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# NEW LINGULIFORMEAN BRACHIOPODS FROM THE LOWER TREMADOCIAN (ORDOVICIAN) OF THE BRABANT MASSIF, BELGIUM, WITH COMMENTS ON CONTEMPORANEOUS FAUNAS FROM THE STAVELOT–VENN MASSIF

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*Keywords*: Brachiopoda; Avalonia; Chevlipont Formation; low diversity; palaeogeography.

*Abstract***.** Lower Ordovician brachiopod macrofaunas in Belgium (Avalonia) are seldom collected and studied due to the poor preservation of material. Here we describe a new fauna of linguliformean brachiopods from the Chevlipont Formation (lower Tremadocian) in the Brabant Massif. The fauna is of low diversity (at least three species belonging to *Rosobolus*?, *Thysanotos*, and *Broeggeria* have been identified) and is dominated by *B.* cf. *salteri* (Holl). Low diversity linguliformean brachiopod assemblages in a peri-Gondwanan terrane are characteristic of the lowermost Ordovician. Such assemblages are rooted in the Cambrian indicating that their geographic distribution during the early Ordovician was controlled by the radiation and dispersion of lineages surviving through the latest Cambrian–earliest Tremadocian linguliformean brachiopods taxonomic crisis. In addition we figure for the first time and comment on contemporaneous brachiopod faunas from the Stavelot-Venn Massif in SE Belgium. Finally, we present new graptolite data that enable a more precise constraint on the age for the Solwaster Member of the Jalhay Formation in the Stavelot-Venn Massif.

## Introduction

Lower Palaeozoic rocks in Belgium crop out in six areas: the Brabant Massif, which constitutes the largest area (relative to its size it offers relatively less exposures) and occupies the central and north-western part of the country; the Condroz Inlier (also known as the Sambre–Meuse Strip) located in the centre; and the Ardennes in southern Belgium, with from the north-east to the south and south-east, the Stavelot–Venn, Serpont, Givonne and Rocroi massifs (also called inliers) (Fig. 1).

Contrary to the Belgian Devonian–Mississippian succession, the Lower Palaeozoic is poor in brachiopods, except for some Upper Ordovician

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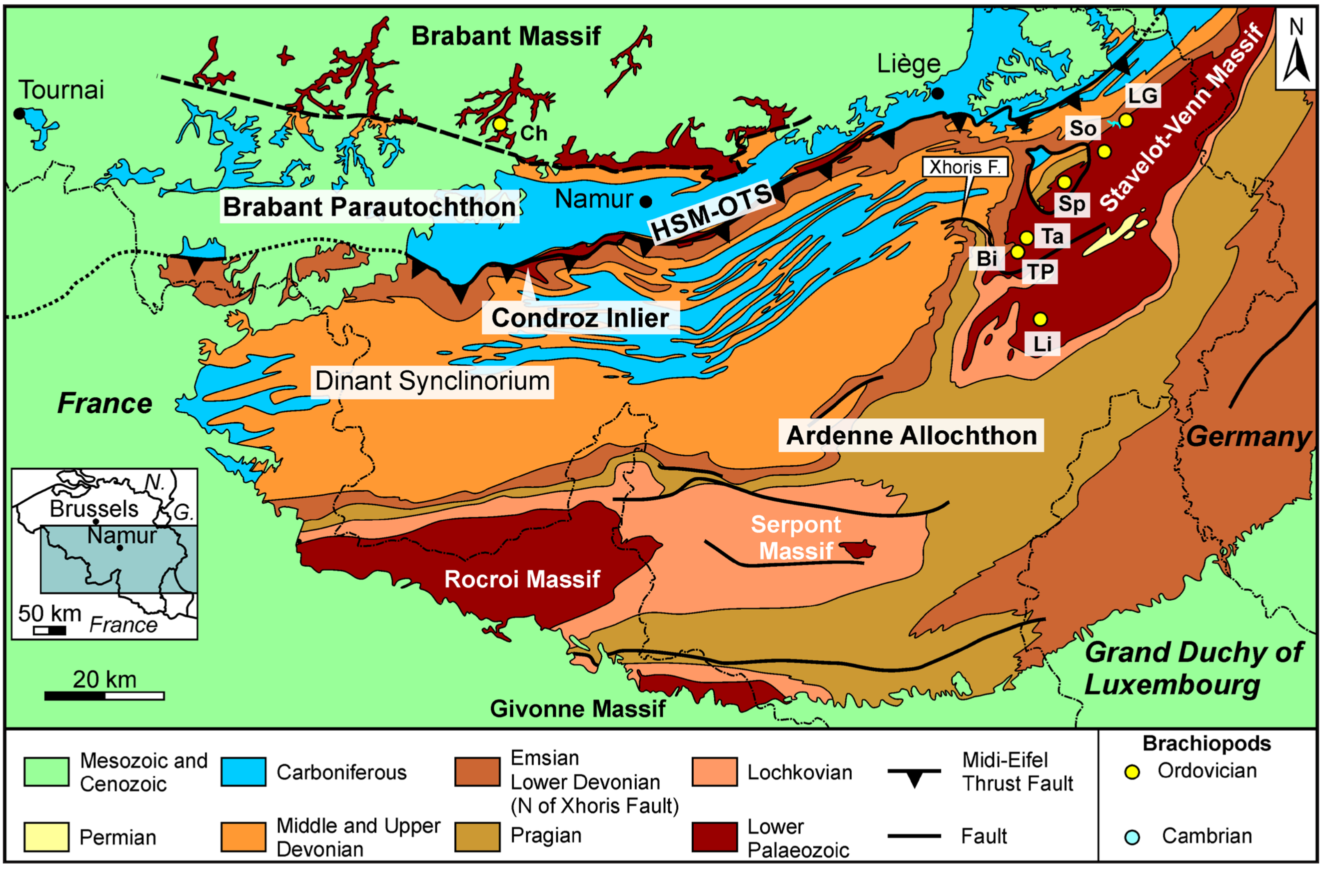


Fig. 1 - Location and schematic geological map of southern Belgium with indication of the localities cited in the text (modified from de Béthune (1954) and Mottequin (2021)). Abbreviations: Bi, Bierleux (Lhoest 1935; Vanguestaine et al. 2004); Ch, Chevlipont (this paper); G, Germany (see black and white insert); HSM OTS, Haine–Sambre–Meuse Overturned Thrust sheets (Belanger et al. 2012); LG, Lake Gileppe (e.g. Roncart 1925; Maillieux 1926; Schmidt & Geukens 1959); Li, Lierneux (Malaise 1878a, 1878b); N, the Netherlands (see black and white insert); So, Solwaster (e.g. Graulich 1963), Sp, Spa (Renier, unpubl.); Ta, Targnon (Charles 1925); TP, Trois-Ponts (Vanguestaine & Rushton 1979).

lithostratigraphic units (the Fosses Formation in the Condroz Inlier and the Huet Formation in the Brabant Massif) that has yielded diverse brachiopod faunas (e.g. Malaise 1873; Lespérance & Sheehan 1987; Sheehan 1987). Only one brachiopod occurrence was documented so far in the Cambrian (Wanne Formation) of the Stavelot–Venn Massif (Vanguestaine & Rushton 1979) (Fig. 2), with *Acrothele* cf. *bergeroni* Walcott, 1908 described from the Trois-Ponts locality (figured here on Fig. 3), whereas the Silurian, mostly represented by graptolitic shaly facies, is almost devoid of brachiopods (Maillieux 1930) although the Pridolian transgressive cover contains abundant but poorly diverse brachiopod faunas (e.g. Godefroid 1995; Mottequin 2019).

The lowermost Ordovician remained undiscovered in the Brabant Massif until the studies of Lecompte (1948, 1949), who recorded the presence of graptolitic horizons and scarce trilobite specimens in the Thyle Valley, demonstrating the presence of Tremadocian rocks. Since these studies no new macrofossil faunas have been described from the Lower Ordovician. Brachiopods are particularly rare in the Tremadocian of southern Belgium according to the literature. Several authors reported occurrences in the Jalhay Formation (Fig. 2) of the Stavelot–Venn Massif (Charles 1925; Roncart 1925; Mailllieux 1926) but these findings have never been illustrated until now. One of us (MW) has recently collected the material from the Chevlipont Formation we are describing below.

The bulk of the illustrated material is stored in the Royal Belgian Institute of Natural Sciences (Brussels; prefixed RBINS) and is complemented by specimens from the collections of the University of Liège (prefixed PA.ULg). Specimens selected for scanning electron microscopy were imaged with an ESEM FEI Quanta 200, under low vacuum; specimens were uncoated, except for *Acrothele* cf. *bergeroni*.

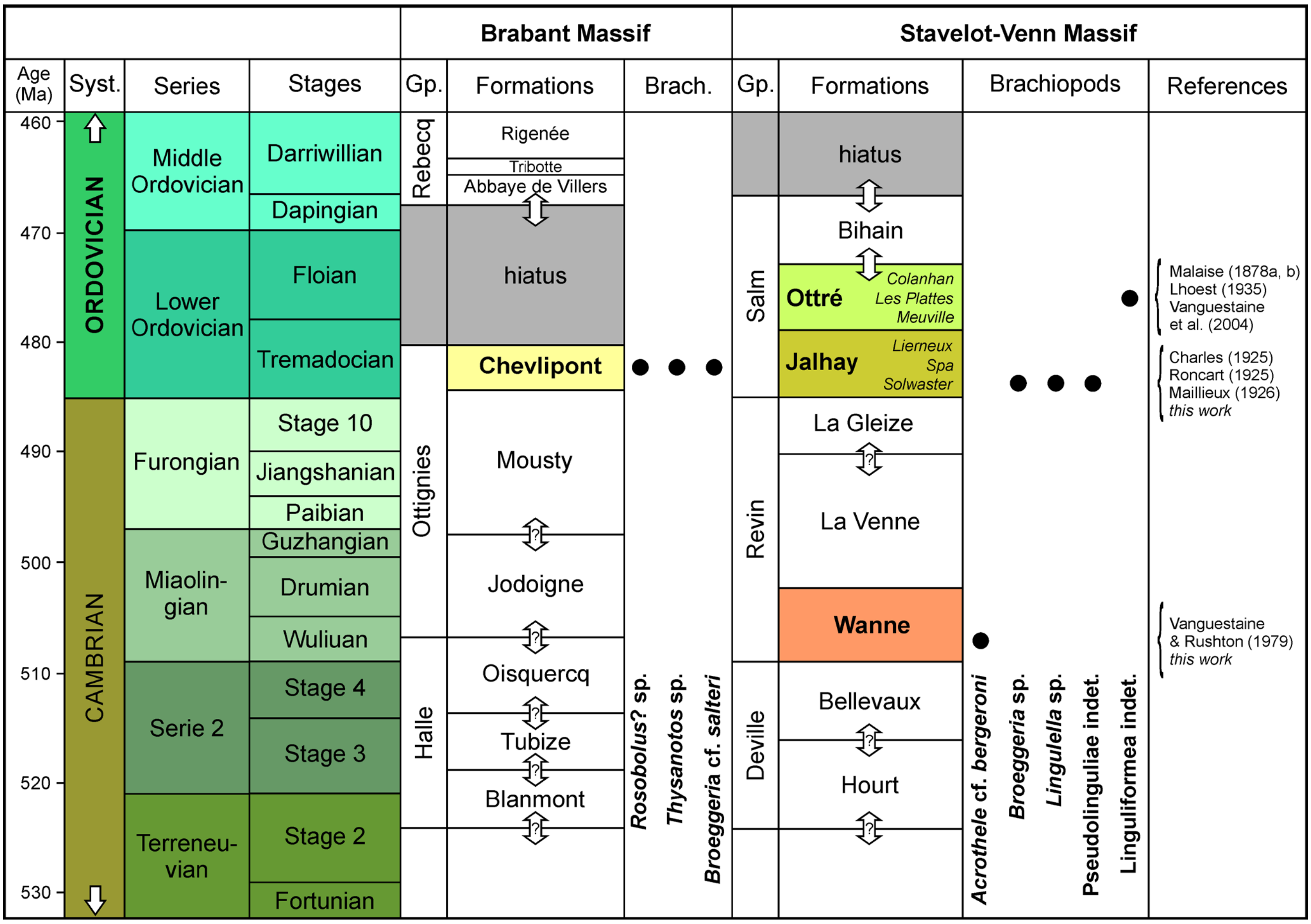


Fig. 2 - Chronostratigraphy and lithostratigraphy of the Brabant and Stavelot–Venn massifs (modified from Herbosch et al. 2020) with the distribution of the linguliformean brachiopods. The double arrows indicate boundaries between formations of uncertain age. Abbreviations: Brach., brachiopods; Gp., Groups; Syst., Systems.

## Geology

### Locality

The brachiopods from the Brabant Massif were collected by MW at the locality "Genappe 9" that is situated along the Charleroi–Ottignies railway, described by Lecompte (1949), in the Thyle Valley (Fig. 4). Lecompte (1949) collected a single specimen of *Dictyonema flabelliforme* var. *sociale* (Salter, 1858), re-identified as *Rhabdinopora flabelliformis socialis* (see Wang & Servais 2015). To date, no additional fauna was collected from locality "Genappe 9". This outcrop is located about 30 m north of Lecompte's locality "Genappe 78", located along what is now known as "Rue Basse Heuval", and about 30 m east of the site of the Moulin de Chevlipont. The locality "Genappe 78" has yielded numerous graptolites, more than 400 specimens according to Lecompte (1949: 5), who ascribed all of them to *Dictyonema flabelliforme* aff. *norvegica* (Kjerulf, 1865), Wang & Servais (2015), however, identified a much more diverse assemblage with *R. praeparabola* Erdtmann, 1982, *R. f. parabola* (Bulman, 1954), *R. f. flabelliformis* (Eichwald, 1840), *R. f. norvegica* and *R. f. socialis*.

### Stratigraphical summary

The locality investigated here lies within the Chevlipont Formation of the Ottignies Group (Fig. 2), in the Brabant Massif. Herbosch & Verniers (2013) and Herbosch & Debacker (2018) have provided detailed information on the geology of the Brabant Massif. The Chevlipont Formation (named by Anthoine & Anthoine 1943; see Verniers et al. 2002) consists typically of grey siltstone (also known as "quartzophyllade" in older literature) with millimetric to centimetric alternations of light grey siltstone and dark grey clayey siltstone and mudstone (Herbosch & Verniers 2013). This facies was interpreted as a low density tur-

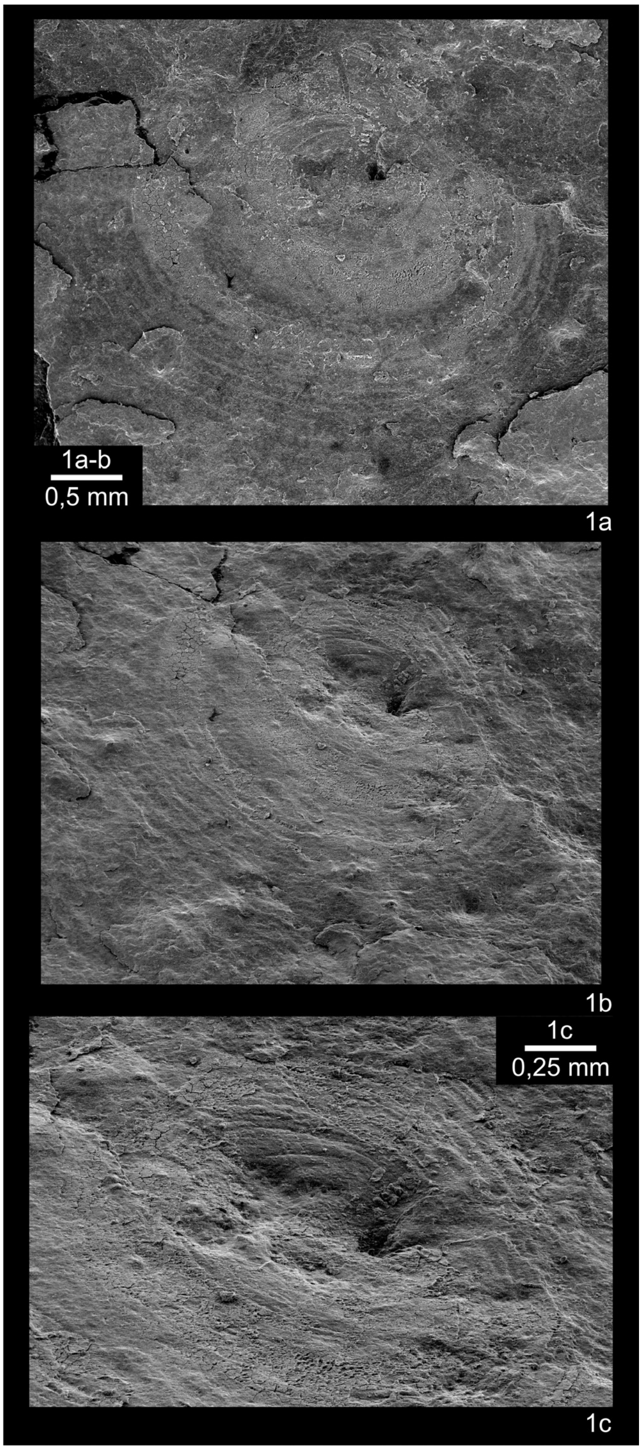


Fig. 3 - *Acrothele* cf. *bergeroni* Walcott, 1908, PA.ULg 6464, Trois-Ponts (Stavelot–Venn Massif), Wanne Formation (Cambrian).

bidite typical of "mud turbidites" (see Herbosch et al. 2002); the Chevlipont Formation has been interpreted as a fine grained turbidite deposit on a depositional slope (Herbosch et al. 1991; André et al. 1991). The Chevlipont Formation shows a shallowing trend (Linnemann et al. 2012). Herbosch et al. (2002) also emphasised the known lack of benthic fauna in the formation and the presence of planktonic fauna (graptolites and acritarchs).

Work on dendroid graptolites and acritarchs (summary in Herbosch & Verniers 2013) has concluded an early Tremadocian age for the Chevlipont Formation. Wang & Servais (2015) have determined the lower boundary of the formation in the *R. praeparabola* graptolite Biozone, indicating an early Tremadocian age, Tr1 stage slice, mid 1a time slice (time slice of Webby et al. 2004) (for more details, see Herbosch & Verniers 2013).

### Palaeogeographical implication

The Brabant Massif (Fig. 1) covers most of the northern part of Belgium and is unconformably covered by Devonian strata (Herbosch et al. 2002). It is within an orogenic zone called the Anglo-Brabant Deformation Belt, extending northwest under the North Sea into the concealed Caledonides of East Anglia (see Herbosch et al. 2002). During the Early Ordovician, the Brabant Massif was part of Avalonia, a peri-Gondwanan terrane located close to the northern margin of Gondwana (Amazonia-West Africa), at high latitudes. Murphy et al. (2006) proposed a rifting age for Avalonia and the opening of the Rheic Ocean constrained between the late Cambrian and the Early Ordovician. Shellnutt et al. (2019) correlated zircon populations with distinct magmatic periods in western Avalonia and more broadly across the whole of Avalonia. One of those magmatic 'pulses' correspond to rift-related magmatism (520 to 480 Ma) and the opening of the Rheic Ocean (Shellnutt et al. 2019). In addition, Herbosch & Verniers (2013) noted the decreasing sedimentation rate in lithostratigraphic units of the Brabant Massif during the late Cambrian and Early Ordovician (497 to 480 Ma) that announced the drifting of Avalonia from Gondwana (marked by the lower Tremadocian to Mid-Ordovician (Dapingian–Darriwilian) hiatus and unconformity) and the birth of the Rheic Ocean (Linnemann et al. 2012).

Early Ordovician macrofaunas are not commonly found in the Brabant Massif, as the thick lithostratigraphic succession (ranging from upper Terreneuvian to lower Tremadocian: 525–482 Ma) comprises clastic, mostly pelagic and turbiditic sediments deposited in an embayment of a large rift that developed on the western Gondwana margin (Linnemann et al. 2012) in continuation with the Pan-African orogen.

The brachiopod assemblage collected from the Chevlipont Formation is neither abundant nor diverse. Eighteen samples were collected totalling over 100 specimens, some of which cannot be fully identified due to their poor preservation. In decreasing abundance the assemblage is composed of *Broeggeria* cf. *salteri* (70% of the total amount of specimens identified), *Thysanotos* sp. (29%) and *Rosobolus*? sp. (1%). The brachiopods are not associated to graptolites and trilobites although these were reported by Lecompte (1949) in the investigated area.

The presence of this low diversity assemblage of linguliformean brachiopods in a peri-Gondwanan terrane, is typical of lowermost Ordovician brachiopod assemblages that have an origin in the Cambrian. Popov et al. (2013) suggested that the radiation and dispersion of lineages that survived the severe crisis linguliformean brachiopods experienced during the late Furongian to early Tremadocian clearly controlled the biogeographic distribution of this group in the Ordovician.

In the early Tremadocian, *Thysanotos* is only known from Belgium (present study). By the late Tremadocian to the earliest Floian, it is present in the South Urals and by the rest of the Floian, *Thysanotos* expanded its geographical distribution to northern Baltica (Estonia and Poland), the Armorica Terrane Assemblage (ATA) (see review of the concept in Servais & Sintubin 2013), and Iran; the last two being distributed along the northern margin of Gondwana. The Early Ordovician geographic extension of the genus is due to the palaeogeographical distribution of these terranes, with the southern part of Baltica and the South Urals in close vicinity of the northern margin of Gondwana and peri-Gondwanan terranes, at high southern latitudes, which may have helped larval expansion.

The genus *Broeggeria*, and in particular its type species *Broeggeria salteri*, is known from the Anglo-Welsh province of Avalonia during the late Cambrian–Tremadocian interval (Herefordshire, Merioneth Series; Wales, Tremadocian), and also contemporaneous horizons in the Kazakh terranes (Kendyktas Range, upper Cambrian–Tremadocian), Baltoscandia (Sweden, Norway, Denmark: upper Cambrian–upper Tremadocian), and Laurentia (Nova Scotia: *Parabolina* Zone, Furongian). The presence of this genus in both High-latitude and Low-latitude provinces, and in the Baltic Province (for the first two see *sensu* Harper et al. 2013) indicates a rapid geographic spread, or an older origin for this genus. By the Tremadocian, the geographical distribution of the genus has expanded to western peri-Gondwana (NW Argentina: *B. omaguaca* Benedetto et al., 2018; Santa Rosita Formation, see Benedetto et al. 2018), eastern peri-Gondwana (Bohemia: *B. ferraria* Mergl, 2002; Třenice Formation, see Mergl 2002), eastern Avalonia (Belgium: present study, Chevlipont and Jalhay formations) and the South Urals (*B. salteri*, lower part of the Kidryas Formation: upper Tremadocian–lower Floian).

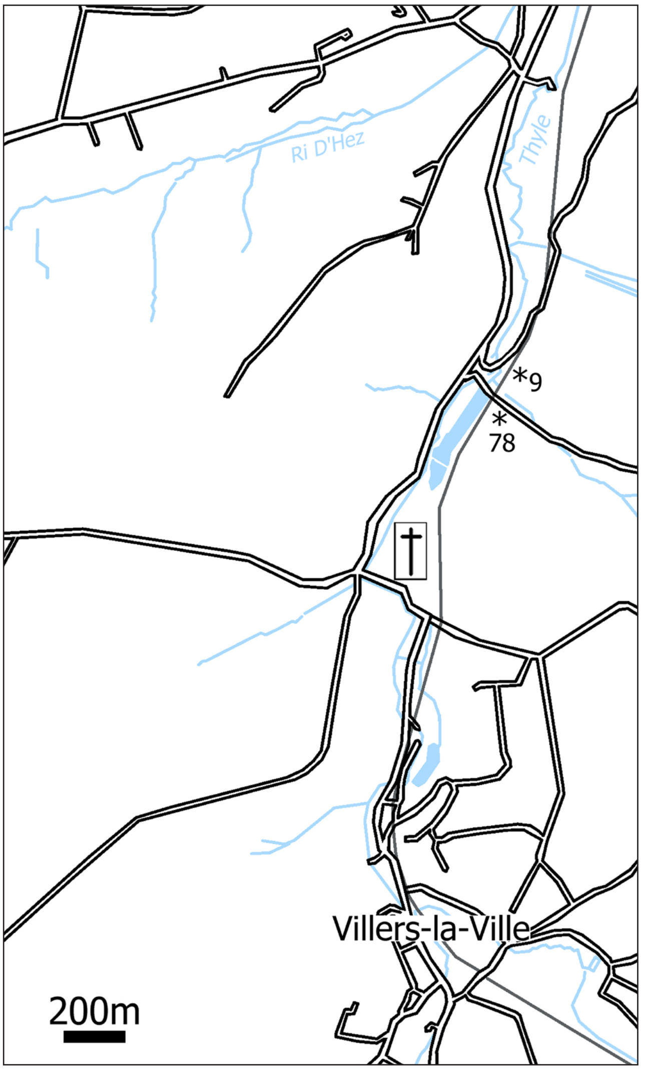


Fig. 4 - Detailed location map for the locality in the Chevlipont Formation (Brabant Massif).

## Systematic Palaeontology

Subphylum **LINGULIFORMEA**
Williams et al., 1996
Class **LINGULATA** Gorjansky & Popov, 1985
Order **Lingulida** Waagen, 1885
Superfamily Linguloidea Menke, 1828
Family Zhanatellidae Koneva, 1986

Genus *Rosobolus* Havlíček, 1982
Type species: *Rosobolus robertinus* Havlíček, 1982, by original designation, from the Třenice Formation (Tremadocian), Holoubkov, Prague Basin, Czech Republic.

***Rosobolus*? sp.**
Fig. 5.1

**Material**: One internal mould of a ventral valve.

**Description**. Ventral valve elongately oval with posterior margin angular; pseudointerarea small, apsacline. Surface of valve with fine, dense radial ornament, numbering 25 per mm. Interior with long, narrow pedicle groove, visceral area poorly preserved; central muscle scars not well defined, possibly subcircular or subrectangular, extending anteriorly for about 40% of valve length; *vascula lateralia* gently curved.

**Remarks**. The genera *Rosobolus* and *Hyperobolus* Havlíček, 1982 are similar but differ by the presence of large and subrectangular central muscle scars, roughly perpendicular to the midline of the ventral valve in the former, whereas in the latter these are shorter and oblique (see generic diagnosis of *Rosobolus* in Havlíček 1982: 19). Havlíček (1982) also emphasised the presence of fine radial capillae intersecting the short concentric lamellae ornamentation in *Rosobolus* only. Mergl (2002) highlighted the 'striking difference' in ornamentation between these two genera, with *Rosobolus* characterised by a smooth exterior, and a remarkably regular microornamentation, consisting of shallow transversely rhomboidal pits arranged in straight radial rows (these were first described by Holmer & Popov 2000: 64, fig. 29.1d). The tentative generic identification is based on the morphology of the central muscle scars and the presence of radial capillae. However, more material is needed to identify the genus with confidence.

Genus *Thysanotos* Mickwitz, 1896
Type species: *Obolus siluricus* von Eichwald, 1840, by original designation, from the Leetse Formation (Tremadocian–Floian), Paldiski, Estonia.

***Thysanotos* sp.**
Fig. 5.2–6

**Material**: 44 internal and external moulds of both ventral and dorsal valves.

**Description**. Ventral valve suboval, 88% as long as wide, weakly convex; interior with visceral area subtriangular to slightly rhomboidal (anterior sides not as long as posterior sides); visceral area slightly raised anteriorly by a callosity, almost extending to mid valve length (Fig. 5.2); *vascula lateralia* divergent anteriorly, poorly preserved possibly extending forward to mid-valve length. Dorsal valve subcircular, 93% as long as wide, gently convex with maximum convexity towards the posterior third of valve length; interior not well-preserved, muscle scars hardly discernible; *vascula lateralia* widely divergent, only preserved in posterior half of the valve. Ornamentation poorly preserved, consisting of 9 concentric lamellae per mm, finer rugellae in the interspace (about 16 per mm); marginal spines infrequently preserved, and observed on one specimen (see Fig. 5.6).

**Remarks**. All the specimens collected from Belgium range from 5 to 7 mm in length; these are much smaller than specimens of *Thysanotos siluricus* in the type material of Bohemia (>30 mm), or specimens from Estonia (25-27 mm), Poland (20-22 mm) or the South Urals (40 mm). A second species from Bohemia, *Thysanotos primus* (Koliha, 1924), is smaller than *T. siluricus*, ranging from 16 to 19 mm long and never exceeding 20 mm (Mergl 1997).

The concentric ornament is also finer in the Belgian specimens (9 rugellae per mm) than in the samples from Bohemia (3-4 per mm for *T. primus*; 4-6 per mm for *T. siluricus*), north-eastern Europe (*T. siluricus* from Poland: 5-6 per mm; from Estonia: 4-6 per mm) and South Urals (4-6 per mm).

The distinction between *T. siluricus* and *T. primus* has focussed primarily on the difference in size and on the finer rugellate ornamentation on *siluricus* than on *primus*.

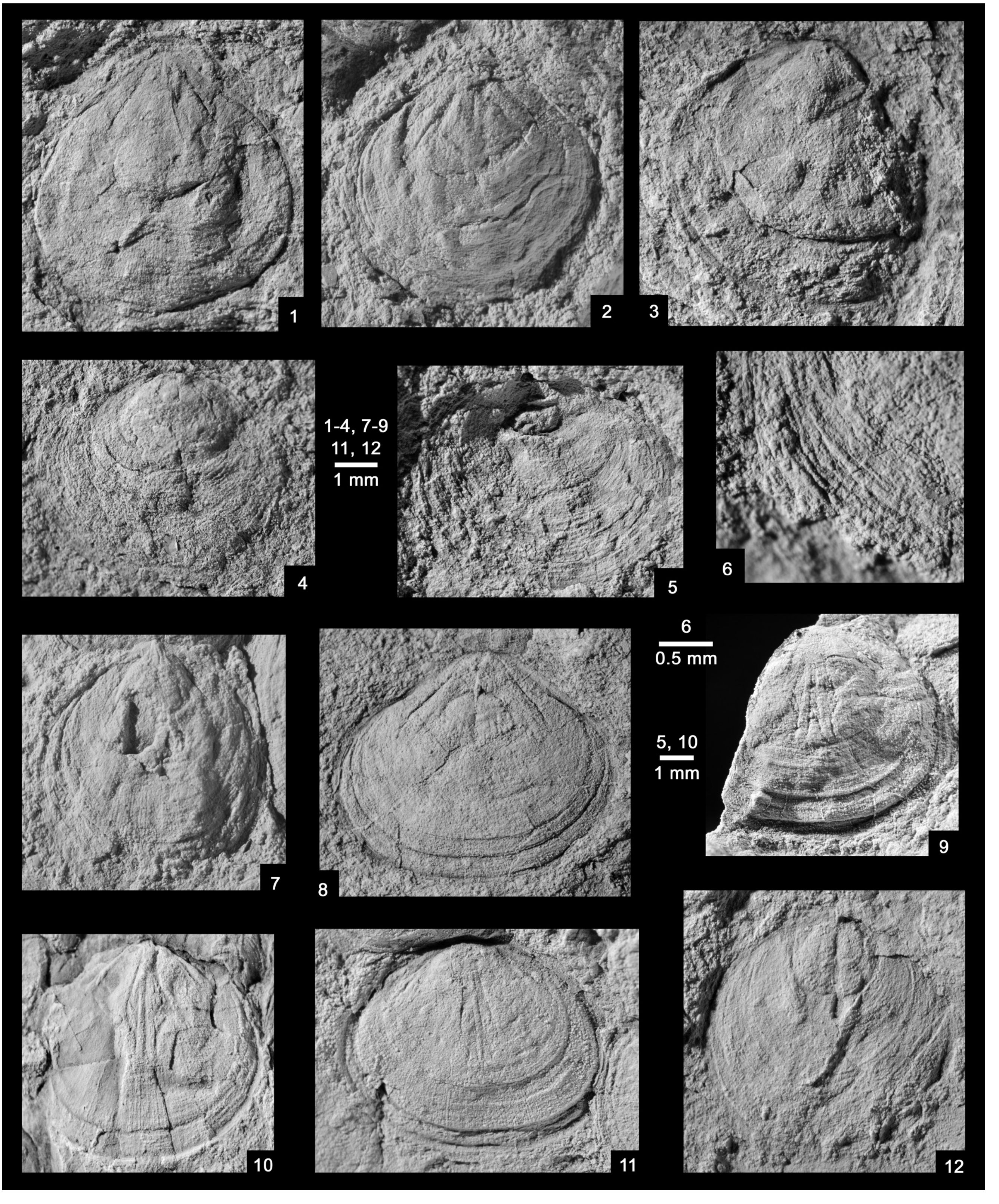


Fig. 5 - 1) *Rosobolus*? sp.; ventral valve interior, RBINS a13477. 2-6: *Thysanotos* sp.; 2) ventral valve interior, RBINS a13478; 3) dorsal valve interior RBINS a13479; 4) dorsal valve interior with impression of wavy concentric ornament, RBINS a13480; 5) dorsal valve exterior, RBINS a13481; 6) detail of external ornament with impression of marginal spines, RBINS a13482. 7-12: *Broeggeria* cf. *salteri* (Holl, 1865); 7) ventral valve interior, RBINS a13483; 8) ventral valve interior, RBINS a13484; 9) dorsal valve interior, RBINS a13485; 10) dorsal valve interior, RBINS a13486; 11) dorsal valve interior, RBINS a13487; 12) dorsal valve exterior, RBINS a13488. All the specimens are collected from the Chevlipont Formation, 2 km north of Villers-la-Ville, Brabant Massif.

Family Elkaniidae Walcott & Schuchert in Walcott, 1908

Genus *Broeggeria* Walcott, 1902

Type species: *Obolella salteri* Holl, 1865, by original designation, from the White-Leaved Oak Shale Formation (upper Cambrian), of the Malvern Hills, South Wales.

***Broeggeria* cf. *salteri*** (Holl, 1865)

Fig. 5.7–12

cf. 1865 *Obolella salteri* Holl, p. 102, fig. 9.

**Material***:* 89 internal and external moulds of both ventral and dorsal valves.

**Description**. Ventral valve subcircular, 85% as long as wide, gently convex in profile. Dorsal valve transversely suboval about 85% as long as wide, gently convex in lateral profile. Ornamentation consists of fine rugellae, numbering about 11-12 per mm. Dense faint radial striation is visible on interior moulds of many specimens (e.g. Fig. 5.7, 10, 11), but it is indistinguishable on the external moulds.

Ventral interior with short orthocline pseudo-interarea; pedicle groove narrow, triangular, about 10% as wide as valve; visceral platform weakly thickened, rhomboidal in outline, with maximum width at anterior end, extending for about a third of valve length; *vascula lateralia* variably impressed in the present material, diverging anteriorly, flanking the visceral platform.

Dorsal interior characterised by a visceral area slightly raised above valve floor and extending beyond mid valve length; central muscle scars elongate (Fig. 5.9–11), gently divergent, bounded laterally by thin ridge, extending anteriorly for 45% of valve length; anterior lateral subcentral muscle scar, extending for 58% of valve length; *vascula media* subparallel to slightly divergent, not preserved anterior to visceral area; *vascula lateralia* widely divergent in posterior half of the valve, but anterior ends are not well preserved.

**Remarks**. *Monobolina* and *Broeggeria* have similar valve shapes and internal characters, but they differ externally in the presence of fila and costellae in *Monobolina* only (see diagnosis for *Monobolina* in Holmer & Popov 2000: 69). Although radial features are observed, in the present Belgian material, in internal moulds only (see also *Broeggeria salteri* in Popov & Holmer 1994: fig. 54D, F and 57D), these cannot be regarded as ornament as they are not expressed externally. These features are similar to the "drapes" described by Williams & Holmer (1992: 388), formed from stresses in the outer mantle groove induced by the spasmodic activity of "muscle sets controlling the setal follicles in the mantle grooves". Therefore, the specimens described here are best assigned to the genus *Broeggeria*.

The present specimens show a well-impressed dorsal visceral area, similar to that displayed in *B. salteri*, but this visceral area extends more anteriorly than in *B. salteri* from the Kendyktas Formation (upper Cambrian-Tremadocian) in the Kendyktas Range, Kazakhstan or from the *Ceratopyge* Shale (upper Tremadocian) in Öland, Sweden. *Broeggeria salteri* from the Tremadocian of South Wales (see Owens et al. 1982) and North Wales (see Sutton et al. 1999, 2000) are more transverse in outline than other populations of the same species and, in that feature, are more similar to the Belgian specimens. The present material is morphologically close to the type species of *Broeggeria* and thus here tentatively assigned to it. More specimens are nevertheless necessary to validate this comparison.

## Comments on the Tremadocian Brachiopods from the Stavelot–Venn Massif

The first reports of linguliformean brachiopods within the Tremadocian of the Belgian part of the Stavelot–Venn Massif were published by Charles (1925) and Roncart (1925). Charles (1925) mentioned, without identifying them further than '*lingule*', two specimens collected by students during an excursion. These specimens, which have not been traced in the collections of the Liège University, were collected from the locality with '*Dictyonema sociale'* in the outcrop south of the confluent between the Lienne and Amblève rivers at Targnon (Fig. 1). Wang & Servais (2015) have re-assessed the graptolite faunas in the lower Tremadocian '*Dictyonema* Shale' in Belgium and have re-identified '*Dictyonema sociale*' as *Rhabdinopora flabelliformis socialis*, which in the Stavelot–Venn Massif, is found in the lower part of the Solwaster Member of the Jalhay Formation (for more information see Verniers et al. 2002) implying an early Tremadocian age (Tr1) for the occurrence (Fig. 2). However, Schmidt &

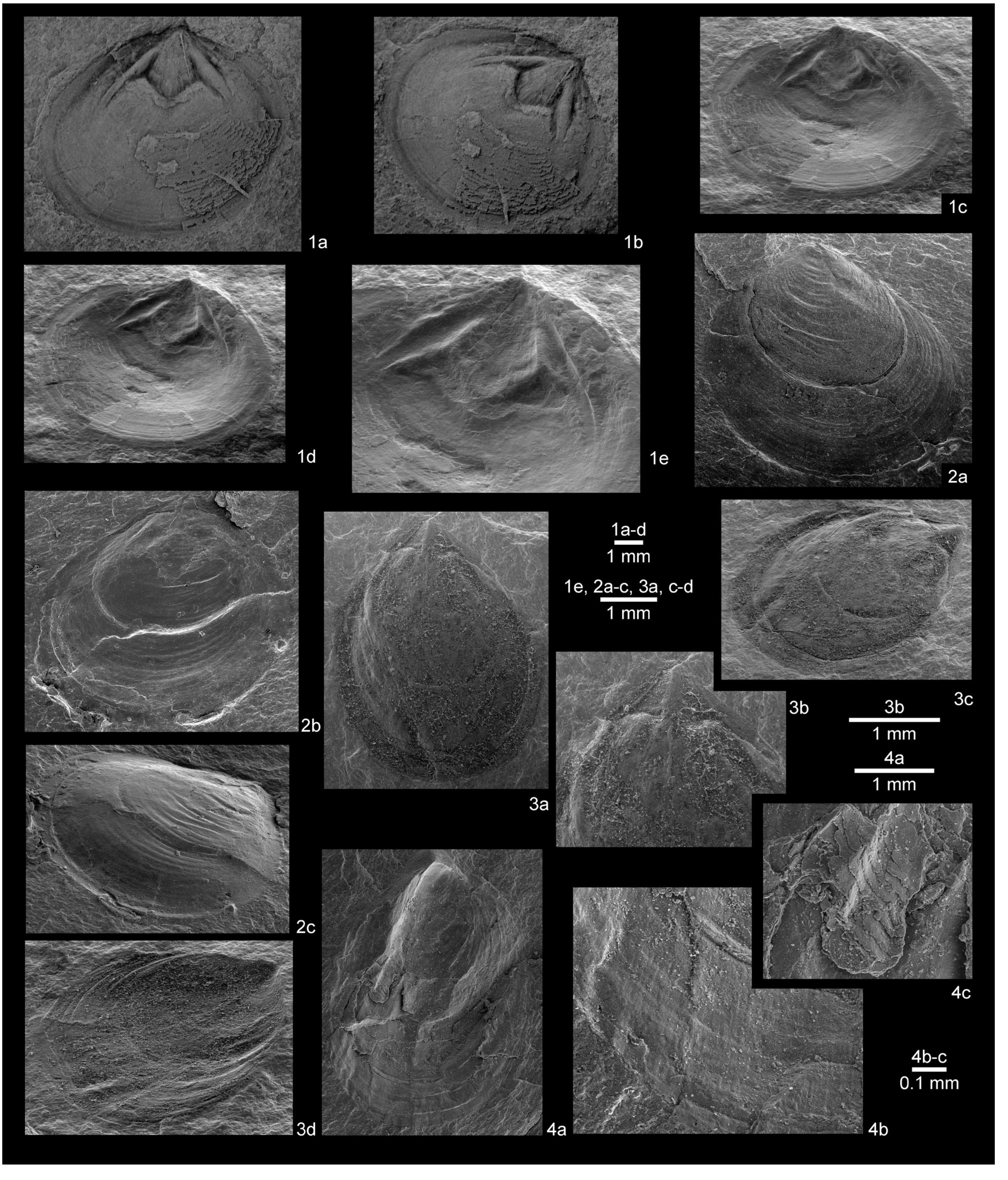


Fig. 6 - 1-2: *Broeggeria* sp.; 1) ventral valve interior in ventral (a) and oblique lateral (b) views, artificial cast of ventral interior in anteroventral (c) and slightly oblique anteroventral (d) views, and detail of visceral platform and *vascula lateralia* impression, RBINS a13489, Spa, route de Sart; 2). ventral valve exterior in ventral view (a), artificial cast of ventral valve exterior in ventral (b) and oblique lateral (c) views, PA.ULg 2020.12.16/1, Solwaster. 3) *Lingulella* sp., ventral valve interior in ventral (a) and oblique lateral (c, d) views and detail of pseudointerarea (b), RBINS a13490, Barrage de la Gileppe. 4) Pseudolingulidae indet., dorsal valve exterior in dorsal view (a) and detail of the ornamentation (b, c), PA.ULg 2020.12.16/2, Solwaster. All material from the Solwaster Member of the Jalhay Formation, Stavelot–Venn Massif. Specimen RBINS a13489 on Fig. 6.1a–b was coated with ammonium chloride; the rest of the material was imaged using a SEM (specimens uncoated).

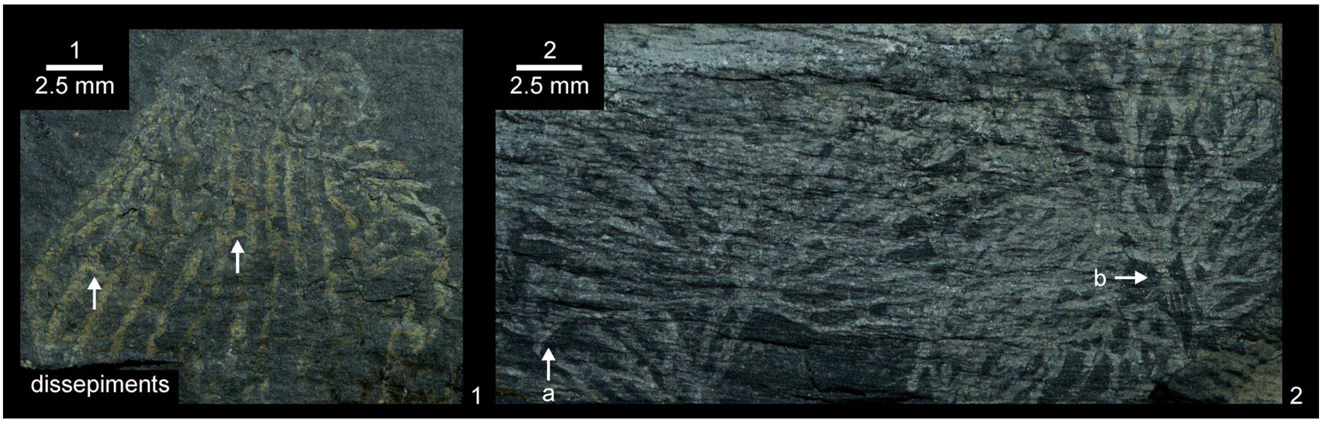


Fig. 7 - 1-2: Graptolites associated with the linguliformean brachiopods from Solwaster (Stavelot–Venn Massif), Jalhay Formation (Solwaster Member). 1) ?*Rhabdinopora praeparabola* Erdtmann,1982, without proximal end but showing clear dissepiments (white arrows), PA.ULg 2020.12.16/3. 2) ?*Rhabdinopora praeparabola* Erdtmann,1982, a, juvenile form with clear planktonic sicula; b, specimen showing clearly divided nema/fibre structure, PA.ULg 2020.12.16/4.

Geukens (1959) critically commented on Charles' (1925) discovery, stressing that the graptolite he described was in fact *Dictyonema flabelliforme flabelliforme*. This form is also found in the lower part of the Solwaster Member of the Jalhay Formation (see Wang & Servais 2015). Roncart (1925) mentioned the discovery of another '*lingule*' at the Lake Gileppe (Fig. 1); he identified it as the obolid *Lingulella* Salter, 1866, without precisely identifying the species (although specifying that it is close to *L. cedens* (Barrande)), due to its poor preservation (Fig. 6.3). Maillieux (1926) identified this obolid brachiopod from the "Assise de Vielsalm" (e.g. Graulich 1954) as *Lingulella insons* Barrande var. *lata* Koliha, confirming a Tremadocian age for this redundant stratigraphical unit that now corresponds to the Jalhay Formation (Verniers et al. 2002). Although they did not illustrate their material, Schmidt & Geukens (1959) reviewed and discussed the occurrence of Tremadocian brachiopods found on both sides of the Belgian–German border within the Stavelot–Venn Massif, i.e. in the Hürtgenwald region in Germany and around Lake Gileppe in Belgium. In summary, they recognised the presence of *Lingulella insons*, *Acrotreta* sp. in the strata with *Rhabdinopora flabelliformis socialis*, as well as *Obolus* (*Bröggeria* [sic]) *salteri* and an unidentified linguliformean brachiopod (mentioned as '*lingule*') in the strata with *Rhabdinopora flabelliformis flabelliformis*. Both are from the uppermost lower Tremadocian (upper Tr1) (see Wang & Servais 2015: fig. 2 for the precise position of the horizon). Graulich (1963) reported *Lingulella* sp. and *Obolus* sp. at Solwaster (see also Geukens in Bulman 1970) (Fig. 1).

In the present study, we have identified more specimens from the Solwaster Member of the Jalhay Formation among the RBINS (Spa and Lake Gileppe; Fig. 1) and Liège University collections (Solwaster), namely *Broeggeria* sp. (Fig. 6.1–2), *Lingulella* sp. (Fig. 6.3) and Pseudolingulidae indet. (Fig. 6.4). *Broeggeria* from the Stavelot–Venn and Brabant massifs, the latter described and illustrated above (Fig. 5.7–12), possibly belong to the same species. However, more material from the Brabant Massif is needed to confirm this. The specimen identified as Pseudolingulidae indet. possesses similar external radial ornament to *Meristopacha* Sutton in Sutton et al., 1999, from the Anglo-Welsh Basin (Sutton et al. 1999) or *Sedlecilingula* Mergl, 1997 from Bohemia (Mergl 1997). However, the lack of more material does not permit a confident identification. Some graptolites were also found together with the brachiopod material from the Jalhay Formation at Solwaster (Fig. 1). These were identified by one of us (WW) as ?*Rhabdinopora praeparabola* (Fig. 7), indicating a mid early Tremadocian age (middle Tr1) for the assemblage (see Wang & Servais 2015).

The youngest Ordovician (early Floian) brachiopods from the Stavelot–Venn Massif are those reported by Malaise (1878a, 1878b) (?), Lhoest (1935) and Vanguestaine et al. (2004) from the Les Plattes Member of the Ottré Formation (Fig. 2) in the Lienne valley, at Bierleux and Lierneux (Fig. 1). Lhoest (1935) collected a single valve identified as *Lingulella* cf. *insons* by E. Maillieux (pers. comm. to Lhoest) (Les Plattes Member; see Vanguestaine et al.'s (2004) and Herbosch et al.'s (2020) discussions for the age of this level). Vanguestaine et al. (2004:

pl. 1, fig. 17, 19-20) were the first to illustrate some of these poorly preserved linguliformean brachiopods.

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