with species identifications of all brachiopods. A single brachiopod from the Picos de Europa near the road Espinama-Aliva (see Maas, 1974, p. 385) tentatively identified by the first author (C.F.W.P.) as *Brachythyris* sp. (cited as *Brachetyra* sp.) could belong to the Ermita Formation or the basal part of the Alba (= Genicera) Formation, but definitely not to the Vegamián Formation, as he suggests.

It is perhaps also interesting to mention that some fragmentary but well-preserved specimens of *Orbiculoidea cincta* from loc. WAG 1165B were made available to Sir Alwyn Williams for study of the shell structure by him and his group (Williams *et al.*, 1998, p. 2021).

Bivalves

Dr R.B. Wilson (in Wagner, 1963, p. 54) gave some tentative identifications, viz. *Euchondria* ? cf. *losseni* (von Koenen) and *Posidonia* ? sp., (see also Winkler Prins, 1968, table I; the difference being a question of nomenclature). Amler and Winkler Prins (in press) were the first to make a detailed study of the bivalves found in the Vegamián Formation.

Ammonites

Some squashed goniatites were tentatively attributed by Mrs C.H.T. Wagner-Gentis (in Wagner, 1963, p. 54) to *Pericyclus.* The only well preserved ammonite found thus far was identified by her (in Wagner *et al.*, 1971) as *Muensteroceras arkansanum* Gordon, 1970.

Ostracodes

Jordan and Bless (1970) described several new species of pelagic ostracodes from the Vegamián Formation and a list was given in Sánchez de Posada (1976).

Trilobites

Gandl (1973) described the trilobite faunas from the Vegamián Formation in the first of a series of papers on the Carboniferous trilobites from the Cantabrian Mountains and discussed their affinities and palaeoecological implications.

Conodonts

Fairly rich conodont faunas have been described by Higgins (in Higgins *et al.*, 1964; Higgins, 1971) from the Genicera section and later (in Higgins and Wagner-Gentis, 1982) assigned to the *Siphonodella cooperi-Polygnathus communis* Zone and the lower *Scaliognathus anchoralis* Zone (top part). Van Adrichem Boogaert (1967) agrees with these identifications and Raven (1983) gives some additional information, notably on conodonts belonging to the intervening *G. pseudosemiglaber* Zone.

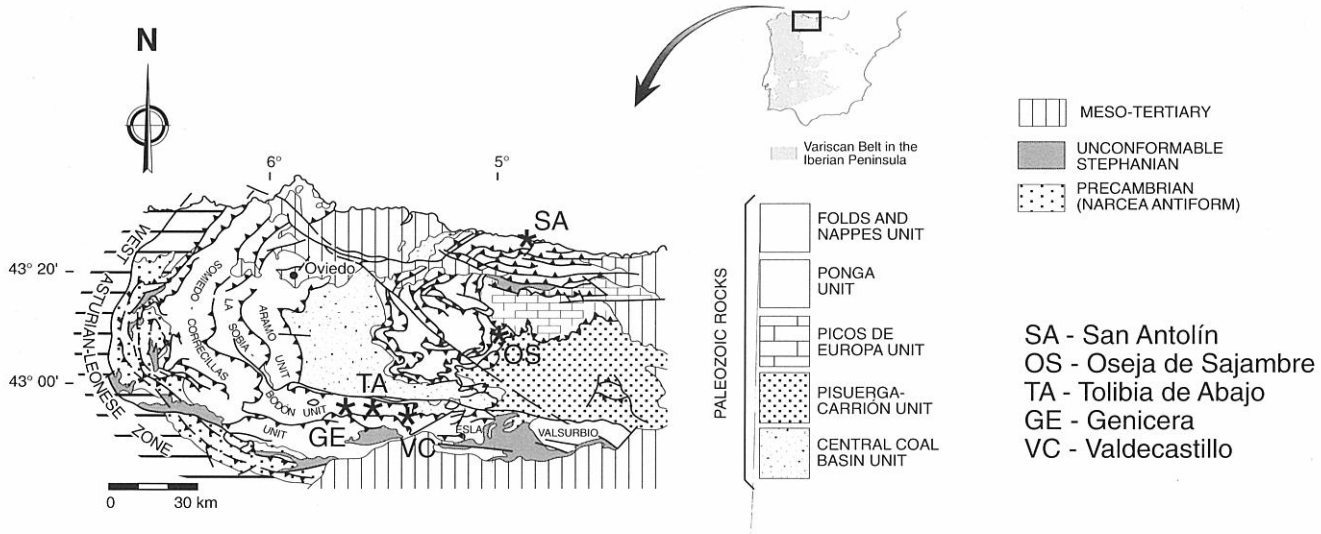

Figure 1. Simplified geological map of the Cantabrian Zone (after Julivert, 1971, modified according to the views of Pérez Estaún *et al.*, 1988), showing the collecting localities.

Other faunal elements

Winkler Prins (1968, table I) listed radiolarians and unidentified fish remains.

AGE

Originally, the black shales of the Vegamián Formation were considered to be of a Devonian age (comparing *e.g.* Barrois, 1882, p. 548). There has also been some confusion with the Silurian Formigoso Formation (*e.g.* Llopis Lladó, 1951, see Sjerp, 1967, p. 77). Comte (1959, p. 331) links the Vegamián Formation lithologically with his Alba Formation and suggests a (late) Viséan age. De Sitter (1962, p. 258) compares it with similar shales from the Pyrenees and suggests a Tournaisian age. The goniatite fragments found in the Gildar-Montó area by Budinger and Kullmann (1964, p. 418) seem to corroborate the Viséan age, but the sandy shales are quite different from true Vegamián Shales (cf. Raven, 1983, p. 296); they are underlain by undated black shales with phosphatic nodules which appear to be typical Vegamián Shales (Wagner and Winkler Prins, personal observations). Higgins (in Higgins *et al.*, 1964) was the first to date the Vegamián Formation reliably with the help of conodont faunas as middle-late Tournaisian, the *S. anchoralis* Zone nowadays being considered late Tournaisian. The view of van Adrichem Boogaert (1967, p. 163) that the upper and lower boundaries of the Vegamián Formation are diachronous and that its fullest development took place in the Palentian facies area is due to the fact that he included the above-mentioned sandy shales as well as cherts that are partly greenish or reddish, which should rather have been included in the overlying Alba (= Genicera) Formation. The top of the underlying Ermita Formation may vary slightly in age, but this does not mean that the age of the base of the Vegamián should also differ, since a slight hiatus is often observed. Raven (1983) agrees with a middle Tournaisian - early Viséan (*S. anchoralis* Zone: now late Tournaisian) age for the Vegamián Formation. Rodríguez Fernández *et al.* (1985) included in the Vegamián Formation some black marly limestones with conodonts of the *kockeli-dentilineatus* Zone of early Tournaisian age, with intercalated black shales, which others had included in either the Ermita Formation or the Baleas Formation. The brachiopod data seem to point to a Viséan age, since they compare well with the Culm faunas from NW Europe of Viséan age (cf. Nicolaus, 1963; Winkler Prins, 1971) but a Tournaisian age cannot be excluded and the fauna is considered a better indicator for the environment (black shales) than for the age (Winkler Prins, 1968, p. 61). The goniatite *Muensteroceras arkansanum* Gordon, 1970 described by Wagner-Gentis (in Wagner *et al.*, 1971) from the Genicera locality is of late Kinderhookian age perhaps ranging into the early Osagean, which could perhaps best be interpreted as middle Tournaisian. Gandl (1973, p. 30) concludes to a late Tournaisian age for the trilobite faunas. In conclusion one may state that a middle-late Tournaisian age for the Vegamián Formation is firmly established and a possible extension into the Viséan depends on whether one wants to include the sandy shales of the Montó area in it.

ENVIRONMENT OF DEPOSITION

The Vegamián Formation is generally considered a quiet-water or "Culm" deposit (*e.g.* Winkler Prins, 1968; Gandl, 1973; Martínez Chacón and Winkler Prins, 1993). The most likely model is a relatively shallow sea with a flat bottom with a slope of only a few degrees at the most (Winkler Prins, 1968, p. 55), which prevents wave action and thus causes a restricted environment with anaerobic bottom conditions at least most of the time (Wagner *et al.*, 1971, p. 645). The Vegamián Formation is closely comparable with other black shale ("Culm") deposits from the Viséan of NW Europe (*e.g.* Dixon and Vaughan, 1911; Nicolaus, 1963).

The linguliform brachiopods are found more

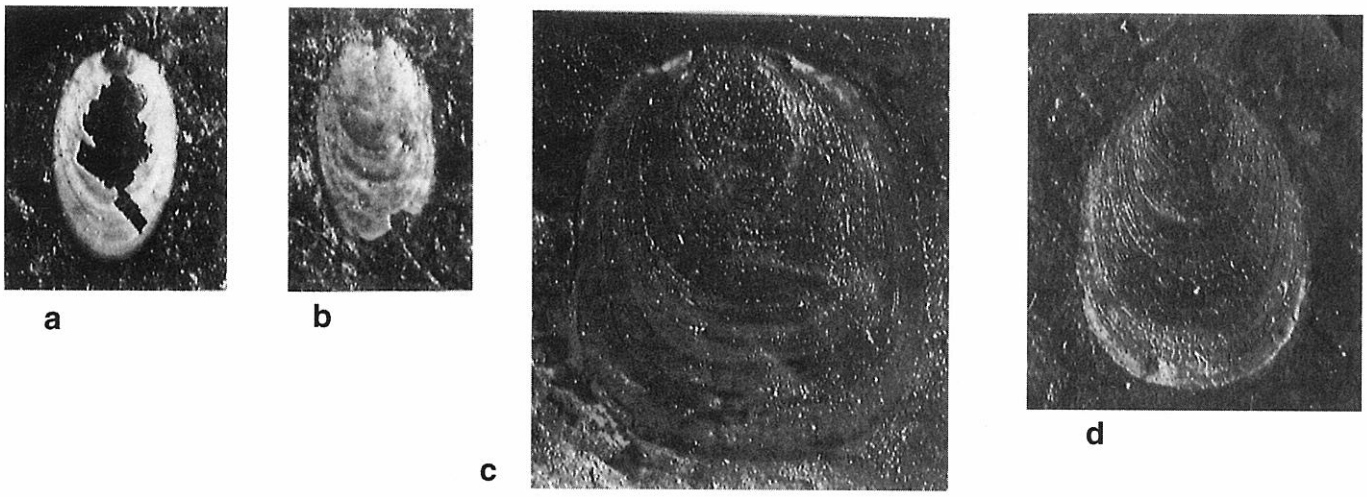

Figure 2. a-b. *"Lingula" mytilloides* J. Sowerby, 1812; Genicera, WAG 1165B; **a:** brachial valve, RGM 131 008, X 10; **b:** pedicle valve, RGM 131 009, X 10. **c-d.** *"Lingula" squamiformis* Phillips, 1836; Genicera, WAG 1165B; **c:** brachial valve, RGM 131 007, X 8; **d**: pedicle valve, RGM 293 330 X 8.

commonly in the black shales, whilst the grayish to cream-coloured shales are richer in rhynchonelliform brachiopods. The latter are generally decalcified, except at the locality of Oseja de Sajambre, where the shales are siliceous.

The Vegamián Formation fits well in a sequence that started with the epeirogenetic movements that caused the hiatus, forming an angular unconformity on the map, below the Ermita Formation. The relief was levelled during the deposition of the Ermita Sandstones and a relatively shallow (*c.* 50 m?), cool sea with a flat bottom was the result, where organic rich muds were deposited at a slow rate (Vegamián Black Shales). In shallow parts closer to the shore high-energetic limestones of the Baleas Formation were formed. When the anaerobic conditions became less extreme, the black colour changed to gray-cream and green when it was still a reducing environment, but became red under oxidising conditions (cf. Winkler Prins, 1968, p. 59). These colours are found in the overlying Genicera Formation which consists of shales, nodular limestones and cherts, still considered to have been deposited below wave base. This may indicate a shallowing of the sea as discussed by van den Bosch (1969, p. 173) on the basis of the studies by McKelvey. Sediment supply must have been very low and the region tectonically very quiet. Deposition was mainly influenced by eustatic sea-level movements. At the end of the Genicera Formation the basin started to deepen again and we see the reverse order of events: the red limestones become gray-greenish and are followed by the black, euxinic, laminated limestones of the Barcaliente Formation, which can reach a considerable thickness.

COLLECTING LOCALITIES (Fig. 1)

Genicera (WAG 1165B)

An exposure 2 km SW of Genicera on the eastern bank of the arroyo Canalón (sheet 104, Boñar, of the geological map of Spain 1:50.000, coördinates 42°56'23"N 5°29'47"W; León), dug out to measure the Vegamián Formation (see Wagner, 1963, p. 224; Higgins *et al.*, 1964, fig. 2). Material in part collected by Dr R.H. Wagner and company (*op. cit.*) and partly by the first author (C.F.W.P.).

Tolibia de Abajo (WP 12)

An exposure situated *c.* 1500 m SE of Tolibia de Abajo in a tributary of the Valle de Valdemaría (sheet 104, Boñar, coördinates 42°57'19"N 5°23'22"W; León), on the east bank of the River Curueño when leaving the gorge formed by the river in the Barcaliente and Valdeteja limestones of the Bodón thrust unit (Evers, 1967). Material collected by both authors.

Valdecastillo (VCO-5)

Locality 300 m W of church of the village of Valdecastillo (sheet 104, Boñar, coördinates 42°54'32"N 5°19'W; León). Material collected by Dr J.M.G. Raven in 1981-1982 (then at Leiden Univ.) and by both authors.

Oseja de Sajambre (WP 17)

Exposure on the main road before tunnel, 1 km SE of Oseja de Sajambre (sheet 80, Burón, coördinates 43°07'34"N 5°01'51"W; León). Material collected by both authors. The locality is of special interest because the shell material of the articulate brachiopods is preserved in the black siliceous shales.

San Antolín (SA)

Beach at San Antolín (sheet 31, Ribadesella, of the geological map of Spain 1:50.000, coördinates 43°26'39"N 4°52'18"W; Asturias). Material collected mainly by the second author (M.L.M.Ch.) and Dr L. Sánchez de Posada (Univ. of Oviedo).

SYSTEMATIC DESCRIPTIONS

The main classification is based on the modern views that presumably will be used for the new edition of the

brachiopod volume of the Treatise on Invertebrate Paleontology (cf. Holmer *et al.*, 1995; Williams *et al.*, 1996).

The material is deposited at the Nationaal Natuurhistorisch Museum in Leiden (prefix RGM) and at the Departamento de Geología of the Universidad de Oviedo (prefix DPO).

PHYLUM BRACHIOPODA Duméril, 1806
SUBPHYLUM LINGULIFORMEA Williams, Carlson, Brunton, Holmer and Popov, 1996
CLASS LINGULATA Gorjansky and Popov, 1985
ORDER LINGULIDA Waagen, 1885
Superfamily **LINGULOIDEA** Menke, 1828
Family **Lingulidae** Menke, 1828
Subfamily **Lingulinae** Menke, 1828
Genus *Lingula* Bruguière, 1797

Type species: *Lingula anatina* Lamarck, 1801 (ICZN decision 1355, see Melville, 1985).

Remarks

The genus deserves a place in the Guinness Book of Records as the longest ranging genus (Ordovician-Recent: *c.* 500 Ma). Whether all material really should be included in one and the same genus seems doubtful. Insufficient knowledge of internal structures of the older species makes assignment to *Lingula* often a matter of convenience, as is actually the case with the present material. Recently, new genera have been created for Mesozoic material (*Lingularia* Biernat and Emig, 1993) and Late Palaeozoic material (*Semilingula* Popov, in Egorov and Popov, 1990) based on the internal structure (muscle scars, mantle canals, etc.). Part of the Late Palaeozoic material may even belong to the Pseudolingulidae, as for example *Liralingula,* which is considered a junior synonym of the pseudolingulid *Bicarinatina* by Popov *et al.* (1994, p. 1217). When known, the musculature differs significantly from these genera, as is the case for the Carboniferous species *"L." squamiformis* and *"L." straeleni* (cf. Graham, 1970, fig. 6).

Since a detailed investigation of the internal structure of the Carboniferous species of *Lingula,* studying type material, is beyond the scope of this paper, we have refrained from creating a new genus for (part of) the Carboniferous species, which are provisionally referred to as *"Lingula"*.

"Lingula" mytilloides J. Sowerby, 1812

Fig. 2a-b

*1812 *Lingula mytilloides* J. Sowerby, 55, pl. XIX, figs. 1-2.
1934 *Lingula paralella* Phillips; Demanet, 15-17, text-fig. 2, pl. I, fig. 6.
?1934 *Lingula elliptica* Phillips; Demanet, 17-18, text-fig. 3, pl. I, fig. 7.
1938 *Lingula paralella* Phillips; Demanet, 54, text-fig. 22, pl. V, figs. 1-2.
1943 *Lingula mytilloides* Sowerby; Dorsman, 16-18, pl. 1, figs. 3-4.
1959 *Lingula mytilloides* Sowerby; Vangerow, 50-51, table 2, pl. 10; pl. 11, figs. 1-3, 6.
1968 Lingula mytilloides Sow.; Winkler Prins, table 1.
1970 *Lingula mytilloides* J. Sowerby; Graham, 143-147, text-figs. 2-4, pl. XIV, pl. XV, figs. 1?, 9-11, pl. XX, fig. 4 (cum syn.).
1972 Lingula mytilloides Winkler Prins, in Bless and Winkler Prins, 234 (table 2).
1979 *Lingula mytilloides* Sow.; Korejwo, 468-469, pl. 1, figs. 1-3.

Diagnosis

Small, moderately convex *"Lingula"* with an elliptical outline, the anterior margin being rounded, rather than acuminate or almost straight. Length/width ratio averages 1.8, the ratio being higher in the smaller specimens. Almost equivalve, the pedicle valve having an acuminate umbo. Ornamentation of weakly developed rugae and irregular subconcentric filae. Internally a subconcentric corrugation and fine radial striae are developed.

Material: Fourteen specimens from locality WAG 1165B: 3 collected by Dr R.H. Wagner and colleagues (see Higgins *et al.*, 1964; RGM 142 594?, 142 654, 142 685) and 11 by the first author (C.F.W.P.; RGM 131 008-015, 020-021, 023); 3 specimens were collected by the second author from locality WP 12 (M.L.M.Ch.; DPO 33 982-984); both brachial and pedicle valves.

Description

The present material is rather small for the species, the largest specimen measuring less than 5 mm in length. Almost equivalve, the pedicle valve having an acuminate umbo and that of the brachial valve showing a large umbonal angle; the valves cannot always be distinguished. The shape is elliptical and the length width ratio varies between 1.5 and 2.0, the smaller specimens normally having the larger ratio. A colour-banding is observed varying from whitish to gray or light brown. The ornamentation consists of weakly developed rugae with fine subconcentric filae (growth lines?) superimposed. The internal surface shows a fine subconcentric corrugation and weakly developed radial striae. Muscle scars were not observed.

Occasionally a groove is observed on the umbonal part of some pedicle valves (Fig. 2b), similar to the ones shown for *L. squamiformis* by Graham (1970, pl. XVI, figs. 9, 12) and presumably due to crushing. They are also found on other parts of the valves.

Measurements (in mm):

Number	L	W	L/W
RGM 131 008	2.8	1.5	1.9
RGM 131 009	2.7	1.4	1.9
RGM 131 011	2.8	1.4	2.0
RGM 131 012	4.2	2.8	1.5
RGM 131 013	3.7	2.2	1.7
RGM 131 020	2.2	1.1	2.0
RGM 142 654	3.8	1.9	2.0
RGM 142 685	3.3	2.1	1.6

Discussion

The species has been excellently described by Graham (1970), who also designated a lectotype. He gave reasons for differentiating between *"L." mytilloides* J. Sowerby, 1812, *"L." straeleni* Demanet, 1934, and *"L." squamiformis* Phillips, 1836, which hold true for the present material. Besides, the fact that the growth lines of *"L." squamiformis* indicate that juvenile specimens have the typical shape and were not suboval clearly indicate that the two species can and should be differentiated.

The pair of diverging folds (= "radial ridges or costae" of Graham, 1970) are considered by us to have a similar function as the diverging septae of the Glottidiinae (Archbold, 1981).

Occurrences

"L." mytilloides is widely found in the Viséan-Bolsovian (ex Westphalian C) of Western Europe and in Spain it is found in the Tournaisian Vegamián Formation and may occasionally occur in younger, Pennsylvanian (= Upper Carboniferous *s.l., i.e.* above the mid-Carboniferous boundary; cf. Wagner and Winkler Prins, 1994) strata of the Cantabrian Mts. It is very likely that the species also occurs in the former Soviet Union, but descriptions and figures are often insufficient for a detailed comparison (*e.g.* Sarytcheva and Sokolskaja, 1952), so no attempt has been made to include the Soviet literature in the synonymy. Also, no comparison has been made with Carboniferous species of *Lingula* from other continents, since this would mean a revision of these species including the study of type material, which is outside the scope of this paper.

"Lingula" squamiformis Phillips, 1836

Fig. 2c-d

*1836 *Lingula squamiformis* Phillips, 221, pl. XI, fig. 14.
1934 *Lingula squamiformis* Phillips; Demanet, 13-14, pl. I, figs. 1-3.
1943 *Lingula credneri* Geinitz; Dorsman, 18, pl. 1, fig. 2.
1943 *Lingula squamiformis* Phillips; Dorsman, 19, pl. 1, fig. 6.
1959 *Lingula* aff. *squamiformis* Phillips; Vangerow, 53, table 2, pl. 12, fig. 1.
1968 Lingula squamiformis Phill.; Winkler Prins, table 1.
1970 *Lingula squamiformis* Phillips; Graham, 150, text-figs. 3, 6d, pl. XVI, figs. 5-15 (cum syn.).
?1984 *Lingulipora squamiformis* (Phillips); Zakowa and Chlebowski, pl. I, fig. 7.
1989 *Lingula squamiformis* (Phillips); Winkler Prins, B10, fig. 40.

Diagnosis

Medium-sized, weakly convex, subquadrate, thin-shelled *"Lingula"* with a truncate anterior margin. Length/width ratio averages 1.5. Almost equivalve, the pedicle valve being slightly extended at the umbo. Ornamentation of growth lines. Two radial folds are normally observed. Internally a fine subconcentric corrugation and radial striae are developed.

Material: Seven specimens from locality WAG 1165B: 4 collected by Dr R.H. Wagner and colleagues (see Higgins *et al.*, 1964; RGM 142 705, 293 329-331) and 3 by the first author (C.F.W.P.; RGM 131 007, 019, 293 335); 3 specimens from loc. WP 17 (293 337; DPO 33 985) are tentatively assigned to this species.

Description

The present material is rather small for the species, the largest specimen measuring 7.6 mm in length. The shape is subquadrate with parallel lateral margins and a truncate (almost straight) anterior margin. Almost equivalve, the pedicle valve is slightly extended at the umbo, the brachial valve having a nearly straight posterior margin (Fig. 2c). The length/width ratio varies between 1.1 and 1.8, averaging 1.5. A colour-banding is observed in different shades of brown and dark gray. The ornamentation consists of fine subconcentric filae (growth lines?). The internal surface shows a fine subconcentric corrugation and very weak, irregular radial striae. Muscle scars were not observed.

Measurements (in mm):

Number	L	W	L/W
RGM 131 007	7.6	6.1	1.1
RGM 142 658	>5.7	4.0	>1.4
RGM 293 325	6.5	3.7	1.8
RGM 293 329	6.0	4.0	1.5
RGM 293 330	5.5	4.0	1.4
RGM 293 337A	7.5	4.3	1.7
RGM 293 337B	7.0	4.3	1.6

Discussion

The species has been excellently described by Graham (1970), who also gave reasons for differentiating between *"L." mytilloides, "L." straeleni* and *"L." squamiformis* (see also Discussion of *"L." mytilloides).* In our material no pair of diverging folds were observed (see Discussion of *"L." mytilloides),* but this may be due to the rather small size of our specimens, which may not have reached maturity.

Occurrences

"L." squamiformis is widely found in Viséan-Bolsovian (ex Westphalian C) deposits of Western Europe (see also *"L." mytilloides).* In Spain it is found in the Tournaisian Vegamián Formation of the Cantabrian Mts.

Subfamily **Lachrymulinae** Winkler Prins and Martínez Chacón, subfam. nov.

Type genus: *Lachrymula* Graham, 1970.

Diagnosis

Lingulidae characterised by relatively thick, subtriangular shells, a distinct pedicle groove and a rugose ornamentation. Internal surface smooth; septae absent.

Genera included

Lachrymula Graham, 1970 (Tournaisian-Bolsovian)

and *Trigonoglossa* Dunbar and Condra, 1932 (Carboniferous).

Discussion

The outline of the Lachrymulinae resembles that of the much older Obolidae, but the latter differ in having well-developed propareas in the pedicle valves and pseudointerareas in the brachial ones. The shape, relatively thick shells, prominent rugae, and the pedicle groove distinguish the Lachrymulinae from the true Lingulinae. Whether the preservation of Lachrymulinae as white shells, in contrast to the more transparent shells of the Lingulinae, often showing colour-banding (different shades of brown to black), has any fundamental significance with regard to their shell structure is unknown at the moment.

Genus *Lachrymula* Graham, 1970

Type species: *Lachrymula inusitata* Graham, 1970 (by original designation).

Diagnosis

Rather small, tear-shaped to subovate Lachrymulinae with a weakly rugose ornamentation and faint radial striae.

Species included

Lachrymula inusitata Graham, 1970; *Lingula latior* McCoy, 1852; *Lingula pringlei* Currie, in Currie *et al.*, 1937 and *Lachrymula truyolsi* sp. nov.

Lachrymula truyolsi Winkler Prins and Martínez Chacón, sp. nov.

Fig. 3a-e

1993 *Lachrymula* aff. *inusitata* Graham; Martínez Chacón and Winkler Prins, pl. 1, fig. 1.

Holotype: Brachial valve (RGM 131 003; Fig. 3a).

Type locality: An exposure 2 km SW of Genicera (León), coördinates 51°31'N 4°21'57"W.

Type horizon: Fossiliferous level at 1.80 m above base of the Vegamián Formation (WAG 1165B, see Wagner, 1963, p. 224; Higgins *et al.*, 1964, fig. 2).

Derivatio nominis: The species is named after Professor Jaime Truyols Santonja (Oviedo Univ.) to whom this volume is dedicated.

Diagnosis

Moderately convex *Lachrymula,* tear-shaped in outline, and up to almost 10 mm in length. L/W ratio 1.5, greatest width anterior of mid length; pedicle valve slightly longer than the brachial one. Umbonal angle 60°. Ornamentation of numerous thin but prominent subconcentric rugae. Brachial valve with short straight posterior margin and two diverging folds. Internal surface (as far as observed) practically smooth; muscle scars not observed.

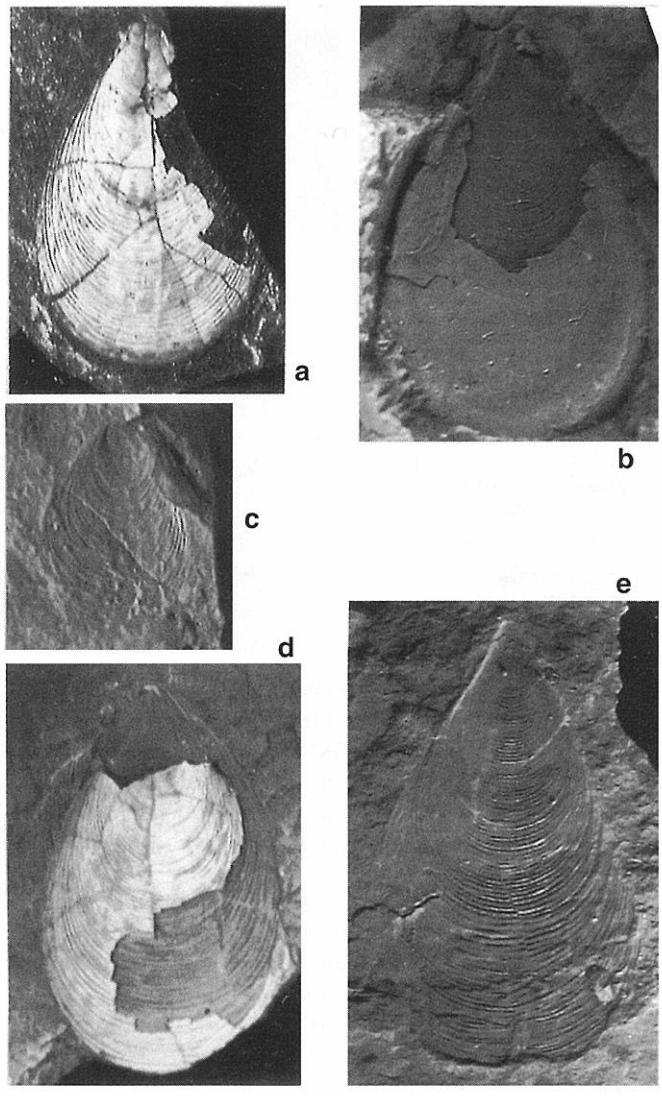

Figure 3. *Lachrymula truyolsi* sp. nov.; Genicera, WAG 1165B; **a**: brachial valve, holotype, RGM 133 003, X 8.5; **b**: fragmentary brachial valve interior, partly external mould, RGM 142 607, X 7; **c**: external mould of young pedicle valve, RGM 131 001, X 10.5; **d**: fragmentary bivalved specimen, partly as external mould, RGM 131 004, X 7; **e**: pedicle valve external mould, RGM 131 005, X 7. b-e: Specimens whitened with magnesium oxide.

Material: Eleven specimens from locality WAG 1165B: 3 collected by Dr R.H. Wagner and colleagues (see Higgins *et al.*, 1964; RGM 142 607, 609, 131 062) and 8 by the first author (C.F.W.P.; RGM 131 000-001, 003-007, 019).

Description

Moderately convex, tear-shaped in outline, and up to almost 10 mm in length. L/W ratio 1.5, greatest width

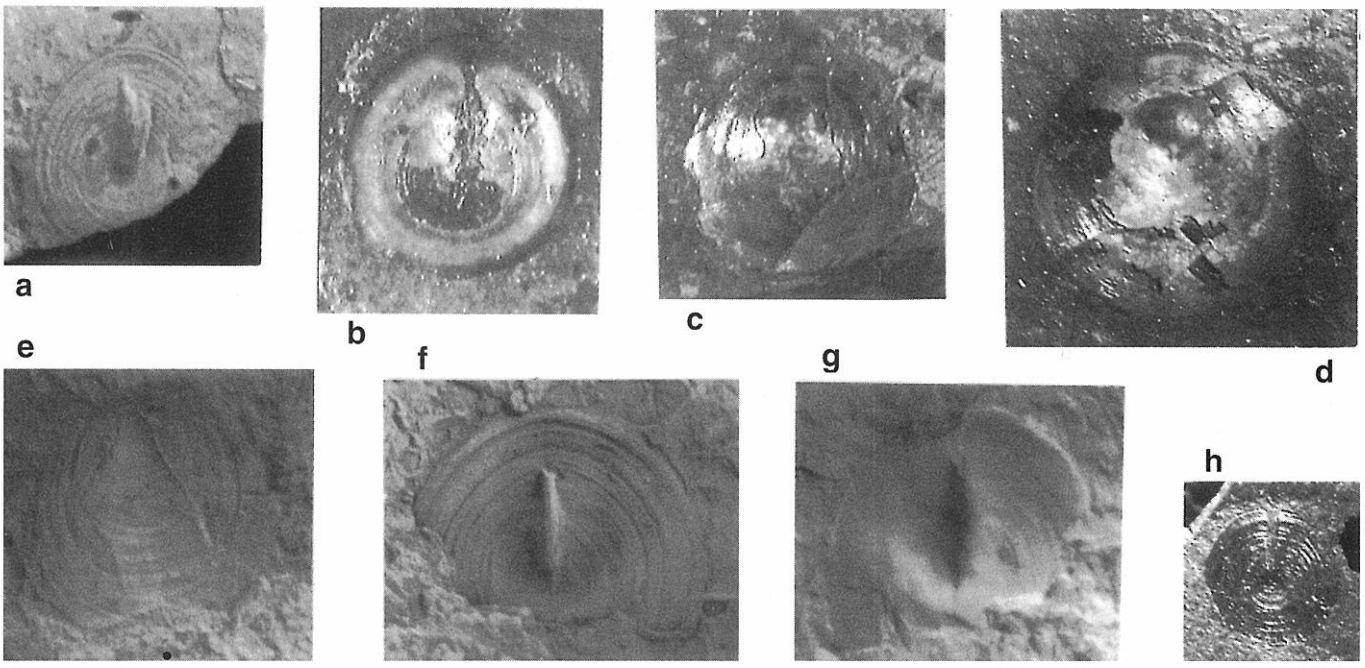

Figure 4. *Orbiculoidea cincta* (Portlock, 1843); **a**: Valdecastillo, WP 15, pedicle valve, external view, RGM 293 338, X 10. **b-h:** Genicera, WAG 1165B; **b**: pedicle valve interior, RGM 293 333, X 8; **c**: brachial valve internal mould with some shell fragments, RGM 293 342, X 8; **d**: brachial valve interior, RGM 293 326, X 8; **e**: brachial valve interior mould showing diverging grooves from umbo, RGM 293 327, X 10; **f**: partial view of pedicle valve external mould, DPO 33 975, X 10; **g**: idem, internal mould, X 10; **h**: pedicle valve external mould with open pedicle slit at margin, RGM 131 031, X 10. **e-g**: Specimens whitened with magnesium oxide.

anterior of mid length; pedicle valve slightly longer than the brachial one, the latter with short straight hinge and two diverging folds. Umbonal angle 60°. Ornamentation of numerous thin but prominent subconcentric rugae.

One specimen (RGM 142 607, Fig. 3b) shows a partially preserved interior, which is smooth except for some faint markings; part with muscle scars not preserved.

Measurements (in mm):

Number	L	W	L/W
RGM 131 001	2.8	1.9	1.5
RGM 131 003	5.9	3.7	1.6
RGM 131 004	8.2	5.5	1.5
RGM 131 005	9.4	5.6	1.7
RGM 131 005A	7.5	5.0	1.5
RGM 131 006	>7.0	5.0	>1.4
RGM 131 007	1.8	1.3	1.4
RGM 142 607	8.7	5.4	1.6

Discussion

Lachrymula truyolsi is distinguished from the closely comparable *L. inusitata* from the Viséan of Scotland by its well developed posterior hinge and pair of diverging radial folds in the brachial valve.

An interesting feature is the preservation of the material of *Lachrymula truyolsi* as white shells, contrary to the *Lingula* shells which often show concentric colour bands of different shades of brown or gray. This could be due to the rather thick shells and characteristic for *Lachrymula* but we are not sure whether this holds also true for the Scottish material (cf. Graham, 1970, pl. XVIII, figs. 6, 7, 10, versus pl. XIV, figs. 5-6).

Occurrence: Type locality only.

Superfamily **DISCINOIDEA** Gray, 1840
Family **Discinidae** Gray, 1840
Subfamily **Orbiculoideinae** Schuchert and LeVene, 1929
Genus *Orbiculoidea* d'Orbigny, 1847 (synonym: *Lingulodiscina* Whitfield, 1890)

Orbiculoidea cincta (Portlock, 1843)

Fig. 4a-h

1843 *Orbicula cincta* Portlock, 446, pl. 32, figs. 15-16 (*fide* Graham, 1971).
1843 *Orbicula Davreuxiana* de Koninck, 306, pl. XXI, fig. 4.
1934 *Orbicula Davreuxiana* de Koninck; Demanet, 21, pl. I, figs. 10-11; text-fig. 4 (cum syn.).
1963 *Orbiculoidea newberryi marshallensis* (Girty); Nicolaus, 145, pl. 9, fig. 2.
1968 Orbiculoidea sp.; Winkler Prins, table 1.
1971 *Orbiculoidea cincta* (Portlock); Graham, 49, pl. III, figs. 1-3; pl. IV, figs. 1-3; pl. V, figs. 7-9 (cum syn.).
1971 *Orbiculoidea* cf. *cincta* (Portlock); Graham, 50, pl. III, figs. 4-5.

Diagnosis

Plano-convex, subcircular *Orbiculoidea* with a distinct concentric ornamentation, consisting of growth

lines and some more prominent rugae which may have a lamellose aspect in the pedicle valve.

Material: Thirty-two specimens from locality WAG 1165B: 8 collected by Dr R.H. Wagner and colleagues (see Higgins *et al.*, 1964; RGM 142 601-604, 658, 705, 707) and 24 by the first author (C.F.W.P.; RGM 131 019, 021, 024-027, 029-033, 035/6, 039-740, 063, 066, 293 326-328, 332-335); seven specimens collected by the second author from locality WP 12 (M.L.M.Ch.; DPO 33 975-971); four specimens collected by Dr J.M.G. Raven from locality WP 15 (RGM 293 338-340); both brachial and pedicle valves.

Description

Both valves are essentially subcircular, small for the species (1-5 mm in diameter). The pedicle valve is flat with a distinct pedicle groove which is closed at the margin in mature specimens (Fig. 4a, b, f, g) but appears open at the margin in juvenile specimens (Fig. 4h). The concentric rugation is in part weakly developed, no more than growth lines, but stronger rugae are intercalated having a lamellose aspect in some mature specimens (Fig. 4f). Internally the surface is practically smooth showing some rugae and fine radial striae, especially near the margin. The brachial valve is conical with a somewhat posteriorly placed umbo. Ornamentation of weakly developed growth lines with some stronger ones, but less strongly developed than in the pedicle one. Internally the surface is smooth with faint radial striae near the margin (Fig. 4d) and some specimens showing very thin ridges diverging from the umbo (Fig. 4e).

Measurements (in mm):

Number	Diameter	Valve
RGM 131 020	2.5	pv
RGM 131 021	2.5	bv
RGM 131 025	3.6	pv
RGM 131 026	3.0	pv
RGM 131 027A	1.1	pv
RGM 131 027B	3.6	bv
RGM 131 028	2.0	pv
RGM 131 030	4.1	bvi
RGM 131 033	1.2	pv
RGM 142 602A	2.4	pv
RGM 142 602B	1.0	pv
RGM 142 604	4.8	bvi
RGM 142 658	3.3	bv
RGM 142 707	2.0	bvi
RGM 293 331	2.0	pve
RGM 293 332	2.5	bvi
RGM 293 333	3.6	pvi
RGM 293 335A	5.0	pvi
RGM 293 335B	2.0	pv
RGM 293 336	1.0	bv
RGM 293 338	2.8	pv
RGM 293 339	3.0	pv
RGM 293 340	2.1	bv

Discussion

The development of the concentric ornamentation is variable in our material (even at one and the same locality), as it appears to be in Graham's (*op. cit.*), with some pedicle valves showing a strong, almost lamellose rugation (Fig. 4f) whilst in other material it is only weakly developed. There appears to be a gradual transition to Graham's *O.* cf. *cincta* (cf. Graham, 1971, pl. III, figs. 3-4), which is compared by him with *O. davreuxiana* de Koninck (*op. cit.*, p. 50). We include the material attributed to the latter species in our synonymy, the more so while the paratype figured by Demanet (1934, text-fig. 4) is closely comparable to our material. Our species is characterised by its subcircular shape and conical pedicle valve with an only slightly eccentric umbo.

This poses the question whether *O. cincta* or *O. davreuxiana* has priority. Demanet (*op. cit.*) gives 1842 as the date of publication of de Koninck's species, whilst Graham gives (correctly) 1843, the publication itself having been published between 1842 and 1844 (pp. 241-480 in 1843). Since Portlock's species was published in 1843, the exact date of publication of both species is essential to decide which has priority. We have so far been unable to obtain the necessary information on this issue, and have left *O. cincta* as the valid species following Graham (*op. cit.*).

Occurrences

O. cincta occurs widely in the Tournaisian-Bolsovian (ex Westphalian C) of NW Europe and is found in Spain in the Vegamián Formation.

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