A poorly diversified trilobite association from the lower Emsian (Lower Devonian) in the Sankt Vith area (East Belgium)

ALLART P. VAN VIERSEN1* & PETER TAGHON2

1 Natuurhistorisch Museum Maastricht, De Bosquetplein 6-7, 6211 KJ Maastricht, The Netherlands; avanviersen@gmail.com.
2 Deinse Horsweg 12, 9031 Gent, Belgium; peter.taghon@telenet.be.

ABSTRACT. A poorly diversified trilobite association is recorded from an outcrop near the village of Breitfeld, Sankt Vith area, East Belgium. The co-occurrence of Arduennella maillieuxi (Asselberghs, 1923) and Burmeisterella quadrispinosa Wenndorf, 1990 in the Breitfeld locality is suggestive of an early lower Emsian age. The outcropping rocks are provisionally attributed to the lower part of the Our Formation (lower Emsian) as opposed to previous assignment to the “Quartzophyllades de Saint Vith” or Sankt Vith Formation (Pragian). Some nomenclatorial notes are provided on the types of A. maillieuxi as the lectotype could not be traced; a cast of the lectotype as well as several parlectotypes of this species are illustrated. Our material of B. quadrispinosa includes cephalic remains that bring new insights into the morphology of this species. A third species, Treveropyge hellemondi sp. nov., is furthermore described. Palaeobiogeographic affiliations of the trilobite association are discussed. A tentative first step is proposed towards trilobite-based correlations of Emsian strata in the Ardenno-Rhenish Mountains.

KEYWORDS: Trilobites, systematic palaeontology, biostratigraphy, palaeobiogeography.

1. Introduction

Contrary to the situation in South Belgium where Devonian trilobites have been the focus of numerous contemporary studies, only few papers have dealt with taxa from East Belgium (Franke, 2006; Hellemond et al., 2019; van Vierson, 2013; van Viersen & Prescher, 2009). Nearly a century ago Asselberghs (1923) reported a poorly diversified, Early Devonian trilobite association from an outcrop near Breitfeld (Sankt Vith [Saint Vith in French] area, East Belgium). Although Asselberghs described and illustrated only one trilobite species, Homalonotus maillieuxi Asselberghs, 1923, he mentioned the occurrences of several others. The present paper aims to document the Breitfeld trilobite association fully, and to discuss its potential for biostratigraphic correlations of Emsian trilobites in the Ardenno-Rhenish Mountains as well as its palaeobiogeographic affinities.

2. Geological context

Locality B-117 (“Pl. Saint-Vith 1” on the field maps of Maillieux that are kept by the Institut royal des Sciences naturelles de Belgique in Brussels (IRSNB)), southwest of the village centre of Breitfeld, East Belgium (Figs 1, 2); probably lower part of the Our Formation (lower Emsian).

This outcrop, which is no longer accessible at present, was located along the former Sankt Vith–Burg Reuland railway tracks. These tracks were part of the dismantled Vennbahn railway line that ran across the Hohes Venn from Troisvierges (Luxembourg) to Aachen (Germany). Asselberghs (1921, 1923) reported what he termed a brachiopod-dominated macrofauna from the “phyllades et schistes phylladeux du Hunsruckien supérieur”, while noting lithological similarities to the upper part of the Hunsrückschiefer in the Rhenish Mountains. Later, Asselberghs (1927) introduced the term “Quartzophyllades de Saint Vith” for the increasingly neritic, northern to northeastern facies of the “Hunsruckien supérieur”. In his classic work on the Lower Devonian of the Ardennes Asselberghs (1946) provided a more detailed definition of the Sankt Vith facies. He also showed its geographic extent on a map as being widely distributed in East Belgium and inclusive of the area of Sankt Vith and Breitfeld (Fig. 2B). Vandeven (1990) recognised the Sankt Vith facies as a distinct stratigraphic unit in referring to it as the Sankt Vith Formation (Pragian). Contrary to Asselberghs (1946), the geological map of Vandeven (1990) attributed a restricted geographic extent to the Sankt Vith Formation. More specifically, Vandeven (1990) did not place the Breitfeld locality in this formation, but in the early Emsian Breitfeld-Steinbrück Formation that was proposed by him (Fig. 2B). Dejonghe et al. (2017) noticed that the outcrops used by Vandeven (1990) to establish the Breitfeld-Steinbrück Formation had disappeared or become inaccessible and so they proposed the Our Formation instead. Dejonghe (2013, 2019) and Dejonghe et al. (2017) furthermore showed the Sankt Vith Formation to be a lateral facies within the lower part of the Pragian La Roche Formation. According to L. Dejonghe (pers. comm. with AVV in July 2019) there is currently no justification for the recognition of the Sankt Vith facies as a distinct formation.

The assignment of the Breitfeld outcrop to the lower part of the Our Formation is not entirely unequivocal. According to Dejonghe et al. (2017) a lower boundary of this formation cannot be precisely established due to its progressive variations in lithology. Furthermore, the possibility cannot be excluded that the contact between the Sankt Vith facies and the Our Formation in the area of study is tectonic. Vandeven (1990, p. 104) indicated the Troisvierges-Malsbenden Fault on his map just south of Sankt Vith (“3’VM’ in our Fig. 2B). Although Vandeven did not directly observe this feature, he considered it to be responsible for the absence of the summit and probably also the middle part of the Sankt Vith Formation there (for discussion on the Troisvierges-Malsbenden Fault see Cambier & Dejonghe, 2010 and Dejonghe, 2019). We were unable to access the Breitfeld outcrop and we have been equally unsuccessful at finding a section in the area to yield a similar trilobite association for comparison. Consequently, it is not possible to position the B-117 locality in the lower part of the Our Formation other than based on the circumstantial evidence of its position on the geological map of Vandeven (1990), the putative (chiefly) early Emsian age of the Our Formation and the biostratigraphic data presented herein.

Besides Homalonotus maillieuxi (the type species of Arduennella Wenndorf, 1990), trilobites reported by Asselberghs (1923) were Cryphaeus drevermanni (the type species of Dunopyge Struve in Becker & Jansen, 1998), Homalonotus aculeatus and Homalonotus chaperoninoni (both species of Burmeisterella Reed, 1918) and Homalonotus planus (a species...
of Wenndorfia Sandford, 2005). According to Asselberghs (1921, 1923) the trilobites from the Breitfeld locality were collected by E. Maillieux and deposited in the IRSNB. Maillieux’s material was examined by us and is assigned here to Arduennella maillieuxi (Asselberghs, 1923), Burmeisterella quadrispinosa Wenndorf, 1990, Wenndorfia sp., Treveropyge hellemondi sp. nov. and Asteropyginæa gen. & sp. indet. Specimens of A. maillieuxi and B. quadrispinosa are sometimes contained within the same rock slab, demonstrating their co-occurrence in the Breitfeld locality.

3. Systematic palaeontology

Material and methods. All specimens were whitened with ammonium chloride prior to photography. The material is housed by the IRSNB. Morphologic terminology follows that of the Revised Trilobite Treatise (Whittington & Kelly, 1997).

Family Homalonotidae Chapman, 1890
Subfamily Homalonotinae Chapman, 1890

Genus Arduennella Wenndorf, 1990

Type species. Homalonotus maillieuxi Asselberghs, 1923 from the Emsian of Belgium.

Arduennella maillieuxi (Asselberghs, 1923)
(Figs 3A-H, 4)

v 1921 H. nov. sp. ab. (sic); Asselberghs, p. 142 [as a species of Homalonotus].
v * 1923 Homalonotus Maillieuxi (sic) Asselberghs, pp. 30-32, pl. 1, figs 1-9.
v 1927 Homalonotus Maillieuxi (sic); Asselberghs, p. 209.
v 1933 Homalonotus (Burmeisteria) Maillieuxi (sic); Maillieux, p. 54.
1940 Homalonotus (Burmeisteria) Maillieuxi (sic); Maillieux, p. 23.
1946 Homalonotus (Burmeisteria) maillieuxi; Asselberghs, p. 337.
1975 D.? maillieuxi; Tomczykowa, tabs II, III [as a questionable species of Digonus].
1990 Arduennella maillieuxi; Wenndorf, pp. 140-143, pl. 4, figs 5-10.
non 1994 Arduennella maillieuxi (sic); Kennedy, 24, 25, pl. 5, figs 5, 7, 16 [=? Digonus sp.].
1997 Arduennella maillieuxi; Müller, pp. 8, 16.
1997 Arduennella maillieuxi; Müller, p. 8, unnumb. figs [lapsus calami].
1998 Arduennella maillieuxi; Schratt, pp. 64, 65, tab. 2, pl. 1, figs 7, 8.
2000 Arduennella maillieuxi; Schratt, pp. 381, 382, pl. 7, figs 1-6.
2004 Arduennella maillieuxi; Basse & Weddige, p. 149.
2004 Arduennella maillieuxi; Jansen et al., p. 64, pl. 1, fig. 9.
2004 Arduennella maillieuxi; Jansen et al., p. 65 [lapsus calami].
2004 Arduennella maillieuxi; Müller in Basse & Müller, pp. 89, 90, pl. 33, 426-432, pl. 34, figs 433-443.
2005 A. maillieuxi; Sandford, tab. 1 [non UK occurrence].
2006 Arduennella maillieuxi; Basse & Franke, p. 13.
2008 Arduennella maillieuxi; Alberti, pp. 39, 40, figs 2, 3.
2011 Arduennella maillieuxi; van Viersen & Prescher, p. 8.

Discussion. Asselberghs (1923, pl. 1, figs 1-9) illustrated several cephalic and pygidial remains of this species but he did not designate a holotype. Wenndorf (1990) selected the pygidium figured by Asselberghs (1923, pl. 1, fig. 9a, b) as the lectotype while referring to its whereabouts as the Asselberghs collection of the IRSNB. At the time of writing of the present note, none of the original specimens figured by Asselberghs (1923) could be traced in the IRSNB. However, we identified two plaster casts in the Maillieux collection of the IRSNB along with a hand-written label by E. Maillieux from 1930. One of these casts (Fig. 3D) belongs to the lectotype pygidium, and the other (Fig. 3A) to the paralectotype cranidium that was figured by Asselberghs (1923, pl. 1, fig. 9). The cast of the lectotype (but also that of the external mould of the paralectotype cranidium) was made of the external mould; it is the paralectotype pygidia (Fig. 3C, H). All from the lower part of the Our Formation of B-117, Breitfeld (= type locality and horizon).
by E. Asselberghs in 1921. They should, thus, be considered part of the type series that collectively constituted the name-bearing type. These specimens were syntypes until Wenndorf (1990) selected the lectotype; as a consequence of that act they all became paralectotypes. Several specimens are illustrated in the present note.

Casts of the types figured by Asselberghs (1923) along with hand-written labels by K.-W. Wenndorf are kept by the Senckenberg Institute (AVV, pers. comm. with M. Basse in September 2019); one of these, a cast of the internal mould of the lectotype, was figured by Müller (in Basse & Müller, 2004, pl. 33, fig. 426). Searches by the authors of the present note in the

Figure 3. Trilobites from the lower part of the Our Formation at B-117, Breitfeld. A-H. Arduennella maillieuxi (Asselberghs, 1923). A. Plaster cast of paralectotype cranium, IRSNB a13441, in dorsal view. B. Paralectotype internal mould of a cephalon, IRSNB a13442, in dorsal view. C. Paralectotype internal mould of a pygidium, IRSNB a13443, in dorsolateral view. D. Plaster cast of lectotype pygidium, IRSNB a13444, in dorsal view. E. Paralectotype external mould of a pygidium, IRSNB a13445, in dorsal view. F. Paralectotype internal mould of a fragmentary cephalon, IRSNB a13446, in dorsal view. G. Paralectotype external mould of a pygidium, IRSNB a13447, in dorsolateral view. H. Paralectotype internal mould of a pygidium, IRSNB a13448, in lateral view.

I. Wenndorfia sp. Internal mould of an incomplete cephalon, IRSNB a13449, in dorsal view.

J. Asteropyginus gen. & sp. indet. External mould of a fragmentary pygidium (digitally inverted), IRSNB a13450, in dorsal view.

All scale bars represent 5 mm.
The morphology of *Arduennella maillieuxi* was documented by Wenndorf (1990), Müller (in Basse & Müller, 2004) and Alberti (2008) mostly based on material from Germany. In our opinion, the conspecific relationship of the specimens from the Belgian and various German localities is not certain. A revision of *A. maillieuxi* would be timely but is beyond the scope of the present note (AVV, in preparation). In addition to previously published descriptions, the presence of numerous small pits on the internal moulds of pygidia (e.g. Fig. 3H) is mentioned by us. The external moulds (e.g. Fig. 3E, G) show the impressions of similarly distributed pits, dorsally on pygidia and cephalia which suggests that the two are associated. From this we deduce that *A. maillieuxi* may have had pit-tubercles with pore canals (cf. Størmer, 1980, p. 243, fig. 1d). The apparent absence of these pits in the German material may be due to unfavourable taphonomic conditions. Alberti (2008, p. 39, fig. 2) illustrated a cranium from the Rhenish Mountains (Taunus) that shows distinct lateral glabellar lobation. This feature is weakly developed in the specimens from the Rhenish Mountains (Westerwald) figured by Müller (in Basse & Müller, 2004, pl. 34, figs 433, 435-437, 440, 443); it is absent in the specimens from Breitfeld. The reconstructions of Wenndorf (1990, p. 141, fig. 56) and Müller (in Basse & Müller, 2004, p. 89, fig. 7) show a narrow glabella anterior to S0; this feature is widened (tr.) in the reconstruction by Alberti (2008, p. 40, fig. 3). The slender base of the pygidial terminal spine in Alberti’s reconstruction is probably more similar to the Belgian material than is the broad spine in Wenndorf’s and Müller’s drawings. Our line drawing (Fig. 4) was based on the reconstruction by Alberti (2008) and subsequently modified to emphasise the broad glabella, the long occipital spine, and the elongated subtriangular pygidium with posteriorly tapered and cylindrically vaulted (tr.) axis, in order to characterise the topotypical material from Belgium.

Basse & Müller (2016) pointed out that Kennedy’s (1994) pygidia of *A. maillieuxi* from England are possibly deformed *Digonus* specimens. Kennedy (1994) commented on the incompleteness of his specimens but argued that they show trademarks of this species nonetheless. The only feature mentioned by him to potentially support that assignment is the acuminate terminal piece of one pygidium (Kennedy, 1994, pl. 5, figs 7, 16). However, that specimen has the elongated triangular terminus of a *Digonus* pygidium with a short, sharply pointed, upward curved tip; it does not resemble pygidia of *Arduennella* from the Ardenno-Rhenish Mountains. The previous standpoint of Basse & Müller (2016) is therefore supported by us. Thus, the occurrence of *Arduennella* in England, despite the presence of strata to potentially bear its members in terms of age and lithology, is at least doubtful.

Basse & Müller (2016) suggested that Schraut’s (1998, 2000) pygidia of *A. maillieuxi* from the Pragian in Morocco could be representatives of the “*Digonus ornatus ornatus group*”. The distinctly vaulted (tr.) axis in the figures of Schraut (2000, pl. 7, figs 1b, 2b), especially posterior to the last pleurae where it rises high above the pleural lobe, is typical of *Arduennella* and not known to us from any *Digonus*. Schraut’s specimens are here regarded as a potentially new species of *Arduennella*.

**Genus Wenndorfia Sandford, 2005**

*Type species*. *Homalonotus mutabilis* Koch, 1880 from the Emsian of Germany.

**Wenndorfia sp.**

(Fig. 3I)

v 1921 *H. planus*; Asselberghs, p. 142 [as a species of *Homalonotus*].

v 1923 *Homalonotus planus*; Asselberghs, p. 29.

v 1927 *H. planus*; Asselberghs, p. 209.

**Material.** IRSNB a13449, internal mould of a partial cephalon, from the lower part of the Our Formation of B-117, Breitfeld.

**Discussion.** *Wenndorfia* appears to be a rare trilobite in the Breitfeld locality with but a single cephalon available for study. Based on its age and general morphology this specimen might be assigned to *Wenndorfia plana* (Koch, 1883) from coeval strata in the Rhenish Mountains but its poor preservation precludes a definite assignment. Of note are the fine pits on the glabella of our cephalon.

**Genus Burmeisterella Reed, 1918**

*Type species*. *Homalonotus* (*Burmeisteria*) *elongatus* Salter, 1865 (a primary homonym replaced with *Burmeisterella neoelongata* by Basse, 2007) from the Emsian of England.

**Discussion.** *Burmeisterella* is widely distributed in Pragian to Emsian strata in the Ardenno-Rhenish Mountains. A single species, *B. aculeata* (Koch, 1883), is known from the Pragian which has comparatively small spines. It was followed up by several species in the early Emsian, appearing successively in the fossil record but with overlapping stratigraphic ranges (Fig. 8). This diversification is accompanied by an increase of spine sizes and numbers in some species, perhaps in response to durophagous predation pressure from cephalopods or gnathostomes.

Besides these general trends, members of *Burmeisterella* show moderate variations of the dorsal spine patterns that sometimes overlap between species, making the current classification far from satisfactory. Müller (in Basse & Müller, 2004) commented that the identifications of isolated sclerites are not rarely equivocal. Indeed, single cranidia or pygidia can be assigned to *B. armata*, *B. aculeata* or *B. vixarmata* Wenndorf, 1990, depending on their spine patterns. Nonetheless, Müller (in Basse & Müller, 2004) considered spine pairs on the pygidial axis to be characteristic of *B. aculeata* and two pairs of spines on the pygidial pleurae (one on the first, and another on the third, fourth or fifth pleurae) to be characteristic of *B. armata*. A disarticulated complete specimen (exuvia of *B. armata* from the lower Emsian (presumably Our Formation) of Consthum, Luxemburg, figured by van Viersen & Prescher (2009, pl. 5, fig. 4), however, combines spines on the first and fifth pairs of pygidial pleurae as well as spine pairs on the pygidial axis. Such seemingly random (at least until more data become available) disparities lead us to hypothesise that in some...
species of *Burmeisterella* gene expression of dorsal spines may not have been strictly regulated. The inclusion of spine patterns in species diagnoses is a potential source of confusion and probably best avoided for taxa involved.

*Burmeisteria* (Digonus?) *delattrei* Pillet & Waterlot, 1983 from the upper part of the Vireux Formation (late lower Emsian) in Vireux-Molhain, northern France, was recognised as a member of *Burmeisterella* by Sandford (2005). The specimens figured by Pillet & Waterlot (1983, pl. 4, figs 1-16) have shallow lateral glabellar furrows and show only single spines on the L1 lateral glabellar lobes and on the first pair of pygidial pleurae. These same features were considered by Wenndorf (1990) and Müller & Alberti (2010) to be diagnostic of *Burmeisterella vixarmata* from the Klerf Formation (late lower Emsian) in Luxemburg and the Eifel. This leads us to regard *B. vixarmata* as a junior subjective synonym of *B. delattrei*.

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**Burmeisterella quadrispinosa Wenndorf, 1990**

(Figs 5, 6)

1921 *Homalonotus aculeatus*; Asselberghs, p. 142.
1921 *H. Champernownei?* (sic); Asselberghs, p. 142 [as a species of *Homalonotus*].
1923 *H. aculeatus*; Asselberghs, p. 29.
1923 *H. Champernownei?* (sic); Asselberghs, p. 29.
1927 *Homalonotus aculeatus*; Asselberghs, p. 209.
2009 *Burmeisterella quadrispinosa*; van Viersen & Prescher, p. 8, pl. 5, fig. 5.

Material. IRSNB a13451, internal mould of a cranidium (Fig. 5A), IRSNB a13452, internal mould of a thoracopygidium (Fig. 5B), IRSNB a13453a+b, external and internal moulds of

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**Figure 5. Burmeisterella quadrispinosa Wenndorf, 1990 from the lower part of the Our Formation at B-117, Breitfeld.**

A. Internal mould of a cranidium, IRSNB a13451, in dorsal view. B. Internal mould of a thoracopygidium, IRSNB a13452, in dorsal view of thorax. C. External mould of a pygidium, IRSNB a13453a, in dorsal view. D. Internal mould of a pygidium, IRSNB a13453c (on same rock slab as IRSNB a13453a), in dorsal view. E. Internal mould of a cephalon, IRSNB a13454, in dorsal view. F. Internal mould of a pygidium, IRSNB a13453b (counterpart of IRSNB a13453a), in dorsal view. G. Internal mould of a pygidium, IRSNB a12691, in dorsal view.

All scale bars represent 10 mm.
Treveropyge hellemondi sp. nov.  
(Fig. 7)

v 1921 Cryphaeus Drevermanni ab. (sic); Asselberghs, p. 142.
v 1923 Cryphaeus Drevermanni (sic); Asselberghs, p. 29.
v 1927 Asteropyge Drevermanni (sic); Asselberghs, p. 209.
cf. e.p. 2006 Piletina luxemburgensis Basse, Müller & Franke, pp. 248-250, pl. 1, figs 6, 7 [only SMF 58703b].

Etymology. Named after Anthonie Hellemond, in recognition of his contribution to Belgian palaeontology.

Holotype. IRSNB a13457a+b, external mould of a pygidium plus plaster cast (Fig. 7D-F).

Paratypes. IRSNB a13455a+b-c, internal and external moulds of a cephalon plus plaster cast (Fig. 7A, B), IRSNB a13456a+b, internal and external moulds of a cephalon (Fig. 7C) and IRSNB a13458, external mould of a pygidium (Fig. 7G). All from type locality and horizon.

Type locality and horizon. B-117, Breitfeld; lower part of the Our Formation, lower Emsian.

Diagnosis. S2 well-developed, even abaxially. Entire glabella covered with densely spaced, very fine granules. Eye moderately small; about 26 dorsoventral files with maximally 8 lenses per file (±26/8). Weakly inflated anterior and posterior pygidial pleural bands. Interpleural furrows narrow (exsag.) but developed throughout.

Description. Cephalon weakly vaulted. Anterior border narrow in front of glabella with weakly developed anterior ledge. Length (sag.) of glabella anterior to S0 slightly greater than width (tr.) across frontal lobe. Axial furrows firmly incised, straight between S0 and S2, abaxially arched near L3 and frontal lobe. S0 firmly incised. Lateral glabellar furrows S1 anteriorly curved adaxially, deep; S2 and S3 more or less straight, moderately firmly impressed. Occipital ring about as wide (tr.) as glabella across L3. Lateral glabellar lobes L1 narrow (exsag.); L2 much larger (exsag.) than L1, of subtrapezoidal outline; L3 slightly larger (exsag.) than L2, of subtrapezoidal outline. Frontal glabellar lobe well demarcated anteriorly and laterally by distinct grooves. Median portion of glabella between occipital ring and anterior lobe not sunk. Librigenal field broadening (tr.) posteriorly, especially beyond δ; bearing a mixture of shallow pits and fine, dense granulation; weakly vaulted (tr.). Lateral border dorsally flattened; lateral border furrow narrow. Fixigenal field bearing similar sculpture as librigenal field. Posterior border furrow broadest posterior of eye. Genal spines short.

Thorax is unknown.

Pygidium of rounded triangular in outline. Axis comprises up to 11 rings; anterior six rings successively narrowing (tr.) backwards, separated by firmly impressed inter-ring furrows; remaining rings barely tapering backwards, separated by increasingly shallow interring furrows. Six pairs of distinct, straight, successively shorter pleurale with rib segmentation of the prorotundifrons-type. Proximal end of sixth pleura meets seventh axial ring. Faintly curved, dagger-shaped pygidial pleural spines, about as long as associated pleural ribs. Terminal lappet with broad basis; short, with sharp, upward directed tip. Pygidium covered with densely spaced, fine granules.

Discussion. Treveropyge prorotundifrons from the lower Emsian of the Eifel differs from the new species in having a narrower (tr.) glabella anterior of S0 with coarser and less densely spaced granulation, larger eyes with maximally 12 lenses per dorsoventral file, a narrower (tr.) librigenal field lateral of the eye, shallow S2, more anteriorly directed S3 that is connected with axial furrow without shallowing, more inflated (exsag.) pygidial pleural bands, and longer, narrower pygidial pleural spines.

Basse et al. (2006) described a new species, Piletina luxemburgensis, based on pygidia and a cephalon from the Our Formation in Luxemburg. These workers selected a large

Family Acastidae Delo, 1935
Subfamily Asteropyginae Delo, 1935

Genus Treveropyge Struve, 1958

Type species. Asteropyge (Asteropyge) prorotundifrons Richter & Richter, 1943 from the Emsian of Germany.
pygidium as the holotype while mentioning striking similarities between their paratype cephalon and that of *T. prorotundifrons*. Basse et al. (2006) argued that their cephalon could also be a *Treveropyge* but chose to include it in *P. luxemburgensis* instead. Likewise, the pygidia and cephalas from Breitfeld have not been found associated yet they are assigned to a single new species. These specimens are generally similar to known *Treveropyge* species (pygidia and cephalas alike), especially to its type species, and we see no reason to doubt that they are all congeneric. Our specimens represent the only asteropygines in the Breitfeld locality with the exception of a single pygidial fragment of indeterminate yet clearly different generic identity (see below). The cephalon of *P. luxemburgensis* is similar to those of *T. hellemondi*: given their stratigraphic proximity these specimens might be conspecific or at least closely related. The pygidium of *P. luxemburgensis* is easily discriminated from that of *T. hellemondi* in having distinct median nodes on the axial rings, deeper pleural and interpleural furrows, and longer and much more robust pleural spines and median lappet.

**Asteropyginae gen. & sp. indet.**

(Fig. 31)

**Material.** IRSNB a13450, external mould of a fragmentary pygidium, from the lower part of the Our Formation of B-117, Breitfeld.

**Discussion.** A single pygidial fragment is available which has posteriorly directed rings in the posterior part of the axis; each ring bears a median tubercle. This specimen is not a *Treveropyge* but may belong to *Dunopyge Struve* in Becker & Jansen, 1998 or, less probably, to *Pilletina* Haas, 1970. All these genera are known from early Emsian strata in the Ardenno-Rhenish Mountains.

4. **Biostratigraphy**

The current and previously published data on trilobites from Belgium, Luxemburg and northern France enable the first rudimentary steps towards Emsian biostratigraphic correlations based on trilobites (Fig. 8).

Firstly, it is important to underline the Pragian age of the trilobites recorded from the “Quartzophyllades de Longlier” in the Longlier area (Fig. 2A), Neuflückéaute Syncinorium, by van Viersen & Prescher (2009). As pointed out by Dejonghe (2013, 2019), the Longlier and Amonines facies of the mid-Pragian Villé Formation pass laterally into one another, and the usage of the Longlier Formation as proposed by Vandenven (1990) is unnecessary.

4.1. **Emsian trilobites in Belgium, Luxemburg and northern France**

Breitfeld trilobite association; Breitfeld, Belgium; Our Formation, probably lower part: *Arduennella maillieuxi*, *Burmeisterella quadrispinosa*, *Treveropyge hellemondi*, *Wenndorfa* sp. and *Asteropyginae gen. & sp. indet.*

Reideschbaach trilobite association; Reideschbaach, Luxemburg; Our Formation, probably basal part: *Paralepidoploeoetus cf. acroductyla* (Haas, 1968), *Luxemburgcoryphae lunkhenheimeri* Basse & Franke, 2006, *Cyphaspis* sp., *Wenndorfa plana* (Koch, 1883) ssp., *Burmeisterella cf. quadrispinosa*, *Spiniscabraella* sp., *Acastava faberi* Basse & Franke, 2006, *Pilletina luxemburgensis* Basse, Müller & Franke, 2006, *Pilletina oeslingiana* Basse & Franke, 2006, *Rhenops australocustos* Basse, Müller & Franke, 2006, *Braunops? sp. and Leonaspis? sp.* See Basse & Franke (2006) and Basse et al. (2006).

Burg Reuland trilobite fauna; Auf Schleid quarry near Burg Reuland, Belgium; Our Formation, probably upper part: *Digonus ornatus ornatus* (Koch, 1883), *Rhenops cf. index* (Richter & Richter, 1943), *Treveropyge cf. prorotundifrons* and *Acastava* sp. See Franke (2006). A preliminary study of the macrofauna including the trilobites was published by Hellemont et al. (2019). *Burmeisterella delattrei* (Pillet & Waterlot, 1983), upper part of the Vireux-Molhain, France; Vireux Formation. See chapter Systematic palaeontology herein.

Mormont trilobite fauna; Mormont-Érêzé area, Belgium; upper part of the Vireux Formation (“grès blancs de Mormont” of Mailleux & Demanet, 1929, of restricted distribution in the area North of Amonines; see also Dejonghe, 2008): *Digonus ornatus ornatus*, *Burmeisterella armata*, *Acastava* sp. and *Treveropyge* sp. Specimens in the Mailleux collections were examined by one of us (AVV) and will be described in a future paper.

Vireux trilobite fauna; Vireux-Molhain, France; Chooz Formation (“schistes rouges de Winenne” of Mailleux, 1932): *Digonus intermedius* (Viétoir, 1919), *Digonus mosanus* (Mailleux, 1932) (synonymy of *D. mosanus* with *D. intermedius*) was proposed by Wenndorf, 1990 but subsequently rejected by van Viersen, 2015, and *Acastava cf. schmidtii* (Richter, 1909).
See Maillieux (1932) and van Viersen (2013). Marche trilobite association; disused quarry near Grimbliémont, Belgium; Hierges Formation (or Hierges–Hampteau complex according to the revised geological map). Acastava lerougei van Viersen, 2013, Delocare sp. and Treveropyge sp. See van Viersen (2013).

Olloy trilobite occurrence; Olloy-sur-Viroin, Belgium; Hierges Formation: Leonaspis? sp. See van Viersen (2013).

4.2. Comparisons to the Rhenish Mountains

As pointed out previously by van Viersen & Prescher (2009) the Breitfeld association includes two index fossils for the lower Emsian in the Rhenish Mountains. These are Arduennella maillieuxi (Ulmen and Singhoen groups) and Burmeisterella quadrispinosa (Ulmen to Vallendar groups).

The Burg Reuland trilobite fauna is known from ex-situ finds in the Auf Schleid quarry. The association of Digonus ornatus ornatus, Rhenops cf. index, Treveropyge cf. prorotundifrons and Acastava is known from the Gladbach Schichten in the Eifel (Vallendar Group). This is consistent with the viewpoint of Franke (2006) who suspected a Vallendar age for this quarry although he attributed it more specifically to the Klerf (Clervaux) level with the much more diversified trilobite fauna of the lateral Wiltz Formation in the Eifel and Luxemburg (Franke, 2010).

The Olloy trilobite occurrence is based on a single odontopleurine specimen that almost certainly belongs to Leonaspis. Putative congeners furthermore occur in the lateral Wiltz Formation in the Eifel and Luxemburg (Franke, 2010).

5. Palaeobiogeographic affinities of the Breitfeld trilobite association

The Breitfeld association does not contain any trilobite genus that is exclusive of the Ardenno-Rhenish Mountains. Treveropyge also occurs in Spain and possibly in France and Morocco (Basse, 2003). Members of Wenndorfia are widely distributed in (peri-) Gondwana, i.e., in Morocco (Schraut, 2000), the Czech Republic (Chlupáč & Kolář, 2001; van Viersen & Prescher, 2009), New Zealand, Turkey, Poland, France (Sandford, 2005), Romania (Iordan, 1981) and Portugal (Caprichoso, 2019). Burmeisterella, which is a characteristic component of homalonotid faunas along the southern margin of Laurussia, was recently reported in Brazil (de Carvalho, 2005) and in Portugal (AVV, pers. comm. with C. Caprichoso in February 2018; Caprichoso, 2019). These records extend its palaeogeographic distribution to Gondwana. Despite many claims by fossil dealers on the Internet, Burmeisterella is not known to occur in Morocco; all those specimens appear to be amalgamated Scabrella or Spiniscabrella parts or complete falsifications. The absence of Burmeisterella in Morocco is arguably due to unsuitable facies there. There is a stratigraphic gap between the earliest occurrences of members of Arduennella in the Pragian of Morocco (Schraut, 2000) and the Ardenno-Rhenish Mountains (lower Emsian). Based on these data it has to be assumed that Arduennella is of Gondwanan origin and that a member migrated to the southern margin of Laurussia in the late Pragian or early Emsian. In this respect the recognition of Arduennella in the Emsian of Romania (peri-Gondwana) by Basse & Müller (2016) (see Iordan, 1981, pl. 19, fig. 7) is worth mentioning.

De Baets et al. (2013) concluded that the first appearances of early ammonoids in the Our Formation in Burg Reuland and more or less coeval localities in the Rhenish Mountains might be related to a regional transgressive event basally in the Singhoen Group rather than a global transgression (Becker & Kullmann,
We are grateful to these persons for their support. In our work, we have benefited from the astute review comments provided by M. Alberti (Landesamt für Geologie und Bergbau Rheinland-Pfalz), M. Basse (Senckenberg Institute) and B. Delcambre (Université catholique de Louvain). Scarcity of data is also an important factor here; this is due to a general sampling bias for Early Devonian strata in the Ardenno-Rhenish Mountains that is possibly poorly preserved for trilobites.

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